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Final Report

DEVELOPING STRATEGIC SYSTEMS SUPPORTING COMMUNITIES OF

PRACTICE IN THE GEORGIA DEPARTMENT OF TRANSPORTATION

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Abstract

This study is designed to explore strategies through which the Georgia Department of Transportation (GDOT) can develop communities of practice to help employees facilitate critical exchanges of knowledge, support organizational learning, and ultimately achieve improvements in performance outcomes. Communities of practice (CoP) are groups of professionals working on behalf of an organization who develop on-going informal knowledge exchanges as a means of learning about and performing key job-related processes and skills. The study consisted of four main objectives: 1) to map the incidence of CoP in GDOT, 2) to monitor patterns of knowledge flows through CoP, 3) to assess the costs and benefits of CoP, and 4) to develop a strategy for application of SharePoint to the development of CoP. The study was conducted using multi-method research including interviews across key agencies, a communications log and workshops with GDOT professionals. A number of existing types of CoP were identified. Through a communications log, knowledge exchanges were mapped and communication patterns were established according to a typology of five CoP characteristics. Six groups of communication patterns were identified with varying degrees of CoP intensity (weak or strong CoP communications). Weak CoP communications are associated with knowledge search costs, while strong CoP communications are associated with knowledge validation and application costs. It is recommended that GDOT tailor its strategy of enhancing communication within the organization by addressing the different needs of weak and strong CoP communications. To reduce knowledge search costs, it is recommended that GDOT conduct a knowledge needs assessment and centralize and enhance expertise information into a common directory. SharePoint utilities may assist with various aspects of this functionality. To reduce the costs associated with validating and applying knowledge, it is recommended that GDOT pursue a strategy of systemically building CoP through a combination of social networking, face-to-face training, on-line documentation of official policy statements and standards, and the dissemination of information and training sessions as changes occur in standards.

Keywords: Communities of Practice, Knowledge Management, Retention, Strategy

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Introduction

This research is designed to explore strategies through which the Georgia Department of Transportation (GDOT) can develop communities of practice to help employees facilitate critical exchanges of knowledge, support organizational learning, and ultimately achieve improvements in performance outcomes. We define communities of practice (CoP) as groups of professionals working on behalf of an organization who develop on-going informal knowledge exchanges as a means of learning about and performing key job-related processes and skills. Those public agencies that have embraced the idea of CoP tend to do so as part of a larger knowledge management agenda of transforming traditional bureaucratic organizations into learning organizations and developing strategies for knowledge retention and management (Snyder, Wenger, and Briggs, 2004).

Public agencies have experienced a growth in interest in supporting CoP (Snyder, Wenger, and Briggs, 2004). Several factors contribute to the urgency felt in human resources offices to develop effective knowledge management and learning strategies (Luen and Al-Hawamdeh, 2001; Desouza, 2009). Chief amongst these is the graying of the public sector work force (Elliott, 1995; DeLong, 2004). To address this issue, public agencies have struggled with the development of effective strategies for transferring knowledge across generations. Communities of practice are seen as one way of holding onto key sources of information by cultivating the transfer of information and learning among informal groups of professionals (DeLong and Davenport, 2003).

Another challenging factor stimulating agencies to develop knowledge management and learning strategies is the dramatic increase in outsourcing of key functions of agencies to the

private or non-profit sectors. It is common now for agencies to rely heavily upon portfolios of contracts or through a mixed portfolio of work conducted in-house and work conducted by consultants, contractors, and/or vendors.   This has led to a broadening in the skill sets demanded of agency professionals to include expertise in contract management. At times the balance can shift precariously away from subject matter expertise to contract management expertise. CoP can be used as a venue for pooling the knowledge and expertise from both the agency and the larger contractor community (Koliba, 2006).

In the public sector, there are also growing calls for the development of CoP that span the federalist system, linking professionals at different levels (Agranoff, 2006). These studies harken back to older narratives in the intergovernmental relations literature such as "picket fence federalism" (Nice & Fredericksen, 1995: 13-14) and ideas concerning policy networks (Heclo, 1978). An important theme to emerge out of this research is the call for strategic collaboration across the federalist layers and amongst the broader stakeholder community (Agranoff and McGuire, 2001; Vanka, Handy, and Kockelman, 2005; Fu, Mayhew, Bailey, and Shoup, 1997; Bryson, Crosby, and Stone, 2006).

Often when agencies explore CoP, they do so in the context of innovative applications of information technology (IT). Consequently, in the original proposal for this research project, we linked our study of strategies for the development of CoP with the development of IT applications (specifically GDOT's efforts to expand the use of SharePoint). We anticipated this linkage might be strong since much of the research literature on CoP explores not only the types of learning engendered through CoP but also the role of IT applications in facilitating the learning. An example of this linkage can be seen in the study of the Federal Highway Administration's efforts to develop CoP across transportation agencies through an application of

SharePoint (Winsor et al., 2004).   This linkage between CoP and IT can be seen in the goals and objectives set forth in the research proposal:

> "The goal of this research project is to develop a strategy for effectively implementing the SharePoint system as a resource to develop, support and build CoP within GDOT and with GDOT's strategic partners. To build this strategy, we will develop an inventory of existing CoP within GDOT and assess the efficacy of current patterns of knowledge flows within the organization. In doing so, we will examine whether flows of knowledge that employ CoP are more effective and efficient. We will also examine the current barriers and facilitators to the use of SharePoint by communities of practice in GDOT and develop a strategy for insuring a match between the information technology support for CoP and the management processes CoP members are involved with."

Early in the study, we observed many knowledge exchanges currently operating within GDOT that have properties normally associated with CoP that are operating independent of IT applications.   In this study, we continue to pursue the original goals of the research project. However, the evidence taught us not to assume that the development of IT applications is a necessary condition, and certainly not a sufficient condition, for the development of CoP.

While the interest in communities of practice is growing, less is known about the source and development of these associations. Studies have found that these groups often develop organically through ties of mutual self-interest that connect individuals from several offices in one or many organizations. Communities of practice can also emerge through cultivation by public agencies (Callahan, 2004) as they attempt to manage land assets and transportation resources (Vanka et al. 2005).   Many researchers suggest that organically developed communities (i.e., those generated solely by participants) buttressed with an effective virtual hub (also developed organically) are more likely to be effective vehicles for knowledge transfer and retention. However, the quality of evidence for this finding is limited.   There has been

limited research on the strategies used by informal groups or by organizations to build informal knowledge exchanges into thriving communities that are important to on-going operations.

Another persistent weaknesses of CoP both in the research literature and as human resource practice is a limited understanding of the pathways through which communities connect to the productive enterprises of an agency. Many CoP studies explore only whether individuals are learning by engaging with a CoP. They do not examine whether this learning is being applied in an effective way to the productive purposes of the agency.

This study attempts to address these weaknesses in the research literature and practice examining strategies that might be used to develop communities of practice. We address this problem through four research tasks:

Task 1: Map the incidence of CoP in GDOT. Our goal in this task was to answer the following questions: Are there existing CoP operating within GDOT? Are there existing patterns of communication and knowledge exchanges that can be developed into CoP? Because CoP have often been observed as informal arrangements operating alongside the standard operating procedures and organizational structures, we cannot assume that management is aware of the full range of CoP or nascent CoP that may be in operation. During the course of this investigation we found one fully functioning CoP in operation within GDOT. We also found four groups of current patterns of knowledge exchanges that GDOT personnel said exhibited three or more of the characteristics of a CoP. We explain in detail the structure and function of these various knowledge exchange types in this report.

Task 2: Monitor patterns of knowledge flows through CoP. Our goal in this task was to answer questions about the nature of existing knowledge exchanges within GDOT. We were interested in the degree to which managers participating in exchanges believed that they were part of an

on-going informal group whose membership was relatively stable and identifiable. We were also interested in ways in which these exchanges were used to contribute to the Plan Development Process (PDP) and to the productive work of the agency. We observed considerable variance across the knowledge exchanges with regards to these two properties. However, strong evidence emerged that when managers participate in these exchanges, it is often in pursuit of knowledge that is critical to solving problems and advancing the work of projects.

Task 3: Assess the costs and benefits of CoP. In our third task, we sought to compare the ease with which managers participating in existing CoP were able to access and apply information as compared to those not participating in CoP. Here, we compared the reports of managers participating in knowledge exchanges that exhibit many of the properties of a CoP with managers participating in less developed knowledge exchanges.

Task 4: Develop a strategy for application of SharePoint to the development of CoP. At the outset of this project, the research team was aware that SharePoint is a new software technology to the agency. Thus, our focus in this task was upon identifying those aspects of SharePoint functionality that might be used to enhance the development of CoP. Early in the project, the data demonstrated that there was a wide variety of nascent CoP operating within existing patterns of knowledge exchange. Consequently, the strategies associated with SharePoint functionality must be contingently matched to the needs of the knowledge exchanges. Most importantly, while we found that SharePoint can be usefully applied, it was not the only factor vital to the development of CoP within GDOT.

Multiple research methods were used in this study as a means of identifying the incidence and influence of CoP within GDOT (for a fuller presentation of the research methods,

the appendix provides examples of the protocols used in this research). We began by conducting 21 semi-structured interviews with senior and mid-level managers within GDOT offices that make direct contributions to the PDP. From these interviews, we received nominations of 12 possible groups that exhibit patterns of communication and knowledge exchanges that may be CoP.

We also conducted a survey of GDOT personnel by asking them to maintain a log of their key communications associated with knowledge exchanges for a week. The logs were designed to inform the following:

1. identify knowledge exchanges that may have properties of CoP

2. identify the ways in which these knowledge exchanges take place

3. understand the costs and benefits of the knowledge exchanges

4. understand the effectiveness of the knowledge exchanges

During the semi-structured interviews, we identified 34 key personnel who may be engaged in CoP. From this base, we conducted a snowball sample asking a series of GDOT respondents over three phases to nominate possible CoP and individuals affiliated with these groups. Unlike the selection of interview respondents, we did not limit the survey to participants in the PDP. Our goal was to explore the natural spread of these communities. The nomination process quickly spread to include individuals working in offices not normally associated with PDP operations. This process yielded 623 individuals affiliated with potential CoP. From this list, we eliminated individuals who had retired, are not GDOT employees, or where there was an indication of a desire not to participate. The final sample frame consisted of 515 individuals working for GDOT.

Workshops of 12-20 individuals were also conducted (and are continuing to be conducted by design) in which small groups of managers participated, who participated in the communication log. The workshops were designed to provide clarification and validation of findings from the interviews and the survey. Thus, the workshops covered the same four themes used in the communications log survey. However, in a small group setting, respondents were given the opportunity to reflect and compare notes on their experiences.

This report provides the findings from each of these tasks. In the next section of the report, we review the research literature on CoP as a means of identifying key concepts used throughout the study. We then discuss the findings associated with each of the tasks associated with the study. The concluding section provides a review of the key findings of the research and recommendations on strategies for developing CoP.

Lessons from the Research Literature on Communities of Practice

Communities of practice have been billed as a new discovery growing out of the emergence of the "Web 2.0" organization or the "learning" organization. Although the term "communities of practice" did not enter the academic literature until the 1990s, it develops themes that have been present in studies of organizational behavior and public management for decades. Perhaps the most obvious thematic connection is with the concepts of the informal organization (Barnard, 1938; Burns and Stalker, 1961). The informal or organic organization refers to the structure of associations among employees that is distinct from the formal hierarchy. Employees form these associations to advance their own mutual interests, which are distinct from and sometimes adverse to those of the organization (Burns and Stalker, 1961: 98-101).

The informal organization operates alongside formal organizational structures and processes. The formal organization provides a roadmap to professional workers of the sanctioned procedures that an organization uses in the production of outputs (Udy, 1959: 792-793). The formal structure is embodied by a hierarchy that provides a superstructure of relationships between offices and functions that are then linked through standard operating procedures (SOP). The hierarchy and the SOPs represent a form of institutional memory of hard won lessons of practices. In principle, these officially sanctioned practices are designed to allow the organization to achieve desired outputs while complying with those external demands identified by senior management as having high salience to the organization (Pfeffer and Salancik, 1974; Perrow, 1986; Weber, 1947; Mintzberg, 1979; Stinchcombe, 1965; Thompson, 1967). In most organizations, human resource officers and senior managers exert great pains to make a record of the formal organization and to disseminate this record.

Communities of practice are a more recent contribution to the narrative of the informal organization. Wenger et al. (2002) describe communities of practice as informal groups of professionals from different offices in one or many organizations who share an interest in a professional practice and exhibit a passion for improving their skills associated with that practice. A key feature of such communities is that their members consult with each other on a regular basis to learn how to improve their skills related to a professional practice. Community members may also ask each other for help in solving problems that they encounter in their work related to the focal practice.

Wenger's description provides a useful lens for understanding how CoP function. Several key characteristics of communities of practice are important to this study (see Table 1 for a summary of characteristics). First, CoP function as informal networks. Membership in

these networks can exhibit considerable variability with regards to the frequency of interaction or even the institutional affiliation of the workers. Yet the communities behave as networks in that their members are self-aware that they have links with one another and in that these links are predicated upon a shared interest in the social exchange of knowledge concerning a professional practice. In the public sector, CoP have been found in a variety of settings from the military (Palos, 2007) to transportation agencies (Winsor et al., 2004) to the Australian Civil Service (Callahan, 2004). CoP in each setting are loose networks of individuals trying to learn how to do something better, whether that something is a skill set associated with Air Force manpower, high performance concrete, or knowledge management in the public sector.

Table 1: Attributes of Communities of Practice

Informal interaction between members (i.e. communication and knowledge exchanges are not required by procedures or the organization's reporting structures)
Participants are highly motivated to improve their professional capabilities in a practice
Participants are drawn from across the organizational chart or even across organizations
Participants are aware that there is a group of individuals who share their interest in a practice
Participants share information and exchange knowledge through the group on a regular basis (at least more than once a year)

A second characteristic of CoP is that the social exchange of knowledge becomes an important component of the work lives of some participants (Wenger et al., 2002). This is generally expressed through the level of "passion" or "intensity" with which participants are committed to their communities of practice (Kwon, Pardo, and Burke, 2009; Pan and Leidner,

2003; Scarbrough and Swan, 1999). In some cases, the focus of the passion is upon the practice itself. Such professionals are so intensely interested in a practice that they are driven to seek social exchanges of knowledge as a means of growing their skill base. In other cases, the focus of the passion is upon building communities: professionals seek to identify other resources that can be called upon to help them in their work and also seek spaces in which they can share their knowledge and build their own reputations as resources for others to seek out. These are not mutually exclusive interests: professionals can be passionate about both gaining skills and building communities. Under these circumstances, CoP can become focal points through which professionals gain a significant sense of meaning and purpose in their work (Brown and Duguid, 1991; Wenger, 1998; Davenport and Hall, 2002; Gherardi and Nicolini, 2002).

A third characteristic of CoP is that they facilitate learning. One of the greatest interests of researchers engaged in the study of communities of practice is identifying instances of learning within these communities. This interest in learning stems from the origin of the term "communities of practice" in a study of situated learning among insurance claims processors (Lave and Wenger, 1991). In that study, Jean Lave and Etienne Wenger argued that communities of practice enabled legitimate peripheral participation. That is, newcomers to CoP participated on the sidelines and then moved toward the center of these groups as their base of knowledge surrounding the practices of interest increased. This conceptualization of social or situated learning draws on earlier ideas of socialization, enculturation, and tacit knowledge (Brown and Duguid, 1991).

A fourth characteristic noted in the literature is the organic nature of the organization of communities of practice. Participants develop CoP as a means of facilitating learning and problem solving. This means that the organization of the communities and the maintenance of

knowledge gained through the communities are dependent upon professionals dedicating time and effort to these tasks. Even though they are not required to do so for their jobs, participants frequently dedicate time and effort to the organization and maintenance of communities of practice. In fact, the early literature on CoP argued that the very bottom-up, grassroots nature of CoP created the vitality and power necessary to foster rich learning environments. However, more recent research on CoP has found that many organizations not only approve of CoP but also devote time and resources to community operations (e.g., Gongla and Rizzuto, 2001).

An important resource in the organization of many CoP is the existence of an information technology backbone for facilitating knowledge exchanges and storing key information sources. For example, the Federal Highway Administration (FHWA) recently used Microsoft SharePoint as an anchor for multiple communities of practice (Winsor et al., 2004). The online SharePoint communities employed site administrators to remove inappropriate or irrelevant content and site facilitators with expert credentials to ensure that questions were answered quickly (Winsor et al., 2004: 93). The FHWA found that having a regulated electronic space helped facilitate communication between transportation professionals in different states and in different levels of government (Winsor et al., 2004: 94). Having a virtual space for communities of practice is a sufficiently important topic that there is a thriving sub-literature within journals related to human computer interface, knowledge management, library sciences, communications, and information studies that focus exclusively on quantitative analyses of the electronic records of communities of practice (e.g., Garcia and Donohovich, 2005; Wasko et al., 2009; Gadja and Koliba, 2007; Henri and Pudelko, 2003).

A CoP is not entirely populated with passionate individuals eagerly communicating with each other about the latest and greatest that they have discovered in their work. Such an

environment would be exhausting after a period of time. CoP are also populated by less passionate people who find participation in knowledge exchange useful. This pattern of participation was found in the Federal Highway Administration study (Winsor et al., 2004). Peripheral participation is vital to the on-going health of a community because it ensures that the community has a greater reach in terms of the number and type of participants. Larger communities allow participants to solve a larger array of problems by sharing a wide variety of experiences in adapting a practice to different work contexts.

The research literatures exploring CoP provide important concepts that we use in this study. Chief amongst these are strategies for identifying the existence of a community of practice. In this study, we examine networks of actors who are engaged in regular exchanges of knowledge as a necessary but not sufficient condition that a CoP exists. We also examine whether the participants are self-aware that they are participating in a community of actors who are exchanging knowledge. In effect, we can identify boundary conditions for CoP.

Where we depart from the CoP literature is with regards to the dependent variable. Individual and community learning are the dependent variables most frequently found in studies of CoP, although they may not be labeled as such in research of a more interpretative tradition. This has led to laments in reviews of the literature that communities of practice need to be studied in a way that links this phenomenon to the productivity of the organization (Fox, 2000; Kimble and Hildreth, 2004; Koliba and Gadja, 2009). In this study we attempt such an exercise.

Task 1: Mapping the Incidence and Nature of CoP in GDOT

As a first step in the research project, we set out to identify existing CoP within GDOT that are relevant to the PDP.

In the research literature, CoP are defined as having the following attributes:

- They (i.e. CoP) emerge as "bottom up" phenomena and self-organize

- There is a growing sense of mutual engagement amongst participants around key tacit knowledge applications that define it as community

- They coalesce around shared interpretations of the tacit knowledge in question

- They have an identifiable set of shared tools that are often developed within

We set out to empirically identify these communities of practice as the first stage in the research. To assist us in identifying existing CoP in GDOT, we created of an advisory board comprised of GDOT officers who have a stake in the development of CoP. The advisory board served as a node of access and feedback as our research progressed.

In developing the inventory of CoP, we also explored the ways in which individual CoP fit into the larger PDP. The basic unit of analysis in this study is the CoP. However, the work of members of CoP is organized through projects that navigate the various phases of the PDP. It is important to map the scope and coverage of CoP within the PDP process. Understanding how knowledge from the CoP is accessed by projects as they move through the phases of the PDP is an important element of this research. We, therefore, made an early distinction between practice-based knowledge exchange (which we identified with CoP from the literature) and project-based knowledge exchanges.

In mapping the relationship between CoP and the PDP, we asked several key questions including: a) What is the concentration of CoP within and across phases of the PDP? b) Taking a sample of current projects, what percentage access CoP as they move through the PDP? We set out these questions to identify a map of existing communities focusing on several key criteria: the incidence of communities of practice, the size and scope of the communities, the degree to which important knowledge sources regarding practice are contained within or external to GDOT, and the criticality of individual nodes within the CoP both as an information conduit and as a quality control point for the accuracy of the knowledge shared.

Interviews Results

To assess the incidence of CoP, we conducted interviews across a range of GDOT offices starting with recommendations from the advisory board. We asked each interviewee for further recommendations for interview candidates. In this way, we created a snowball sample of interviewees.

In total, we conducted 21 semi-structured interviews. The duration of interviews lasted from 45 minutes to 1.25 hours. Our interviews have yielded a variety of perspectives on GDOT and the role of knowledge and information in work. The following three tables summarize our findings.

Table 2. GDOT Groups Identified as Communities of Practice

Name	Description
GIS users' group	GDOT has approximately 450 installations of arcGIS. The SharePoint team site has about 380 visitors with permissions, 200 of whom are active. Overall, these 200 users of the SharePoint site make about 17,000 visits per month to the site. Users click through to the SharePoint site via emails from a listserv. GIS users are drawn from many offices, including Transportation Data, Government Services, Traffic Operations, and Planning.
Monthly design group workshops	Once per month, a design group hosts other groups in a knowledge sharing workshop. Groups pick their own topics. The workshops started in August 2010.
Practical design training	Experienced engineers teach new hires about the four disciplines of roadway design: geometric design, pavement design, drainage design, and capacity analysis. It took 18 months to develop the material. Each cohort of new engineers develops lasting relationships within the group. There are about 6 engineers per cohort.
Construction inspectors	We've heard of lasting ties among construction inspectors within and beyond GDOT.
Maintenance engineers	GDOT maintenance engineering managers statewide hold monthly meetings to discuss issues and solve problems. They communicate across districts to share equipment and resources.
Traffic signal staff and contacts	There is a tight-knit group of 5 traffic signaling staff and contacts who talk to one another often to share best practices and solve problems.
Middle managers	Individuals at a higher rank seem more likely to consult with others of their rank outside their office to solve problems.
Institute of Transportation Engineers (ITE)	Institute of Transportation Engineers. National association with a Georgia chapter. Monthly face-to-face meetings are formal lunches with invited speakers.
Intelligent Transportation Systems (ITS)	Intelligent Transportation Systems. National association with a Georgia chapter. Monthly face-to-face meetings.
Regional Traffic Operations Task Force (RTOTF)	Regional Traffic Operations Task Force. This is a working group created to exchange best practices. Each meeting focuses on a single topic of interest to the group, such as traffic signal clearance intervals. The meetings occur anywhere from monthly to quarterly to annually, based on demand. About 40 people attend each meeting, mostly from GDOT and local agencies. The facilitator of the task force sends out meeting minutes after each meeting.
NEPA Analysts	NEPA analysts at GDOT consult with one another and with their counterparts at the FHWA in order to best interpret the guidelines of the National Environmental Policy Act.
Archaeologists	Archaeologists at GDOT frequently work together in order to improve their practices in identifying and preserving Georgia's archaeological artifacts.

As can be seen in Table 2, during our interviews GDOT employees identified a number of

groups that exhibit the properties of CoP. Drawing from the research literature, we employed

several criteria to describe these groups. Table 3 provides a summary of the evidence from the interviews regarding the following criteria:

Members refers to the number of individuals associated with the group. There was considerable variance in size of the groups reported ranging from a high of 200 members for the Geographic Information Systems (GIS) group to the small group of 5 members reported for the Traffic Signals group. In some cases respondents did not know the full size of the group. When evidence was lacking, we leave the cell blank in Table 3 (as we do for other criteria).

Formality refers to whether the group operates as part of a formal operating procedure within GDOT or functions as part of the hierarchic reporting structure of GDOT.

Practice describes the subject content of the knowledge that is exchanged through the group.

Exchange describes the types of communication channels that are most frequently used by group members to exchange knowledge. The most common forms were through email, phone, and face-to-face communications. We also examined the use of SharePoint as this is a resource that GDOT is attempting to promote as a means for knowledge management and exchange.

Self-Aware describes whether the members of the group think of themselves as having an affiliation with a distinct group of professionals. Alternatively, the members could view their exchanges as communication between co-workers absent a group identity.

The characterizations of each community can be seen in Table 3.

Table 3. Features of GDOT's communities of practice

Name	Members	Formality	Practice	Exchange	Self-Aware
GIS users' group	200	Informal	Geographic information systems	SharePoint	Yes
Monthly design group workshops	20	Formal	Topics within design	Face-to-face	Yes
Practical design training	6	Formal	Geometric design, pavement design, drainage design, capacity analysis	Face-to-face	Yes
Construction inspectors		Informal	Inspection		
Maintenance engineers		Informal	Maintenance engineering		
Traffic signal staff and contacts	5	Informal	Traffic signal engineering	Face-to-face, phone	Yes
Middle managers		Informal	Management	Face-to-face, phone, email	
Institute of Transportation Engineers (ITE)		Formal	Transportation engineering	Face-to-face	Yes
Intelligent Transportation Systems (ITS)		Formal	Intelligent transportation technology (e.g., Georgia Navigator)	Face-to-face	Yes
Regional Traffic Operations Task Force (RTOTF)	40	Formal	Topics within traffic operations (e.g., traffic signal clearance intervals)	Face-to-face	Yes
NEPA Analysts		Informal	Interpretation of the National Environmental Policy Act (NEPA)	Face-to-face, email	
Archaeologists		Informal	Identification and preservation of Georgia's archaeological resources	SharePoint, face-to-face, email	Yes

With these characterizations, we were able to group these communities into a typology according to their level of communication and their practice or problem based orientation. These results can be seen in Figure 1.

Figure 1. Typology of GDOT's communities of practice
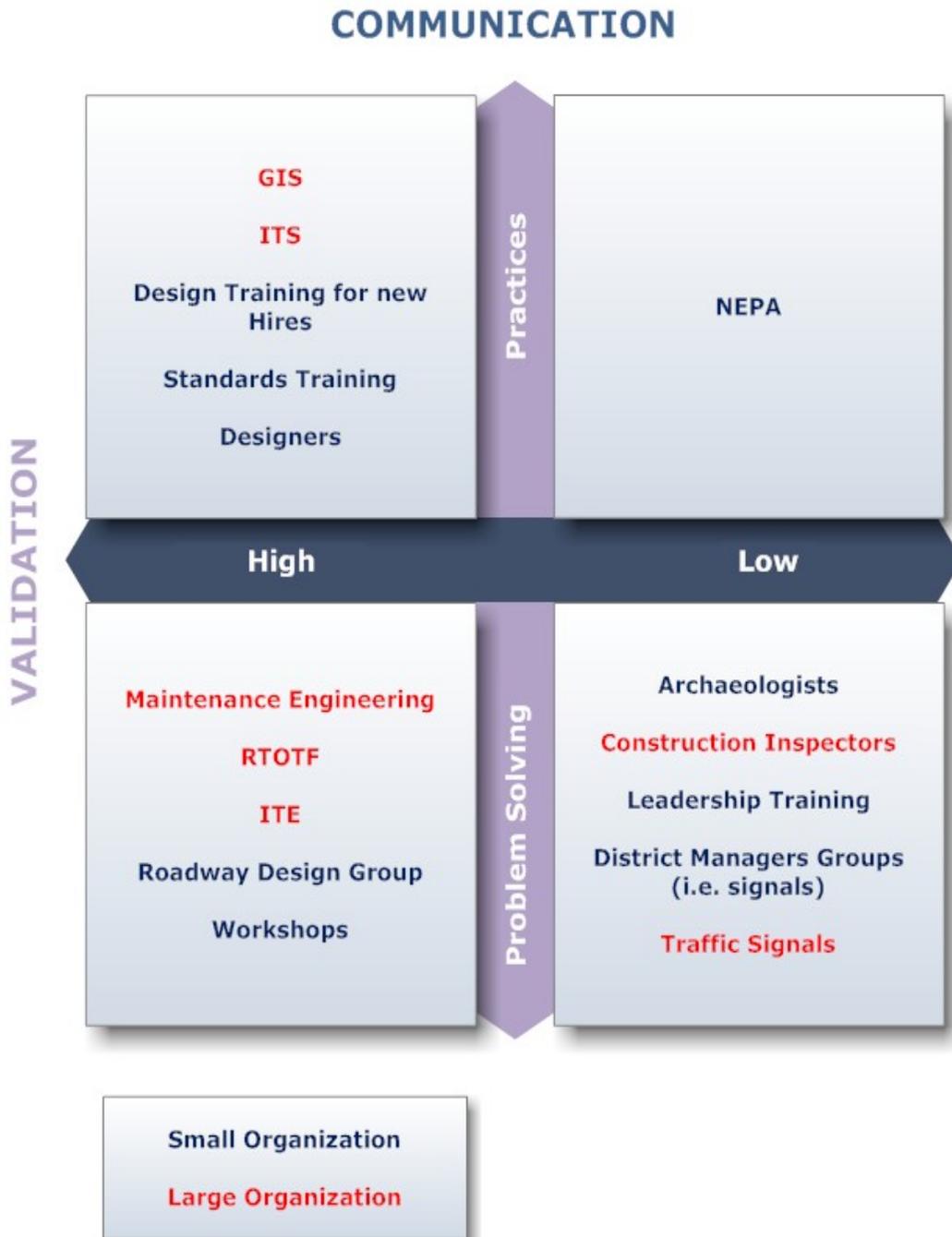
In the top left quadrant of Figure 1, we placed CoP which had highest level of communication within the organization, and which were practice oriented. The GIS users group is an excellent example. The group has an online website and forum of discussion that is managed, monitored, and validated by a GDOT manager. Groups in the left bottom corner were also highly active within the organization but focused more on problem solving. On the right side of the diagram, we identified groups, which were less active. We only identified one group, the NEPA that appeared to be practice oriented (top right quadrant). The majority of groups that were less active were more problem oriented (bottom right quadrant).

The CoP typology demonstrates that a range of CoP exists within the organization. Our interview data suggest that these varying CoP have different support requirements. Problem oriented groups like the archeologists and traffic signals groups form naturally and require little organizational support. More practice oriented groups that are highly active like the GIS are time and energy intensive and require significant organizational support. We also distinguished among the size of the groups. Interestingly, most small CoP are less active, whereas most large CoP have higher levels of communication. This suggests that to support larger CoP, it requires more administrative and other organizational resources, whereas the organization may be able to encourage smaller informal groups through other techniques.

To better understand these communication types and knowledge exchange needs within the organization, we set out to map and differentiate knowledge exchanges through the communication logs.

Analysis of the Communication Logs

Most of the communities of practice identified in the interviews were also identified in the communication logs. The logs confirm the fact that these groups exist within the

organization and function as communities of practice. We identified several other CoP through the communication logs as can be seen in Table 4.

Table 4. *COP Identified in Interview and in the communication log surveys:*

1. GIS users' group   ☑ also in Survey

2. Monthly design group workshops   ☑ also in Survey

3. Practical design training   ☑ also in Survey

4. Construction inspectors

5. Maintenance engineers   ☑ also in Survey

6. Traffic signal staff and contacts   ☑ also in Survey

7. Middle managers leadership groups

8. Institute of Transportation Engineers (ITE)   ☑ also in Survey

9. Intelligent Transportation Systems (ITS)   ☑ also in Survey

10. Regional Traffic Operations Task Force (RTOTF) ☑ also in Survey

11. NEPA Analysts   ☑ also in Survey

12. Archaeologists   ☑ also in Survey

Knowledge Exchanges

The communication logs gave us rich information on the types of exchanges of knowledge.   A descriptive analysis of the raw data reveals insights into communication patterns within the organization.

In the log, we asked respondents to record of knowledge of a technical or professional nature. As can be seen in Table 5, out of 335 respondents, 254 recorded at least one knowledge

exchange over the course of the week. The majority of respondents had 2 to 3 knowledge exchanges over the course of the week. However, close to 10% had as many as 4 exchanges, which suggests a considerable frequency of technical and professional knowledge exchange occurring in GDOT on a daily basis.

Table 5. Knowledge Exchanges over the course of the week

Days with exchanges	None	One Day	Two Days	Three Days	Four Days	Five Days
# Respondents	81	97	68	52	28	9

We also asked respondents to identify who had initiated the contact. The majority of responses (60%) were individuals seeking rather than giving knowledge, which suggests that this type of knowledge exchanges occur when an individual needs information for a task (Table 6).

Table 6. Percentage of Respondents who initiated the knowledge exchange

We asked respondents whether the individual with whom knowledge was exchanged, shared responsibility for a task. The majority of respondents (80%) indicated that they shared

responsibility for a task (Table 7). This suggests that knowledge exchanges are within teams that

share common task responsibilities.

Table 7. Percentage of respondents who exchanged knowledge with someone who shared responsibility for a task
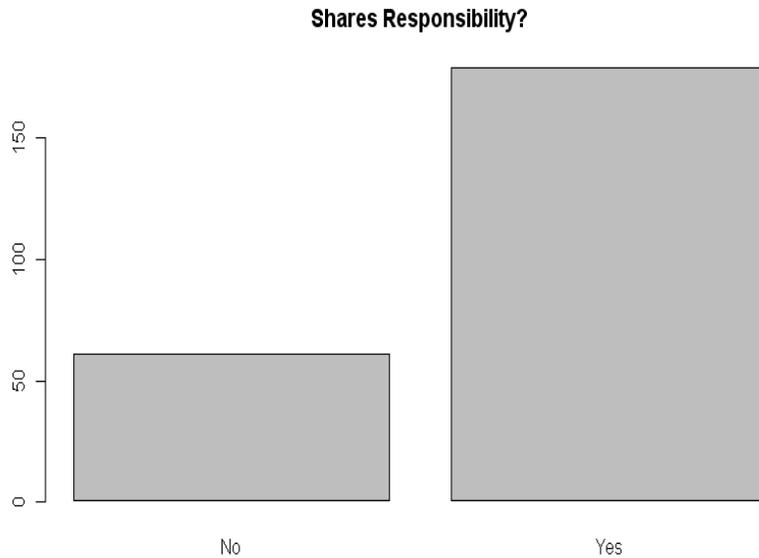
Similarly, when asked if the knowledge exchange required expertise outside of a team,

the majority of respondents (63%) indicated that it did not (Table 8). This also suggests that

most knowledge exchanges are team specific and most likely focused on project work.

Table 8: Percentage of knowledge exchanges that required expertise outside of the team

Need Expertise Outside Team?
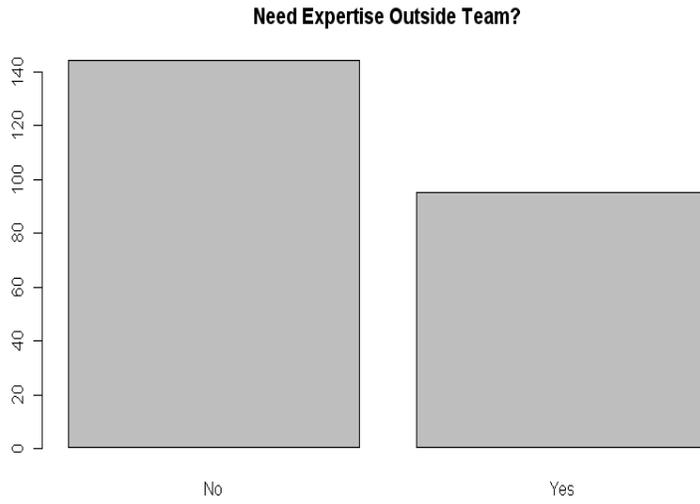
Finally, with respect to the urgency of the communication that was exchanged, most respondents (80%) indicated that the task on which they were working could not be completed without the information that was exchanged (Table 9).

Table 9. Percentage of respondents that could not complete a task without the knowledge that was exchanged

Could Task Be Redesigned?
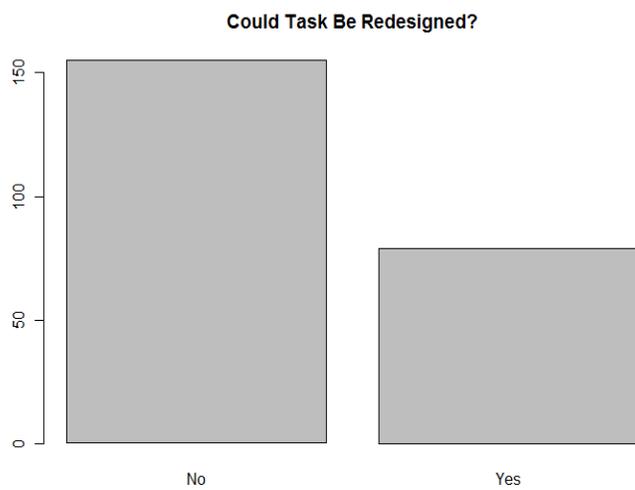
Taken together, these results indicate that the technical or professional communications, which are being exchanged in GDOT are frequent, urgent and time and cost intensive in that employees need the information exchange to complete work. Communities of practice are not necessarily the most efficient ways to exchange this type of knowledge. Rather, as was indicated from our interviews, it seems GDOT could benefit from a system through which knowledge is more efficiently organized. In interviews, communication logs, and workshops, respondents indicated the importance of identifying sources of knowledge, and a lack of information about who holds what knowledge within the organization. This could be addressed through more centralized and updated databases of personnel and personnel expertise.

Analyzing Communication Patterns associated with Communities of Practice

To better understand both communication types and communication needs within the organization, we also analyzed the types of communications respondents associated with CoP. Incidents of CoP were analyzed in the logs through a five-point metric that identified characteristics of communities of practice including: informality, practice improvement motivation, organizational reach, awareness of practice, and frequency of communication. Respondents were instructed to reflect on the communication from this week that most strongly resembled communication with a community of practice. They were asked to check which attributes are consistent with a community of practice:

- o informal interaction between members (i.e., the communication is not required by procedures or the organization's reporting structures) [INFORMALITY]
- o participants are highly motivated to improve their professional capabilities in a practice or skill set [PRACTICE MOTIVATION]
- o participants are drawn from across the organizational chart, or even across organizations [ORGANIZATIONAL REACH]
- o participants are aware that there is a group of individuals that share their interest in a practice or skill set [AWARENESS OF PRACTICE]
- o participants share information and exchange knowledge through the group more than once a year [FREQUENCY OF COMMUNICATION]

When evaluated independently, a high percentage (52%) of respondents indicate that the exchanges are informal, which seems to be the most significant CoP attribute in the data. The other CoP attributes are identified in about 30%-37% of exchanges (Table 10). While 35% of knowledge exchanges exhibit 3 or more attributes, only 10% of knowledge exchanges exhibit all five attributes of a community of practice. This means that communication types within the organization vary considerably, and do not necessarily need all of the support of a CoP to be enhanced and improved.

Table 10. CoP Attributes identified as characterizing respondent knowledge exchanges

COP Attribute	#	%
Informal interaction between members (i.e., the communication is not required by procedures or the organization's reporting structures)	146	52
Participants are highly motivated to improve their professional capabilities in a practice or skill set	83	30
Participants are drawn from across the organizational chart, or even across organizations	78	30
Participants are aware that there is a group of individuals that share their interest in a practice or skill set	93	33
Participants share information and exchange knowledge through the group more than once a year	102	37

Additionally, in evaluating the exchanges, we found that 61% of the knowledge exchanges that respondents associate with a CoP occur on a monthly basis or more frequently. Up to 20% occur on a daily basis, and 25% occur on a weekly basis. This means that the communications that respondents associate with CoP are frequent, and that to the extent that

these groups exist and they are highly active. Furthermore, the membership of CoP is relatively

high. Of the 274 respondents who did a fifth day log, 140 (about 50%) indicated that they know

of CoP in GDOT and 115 (40%) consider themselves members of a CoP.

The evaluation of knowledge exchanges gives us some insight into the types of

knowledge exchanges occurring, and the varying CoP intensity of these knowledge exchanges

within GDOT. To get a better sense of the patterns of these communications and to identify

needs and areas where GDOT could strengthen these nodes, we undertook a sophisticated

analysis of knowledge exchange patterns with factor and cluster analysis.

Evaluating the CoP metrics with factor analysis

We used factor and cluster analysis to analyze patterns among the five metrics when

considered together.   This analysis allowed us to identify natural groupings within the

communications described as CoP exchanges. Using factor analysis, the data clustered most

significantly according to three categories: 1) informality 2) awareness of practice, and 3)

organizational reach. Informality had the highest level of variation from the other four metrics

we evaluated.   Therefore, we first grouped exchanges according to whether they were

categorized as formal or informal. Awareness of a shared practice exhibited the second most

degree of variation, and so we ranked these exchanges next. The third strongest variant was

organizational reach, and so we then divided the exchanges by organizational reach. Using this

ranking system, the knowledge exchanges clustered into 4 groupings. Grouping 1 consists of

communications that are characterized as formal by participants.   Grouping 2 consists of

communications that are characterized as informal but not practice aware. Grouping 3 consists

of communications that are characterized as informal and practice aware, but not distributed

across organizations. Grouping 4 consists of communications that are informal, practice aware

and drawn from across organizations. Grouping 4 consists of the types of communications that
are most strongly associated with communities of practice in the literature. Figure 2 illustrates
the logic of grouping.

*Figure 2. Four Groupings of Communications According to Informality, Awareness of Practice,
and Organizational Reach*
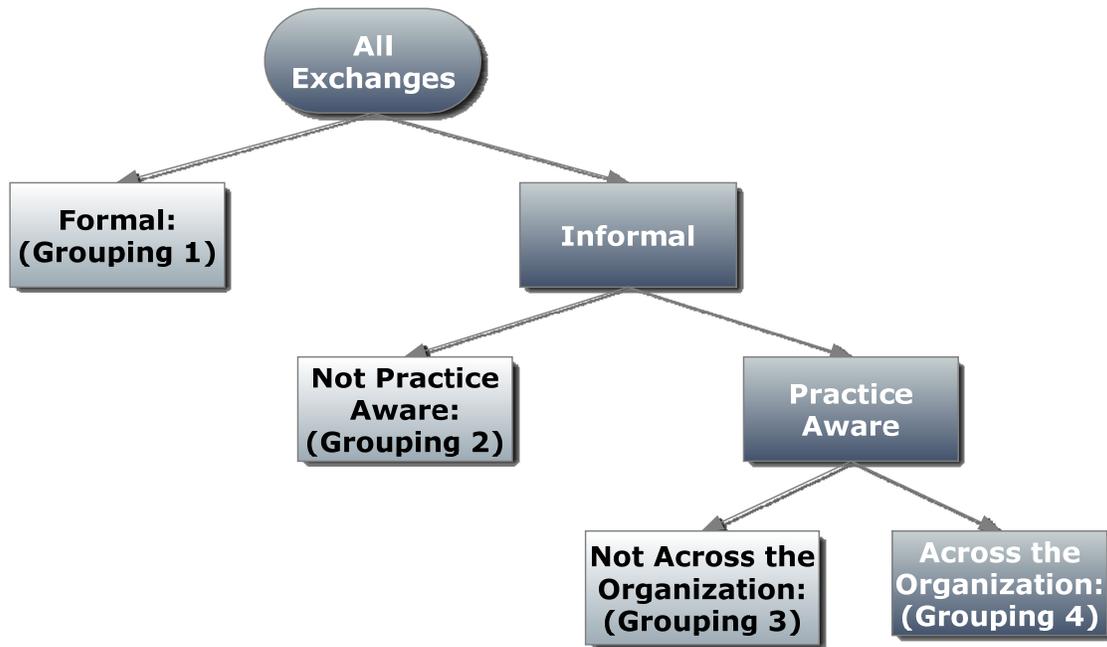
Figure 3 illustrates the frequency of communications within each grouping. The majority (40%)
of communications are informal but not with awareness of shared practices.

Percentage of knowledge exchanges across four groupings
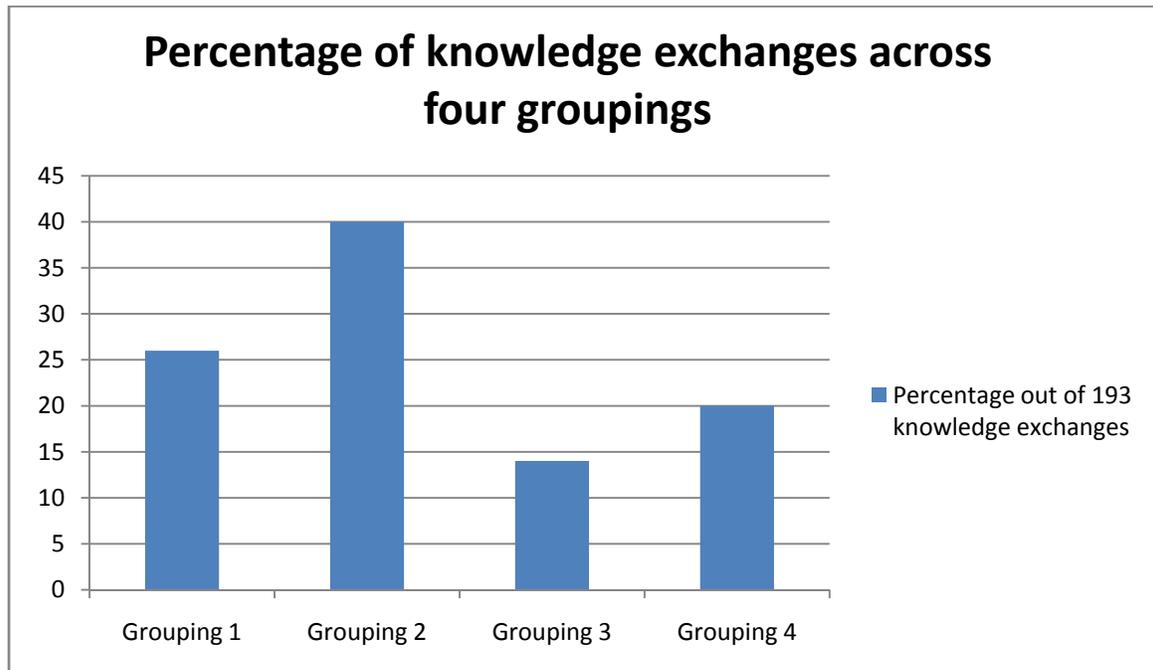
As can be seen from Figure 3, the majority (40%) of knowledge exchanges are informal but not practice oriented. However, there are also high occurrences of each of the other knowledge exchange types. What is noticeable here is the high percentage (20%) of knowledge exchanges that fall under grouping 4, meaning that they have 3 of the most significant attributes of a community of practice (they are informal, practice aware and with broad organizational reach). Figure 4 presents a summary of a detailed summary of the types of communications conducted under each grouping as described by the respondents themselves.
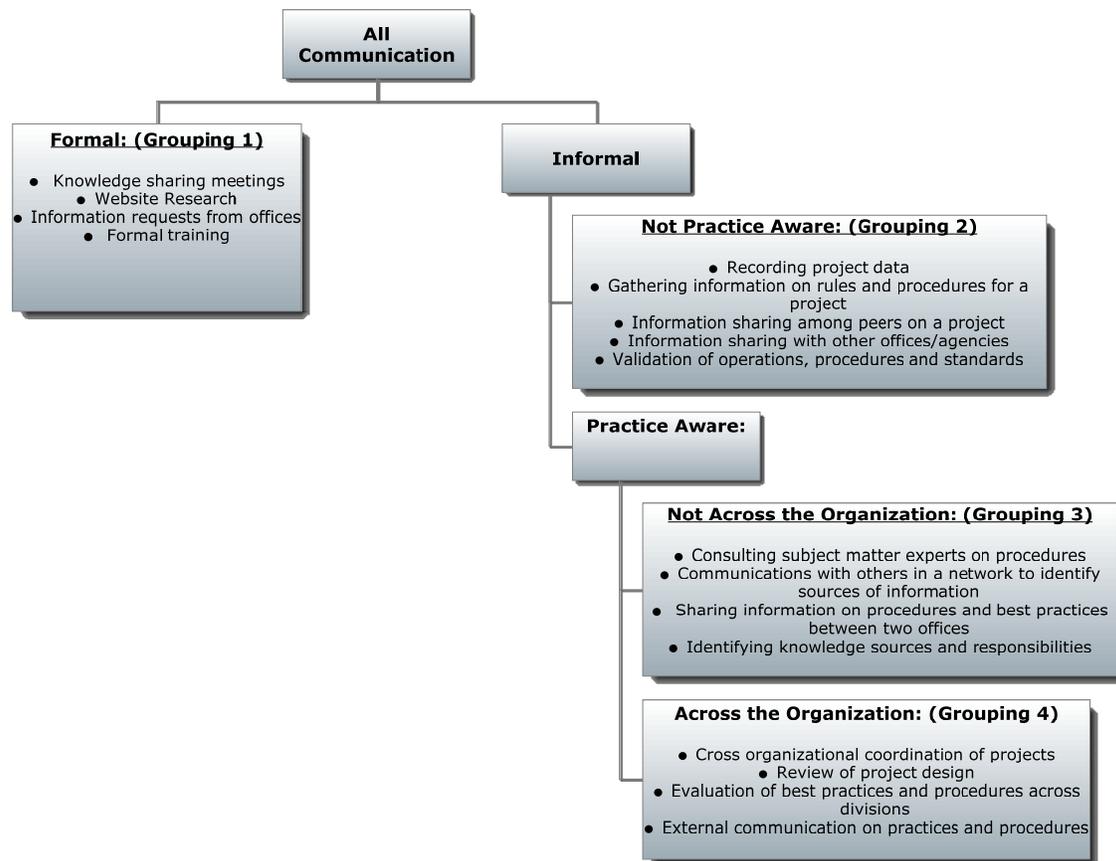
Grouping 1 consists of formal knowledge exchanges having a variety of the other four

attributes. We did not further divide this category because beyond the fact that the exchanges

were formal, they did not exhibit considerable variation across other CoP type categories. 25%

of exchanges fit within this grouping. The exchanges within this group were described by

participants as focusing on knowledge sharing in meetings, being focused on website research

and web-based forums for knowledge exchange, addressing information requests from offices,

and doing formal trainings. Within our workshops, we identified trainings and website forums

as a formal way to facilitate knowledge building and knowledge sharing, so is certainly an area GDOT could work on to facilitate formal knowledge exchanges.

Grouping 2 consists of communications, which are classified as informal but not practice aware. These groupings are most likely associated with getting information related to project work. 40% of communications fall within this grouping. These knowledge exchanges were described by participants as focusing on recording project data, gathering information on rules and procedures for a project, information sharing among peers on a project, information sharing with other offices and agencies and validation of operations, procedures and standards. In other words, these communications are informal but centered on gathering information on rules, guidelines and procedures and knowing where to identify this information. A variety of web and other interfaces like a centralized chart of personnel and expertise might better facilitate communications within this grouping. These communications are about identifying sources of knowledge, either in guidelines or in individual expertise. A lot of these communications can be facilitated through better institutional awareness of and presentation of sources of knowledge and nodes of expertise.

Grouping 3 consists of communications which are informal and practice aware, but not spread across the organization. 14% of communications fit into this grouping. Respondents described these knowledge exchanges as relating to consultation with subject matter experts on procedures, communications within networks to identify subject experts, sharing information on procedures and best practice between offices, and identifying knowledge sources and responsibilities. These communications are similar to Grouping 2 but seem to be less urgent and more about building long term stocks of knowledge, extending communication networks and sharing best practices within teams or perhaps even between offices. Here knowing other

individuals and getting to know other individuals is a strong facet of the tacit knowledge that is exchanged. GDOT might better sponsor these communications through inter-department social meetings.

Grouping 4 consists of communications, which are informal, practice aware and spread across the organization. 20% of communications fit within this grouping. The knowledge exchanges within this grouping are described as associated with cross organizational coordination of projects, review of project design, evolution of practices and procedures across divisions, and external (with other agencies) communication on practices and procedures. In other words, within this grouping the knowledge exchanges start to identify the patterns that are associated with communications of practice within the literature. As with Grouping 3, interpersonal connections are very important to these types of communications. A lot of these networks in the workshops are described as being developed in the initial engineers training for example, or through years of experience working with different parts of the organization. These longer standing networks are more difficult to establish, and may be more time intensive, but again as with Grouping 3, GDOT might better facilitate these communications through social network opportunities, both between offices, and perhaps focused on particular themes or types of expertise. Additionally, it is most likely more senior personnel who are dealing with these types of communications and so the methods used to build these networks should focus on developing mid-level managers.

Evaluating the CoP metrics across all five categories

To achieve a finer grained analysis of the communications within grouping four, the data were also analyzed across the two additional CoP measures of ranking: 4) whether the communications are motivated to improve a practice and 5) whether the communications are

frequent (as occurring more than once a year). Using these additional rankings, 6 groupings were established (the first 3 original groupings) and 3 new groupings from further division of the original Grouping 4. Here Grouping 4 consists of communications, which are informal, practice aware and drawn from across organizations, but not motivated to improve practice. Grouping 5 consists of communications which are informal, practice aware, spread across organizations, and motivated to improve practice but infrequent. Grouping 6 represents communications, which have all 5 metrics of CoP and are most closely associated with CoP in the literature.

Figure 5 illustrates the logic of grouping, with the new groupings circled in red.

Figure 5. Six Groupings of Knowledge Exchange According to Informality, Awareness of Practice, Organizational Reach, Practice Motivation and Frequency.
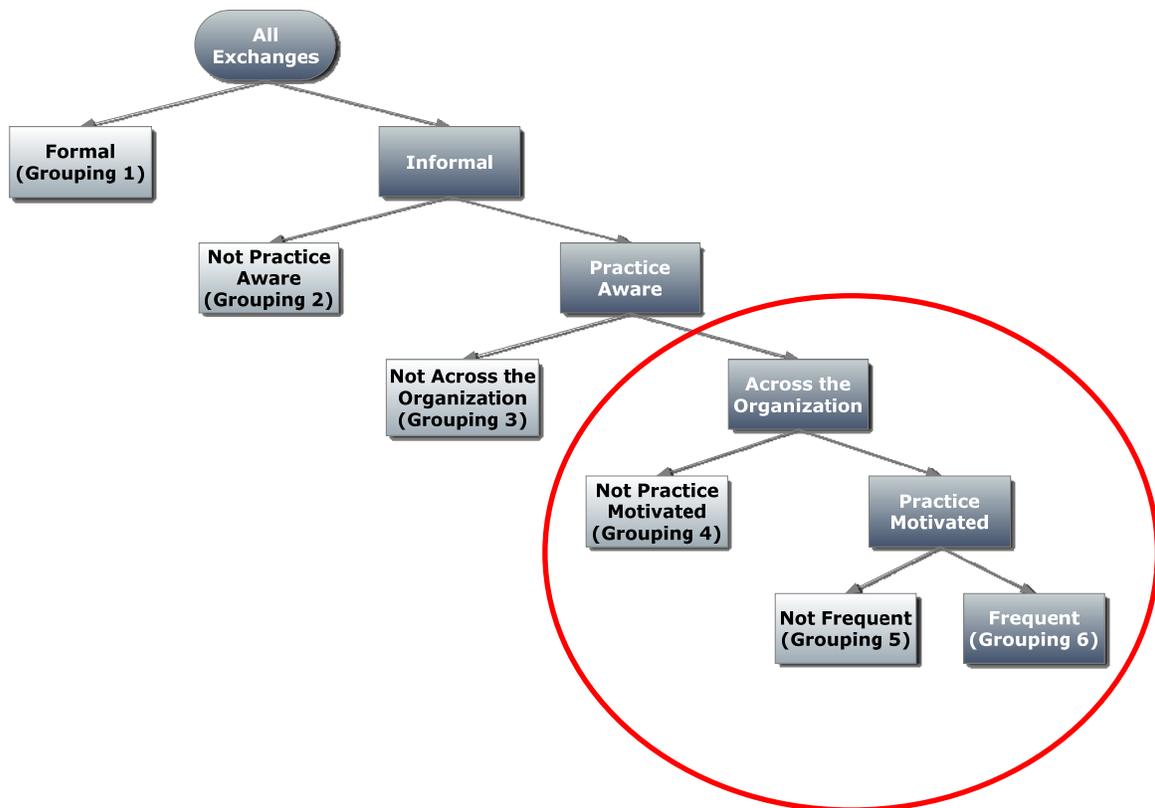
The percentage of communications falling into each of the six groupings is illustrated in Figure 6. Dividing the original Grouping 4 into 3 categories reduces the percentage of exchanges in each category but gives additional insight to the types of knowledge exchanged in GDOT. Of the 2 additional categories, the most significant groupings are Grouping 4 with 7% of communications and Grouping 6 with 10% of communications. Grouping 5 had very few communications, but also might be a category upon which GDOT should focus less attention.

Figure 6. Percentage of knowledge exchanges across six groupings of exchange type
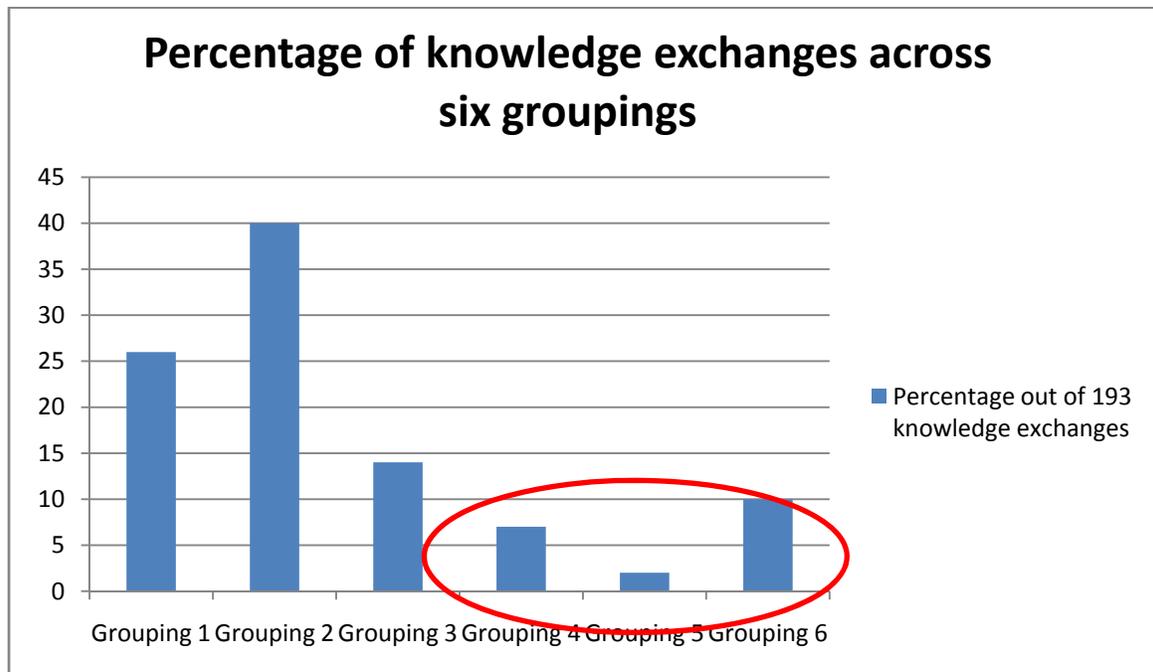
Figure 7 presents a summary of a summary of the types of communications conducted under each grouping. The new groupings are highlighted in red.

Figure 7. Summary of respondent description of knowledge exchanges under six groupings

All Communication

Formal: (Grouping 1)
- Knowledge sharing meetings
- Website Research
- Information requests from offices
- Formal training

Informal

Not Practice Aware: (Grouping 2)
- Recording project data
- Gathering information on rules and procedures for a project
- Information sharing among peers on a project
- Information sharing with other offices/agencies
- Validation of operations, procedures and standards

Practice Aware:

Not Across the Organization: (Grouping 3)
- Consulting subject matter experts on procedures
- Communications with others in a network to identify sources of information
- Sharing information on procedures and best practices between two offices
- Identifying knowledge sources and responsibilities

Across the Organization

Not Practice Motivated (Grouping 4):
- Communications across offices on procedures
- Communications outside of agency
- Multi-division communications on projects
- Evaluating projects

Practice Improvement Motivated

Not Frequent: (Grouping 5)
- Tasks related to surveying
- Training external to the organization
- IT and GIS work

Frequent: (Grouping 6)
- Cross organizational coordination of projects and procedures
- Review of project design
- Evaluation of best practices and procedures across divisions
- External communication on practices and procedures

Communities Identified
- (TIME Task Force,
- Task Team of Strategic Highway Safety Plan,
- PM and Roadway Design Group,
- Landscape Architecture Group,
- GIS (EGIS) Group

The new **Grouping 4** consists of communications, which are informal, practice aware, spread across the organization, but not motivated to improve a particular practice. 7% of communications fell into this grouping. The respondents described these communications as focusing on procedures shared across offices, communications with outside agencies, multi-division communications on projects and evaluation of projects. These communications focused on sharing procedures across organizations and outside of the agency, as well as on evaluating projects. These communications are quite specific and infrequent, and could be enhanced by GDOT through informational awareness and presentation of sources as well as nodes of knowledge.

Grouping 5 consists of informal communications that are practice aware, spread across the organization, motivated to improve practice but not frequent. There were very few (2%) communications that fell under this grouping. Respondents described communications as being very technical and focused on things like surveying, completing training external to the organization, and completing GIS and IT work. These communications have a technical requirement and should not necessarily be the emphasis of GDOT for improving communication patterns as they have a specific nature and are not likely to benefit the organization heavily through efficiency improvements.

Grouping 6 consists of communications that have all five categories of a CoP as identified in the literature. These communications are informal, practice aware, spread across the organization or organizations, are motivated to improve practice, and are frequent. A surprising 10% of communications fall within this grouping. Respondents described these exchanges as being associated with cross-organizational coordination of projects and procedures, review of project designs, evaluation of best practices and procedures across

divisions, and having external communications on practices and procedures. Additionally, a high percentage of respondents actually listed CoP within their descriptions of knowledge exchanges within this category.   These groups included the Time Task Force, the Task Team of Strategic Highway Safety Plan, PM and Roadway Design Group, the Landscape Architecture Group, and the GIS (EGIS) Group.   Communications within this grouping are typical CoP communications. They are informal, practice oriented, frequent and yet the urgency of these communications is less direct as project communications. Here again, it is likely that it is more senior professionals within GDOT engaged in these types of communications. As other data from our interviews and communications logs suggest, these communities are built over years of experience and through strong interpersonal networks.   To facilitate these types of communications, GDOT should encourage social networking among and between organizations, perhaps with a focus on particular themes. Additionally, this type of social networking and/or training should be focused on middle managers that are being developed for senior leadership within the organization.

Task 2: Monitoring Patterns of Communication and Knowledge Exchanges and CoP in GDOT

In the previous section, we observed that GDOT personnel (in both interviews and surveys) were able to identify numerous knowledge exchanges that have many if not all the attributes of a community of practice. This might lead one to think that CoPs can be encouraged through a strategy of developing missing attributes and building an IT infrastructure through SharePoint to provide greater capacity for storing and sharing key knowledge.

However, during our interviews, GDOT personnel described a more complicated reality of an organizational culture that has significant challenges associated with communication and knowledge exchanges. While respondents shared war stories of challenges that they had faced, these narratives could be organized into two classes of challenges:

Plan Development Process (PDP) Complexity Narratives: By focusing on the professional skill sets associated with the PDP, our inquiries have concentrated on those portions of GDOT work where the relationships between offices and areas of expertise are well specified into standard operating procedures. Work that flows through the PDP is organized as projects that have been approved as part of the State Transportation Implementation Plan and funded for development. Each of the offices contributing to a project through the PDP are highly regulated and required to align their work with internal rules as well as policies and procedures from outside authorities (i.e. the U.S. Department of Transportation). Each office also aligns work with professional standards set by professional organizations. However, much of the work under the PDP is also non-routine and requires considerable skill and judgment by GDOT personnel. This means that an important source of knowledge about practices within the PDP is embedded in the regulatory

code of GDOT, in external sources of professional authority, and in the tacit knowledge of experienced GDOT professionals.

Work on a project takes place over a long time horizon (months if not years) and is, for individual managers, episodic in nature. Managers describe working on portfolios of projects. At any point in time, they may be actively pushing one set of projects forward while they wait for the results of the work of other offices or consultants engaged in the PDP.

The coordination of offices over a long period of time, each of which complies with requirements governing its work, means that alignment is a key and complicated task expected of GDOT managers. It also means that practice knowledge demands a combination of expertise and authority. However, work processes in the PDP also require the application and adaptation of knowledge to the specific and local circumstances associated with the project. It is this process of aligning knowledge of expertise and authority in an adaptive problem solving fashion that defines the work practices of GDOT within the PDP.

Change Narratives: The second type of narrative that emerged in the interviews notes the tremendous challenge of coping with the numerous organizational changes that have occurred within the agency. The most frequent type of change noted by respondents stems from retirements and changes in personnel. Descriptions of knowledge exchanges that resemble CoP were often accompanied by worries about the impending loss of a key person and what the agency would do in the face of the loss of knowledge.

The second source of change most frequently mentioned is associated with the numerous changes in leadership over the last 10 years that has been accompanied by regular reorganizations. One manager described these changes like being one of the cards in a deck that was being shuffled over and over again. A consequence of these reorganizations has been

to increase the uncertainty over who has the authority for bodies of knowledge as well as the location of the expertise within the agency.

Strategies for developing CoP within GDOT will have to address the state of knowledge exchanges as described by current participants in our data. But the strategies will also have to address the challenges and barriers to knowledge exchanges that stem from the PDP complexity narratives and the changed narratives that are so worrisome to GDOT personnel. Given the nature of our study and the methods that we employed, it is more likely that we have a strong representation of the highly motivated rather than the modal person within the agency.

In the semi-structured interviews, there was convergence across respondents on the characteristics of current patterns of communication and knowledge exchanges. The following are the most frequently mentioned characteristics of these patterns:

- GDOT managers experience considerable challenges of finding the correct source of expertise. This is a non-trivial exercise as GDOT does not maintain a formal central guide to expertise within the agency.
- Most knowledge exchanges are conducted on an interpersonal basis.
- Managers confronting project problems pursue most knowledge exchanges on a need-to-know basis.
- The knowledge sought is often aimed at solving project-based problems.
- Knowledge may be seen as a source of prestige and power within the agency stemming from peer recognition.
- Knowledge is poorly retained within the agency except as tacit knowledge.
- The threat of knowledge loss is high in the minds of respondents.
- An equal threat is the application of knowledge that has not been validated by the agency.

There is a fairly large amount of knowledge exchange occurring in GDOT, as we were able to ascertain from the week-long communication log survey. From a total of 335

respondents, 254, or 76%, reported having at least one knowledge exchange and counting all occurrences including those who had several over the week, there were a total of 546 instances of knowledge exchanges that were reported and described in answering the survey questions. This represents 47% of all responses received. In other words, over the space of a week, GDOT employees tracking their communication patterns report having a knowledge exchange about half the time. Taking both the number of respondents reporting at least one knowledge exchange and the number of total reports that had knowledge exchanges, we conclude that work at GDOT is highly dependent on the knowledge exchanges that its employees engage in.

The frequency with which knowledge exchanges occur in the typical workweek reflected in the log survey is also quite high. About 62% of those who reported knowledge exchanges had at least two in the week and 35% had three or more times (as previously shown in Table 5). Taking into account that the log responses represent an undercount of knowledge exchanges because there was a slowdown of responses in days three and four due in part to a technical problem with the survey web site and the natural drop in responses due to crowding out by other activities of GDOT employees, the observation that these knowledge exchanges are a natural and frequent occurrence in the life of the organization is reinforced.

We explored the relationship of the frequency of knowledge exchanges with the age of the respondents, as a proxy for experience, to determine whether there was a connection between the two and we found, as expected, that especially the probability of the most frequent exchanges increase with age. On average, the number of days that respondents reported exchanges increased by one day per week for every five years increase in age of the respondent.

Figure 8. Days with Exchanges as a Function of Age
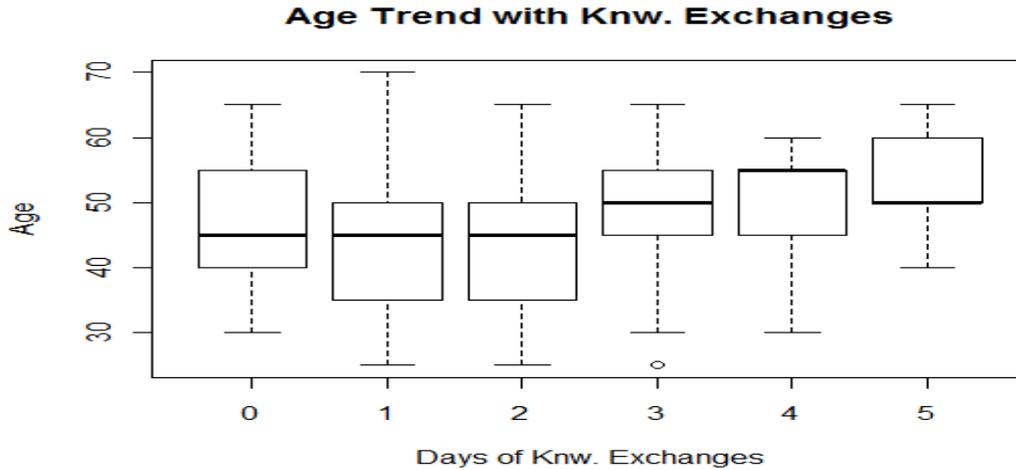

```
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)        0.869280     0.376854    2.307    0.0217 *
AGE                0.017276     0.007961    2.170    0.0308 *
```

The log survey responses also indicate a prevalent pattern of use of knowledge sources in the knowledge exchanges. There were several options to indicate the source of the knowledge drawn on for the exchange: a database, a map, a website, a Sharepoint component, an electronic file, a book, a paper file and a person. Persons were the dominant source of knowledge in these exchanges. They roughly doubled in frequency the three sources that came in at similar levels in second place, namely, databases, websites, and electronic files. Since this question requested indicating all the sources that applied, it is possible that access to the other sources were facilitated by communication with a person first, explaining why persons as sources are so much more frequent. This means that all the knowledge sources at GDOT are heavily mediated or brokered by individuals who represent key conduits to needed knowledge.

Table 11. Use of Various Knowledge Sources

Source	Database	Map	Website	SharePt	Efile	Book	PpFile	Person
Frequency	149	99	185	35	194	54	106	373

Figure 9. Frequency of Use of Sources

Frequency of Use of Sources
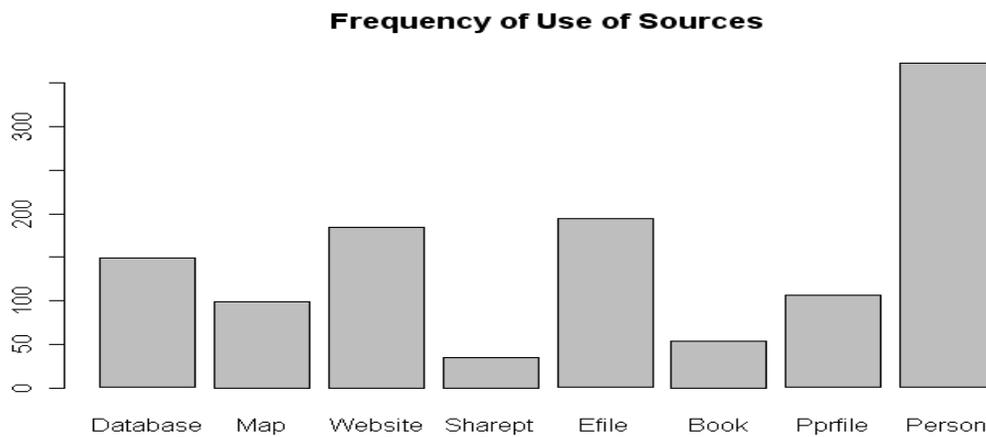
The knowledge flows detected in the log survey reveal a pattern related to the purposes for which most knowledge exchanges occur. The questionnaire asked respondents to indicate if the knowledge exchange was for solving an engineering problem, choosing an appropriate procedure, determining applicable rules for a task, finding an expert for a component of a task or determining the most useful tools for a task. The combination of inquiries on procedures and rules was the dominant purpose of these knowledge exchanges, more than tripling the purpose of solving an engineering problem. Seeking an expert or a tool was also important but at a much lower level. This result is not very surprising given that GDOT work is heavily laden with rules and prescribed procedures and that much of its technical work is written into general rules and

even state and federal law. At the same time, the importance of this result lies in the fact that it suggests ways of facilitating access to needed knowledge by focusing on key repositories of rules and procedures or on their application or "jurisprudence" if there is ambiguity in if and how they apply to current activities and projects.

Table 12. Knowledge Exchange Purposes

Purpose	Eng.Prblm	Proceedure	Rules Task	Expert Tsk	Tools Tsk	Other
	137	263	194	97	113	130

Figure 10. Frequency of Knowledge Exchange Purposes
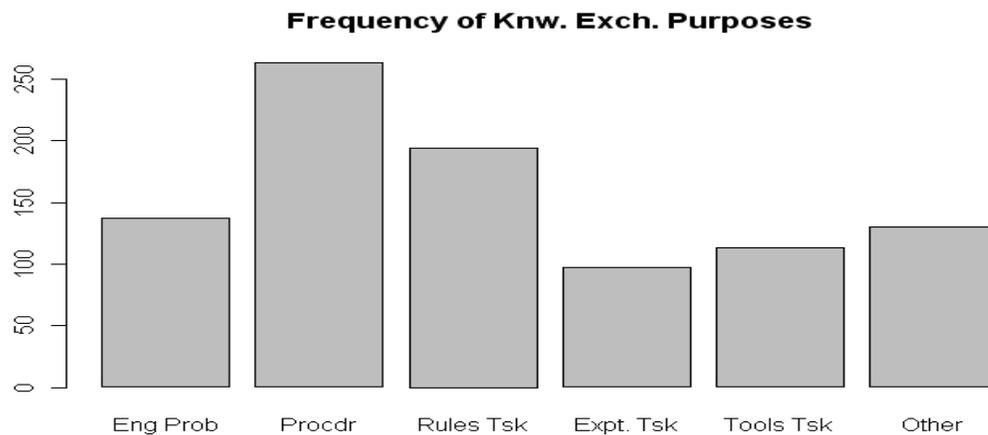
The features of the knowledge flow are further elucidated by the information on the types of knowledge that were exchanged in each instance. Respondents had a list of possibilities on this matter: standards and rules; information on standards; information on rule compliance; information on federal rules and procedures; information on GDOT rules and procedures; advice on process, information on adapting to local conditions; information on projects; information on partner organizations; information on personnel; data; maps;

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databases; and performance metrics. Consistent with the responses on the purposes of the knowledge exchanges, a cluster of types consisting of information on standards, information on rule compliance, GDOT rules and practices and federal rules and practices, captures a large fraction of knowledge types in all exchanges. Information on adaptation to local conditions, information on projects, maps and databases complete the picture on information types. This finding reinforces the observation that the importance and applicability of rules and practices of various sorts are at the core of the content of knowledge exchanges in the organization.

Table 13. Types of Knowledge Exchanged

Rules	Info on Standards	Compliance	Federal Rules	GDOT Rules	Process	Local Conditions	Projects
3	197	155	118	295	1	126	253

Partner Orgs	Personnel	Data	Map	Data Bases	Perf. Metrics	Other
73	62	0	123	207	62	107

Figure 11. Frequencies of information type consulted
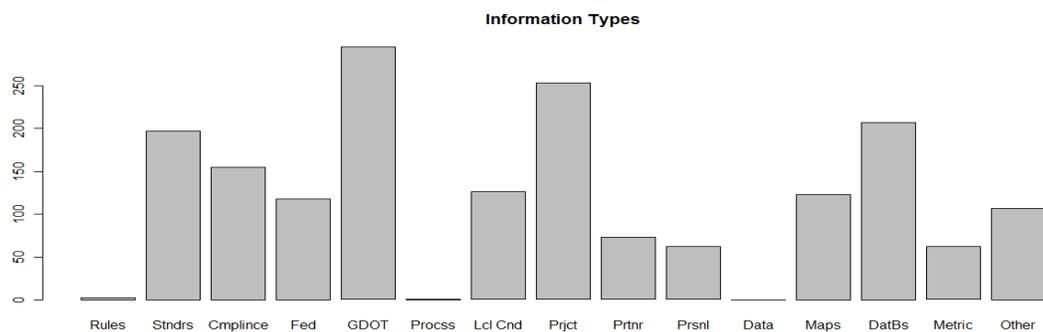
We gauged the role of the knowledge exchanges of members of the GDOT organization with a question on the importance of each knowledge exchange. The options presented to respondents were that the knowledge allowed the respondents to complete the task; allowed to save time in their work; allowed to save money in their work; allowed to work efficiently; allowed to work effectively; allowed to solve a problem; enhanced their creativity; or it was not important; or it did not help in the performance of the task. A negligible minority responded with one of the two negative options indicating that the knowledge exchanges are always of some importance. Completing the task, effectiveness, and solving a problem account for the overwhelming majority of responses. There is some evidence for the efficiency categories as well (save time, save money and efficiency). However, the main picture that emerges from these responses is that the knowledge exchanges are associated with overcoming obstacles that stand in the way of doing their work satisfactorily. There seems to be a degree of urgency that underlies them given that the main categories of importance are related to effectiveness, task completion and problem solving.

Table 14. Importance of Knowledge Exchanges

Complete Task	Save Time	Save Money	Efficiency	Effective	Solve Problem	Creativity	Not Important	Not Help Task
350	151	69	198	251	324	80	15	11

Up to this point, we have an initial idea of what the knowledge flows are about and the role they play in peoples' work. Below we explore other circumstances of the knowledge exchanges are of interest, such as the satisfaction of the parties, the relationship of the persons

exchanging knowledge, their modes of communication and the circumstances that led to the communication.

Figure 12. Frequencies of the importance of the knowledge exchanged
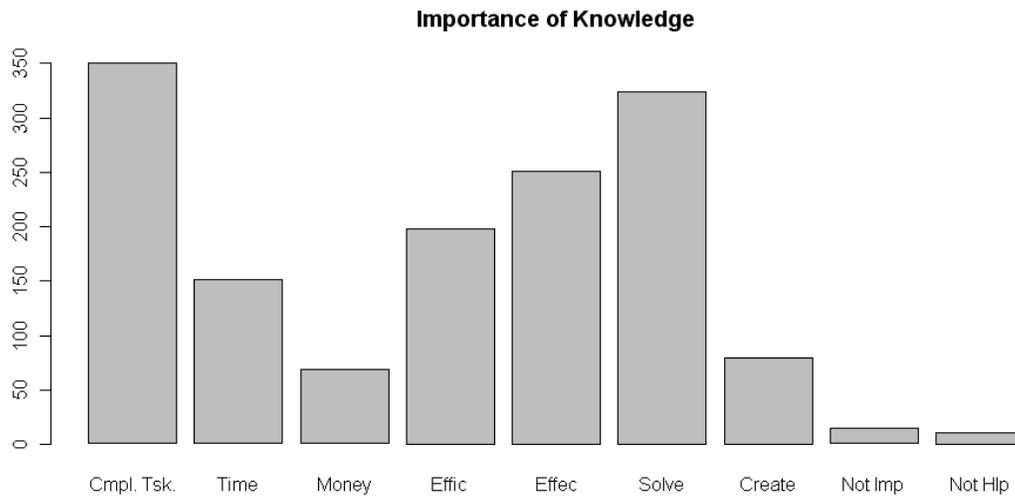
Respondents reported that they were successful and satisfied that all the knowledge sought was found in 228 of the 254 cases of different knowledge exchange respondents. In other words, people found all the knowledge they were seeking almost 90% of the time. Together with this, it is interesting to observe that respondents knew the contact person for years, as opposed to only days or months. The earlier finding that most of the knowledge exchanges involved individuals as sources, indicates a large network of trusted, well known contacts on whom GDOT members draw to solve their problems and overcome obstacles to complete their work.

The mode of communication is very personal and informal as well. When asked about the mode of communication, the combination of phone, email and informal chat accounted for

84% of all modes of communication reported for knowledge exchanges. Some formal meetings also occurred, but those accounted for about 14% of reported instances.

Table 15. Modes of Communication

Phone	Email	Informal Chat	Formal Meeting	Letter	Fax	Share-Point	Text Message
159	178	176	81	5	2	3	4

Most of the knowledge exchanges were initiated by the respondent (about 70% of reported cases) and in a similar proportion (about 75% of reported cases) the contact person shared responsibility for completing the task. The cases in the minority are interesting in this case. There are about 25% of cases in which it was necessary to reach out to persons outside the circle of responsibility to obtain the needed knowledge.

Figure 13. Frequency of modes of communication
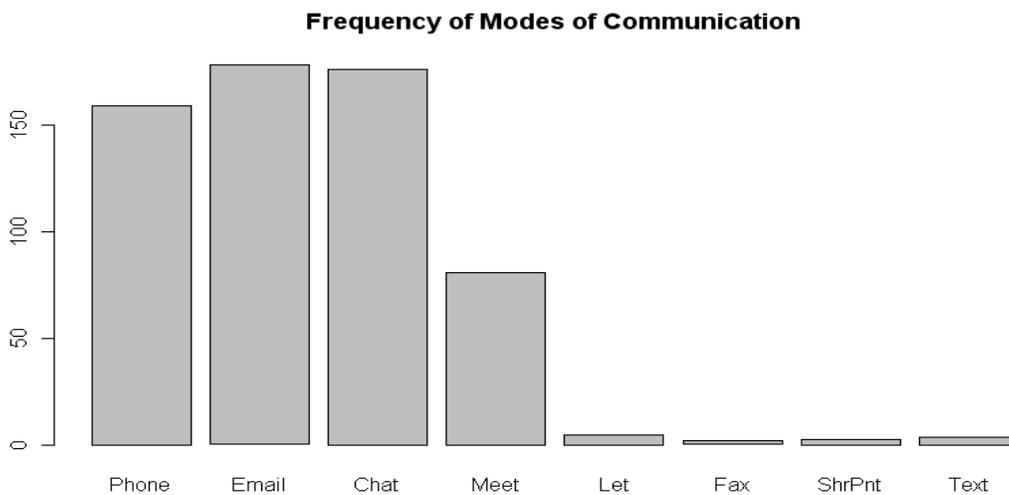
This raises the question on whether some changes might be introduced into some of the work routines to make the need to access external knowledge unnecessary. When asked, 40% of respondents indicated that the sort of task that was related to the knowledge exchanges always requires knowledge from outside the team. They also indicated in 34% of instances that the task could be redesigned to avoid this need. It seems that there is an opportunity for GDOT management to make some adjustments that could have relatively high payoff at not a too high cost.

Task 3: Assessing Costs and Benefits of CoP

When GDOT personnel discuss knowledge exchanges and CoP, they do not naturally think in terms of costs and benefits of the exchange. We can see this result in Figure 12 (see the previous section). In the communication logs, the importance of the knowledge exchanged was most frequently judged in terms of whether the task was completed or the problem was solved. Saving money was the least frequently reported characterization of the "importance of the knowledge exchanged"; occurring even less frequently than respondents enhancing their creativity.

This does not mean that GDOT managers fail to understand the costs associated with efficient knowledge exchanges. In this task, we explore whether or not participation in a CoP may have an impact upon the costs and benefits experienced by managers as they sought and used knowledge. We did so by comparing the experience of managers participating in knowledge exchanges that have few of the attributes of a CoP with managers engaged in knowledge exchanges that exhibit many of the properties of a CoP. We then observed the types and intensity of costs and benefits reported by the managers in each group. This analysis summarizes information drawn through the interviews, surveys and workshops by contrasting managers in weak CoP and strong CoP knowledge exchanges.

In the communication log survey, 65% of the knowledge exchanges reported were associated with two or less of the attributes of a CoP (i.e., weak CoP). This group of managers is more likely to engage in knowledge exchanges where participants are not highly motivated to improve their professional capabilities. These managers are less likely to communicate with individuals from across the organizational chart or outside the agency. When they do engage in

knowledge exchanges, it is through a network that does not contain a group of participants who share an interest in improving practice. The communication log indicates that this is the norm for most GDOT managers in the present climate. This is not terribly surprising as the research literature indicates that CoP are exceptional events rather than the norm in the lives of managers.

To explore a comparison of costs and benefits, we focus on two groups in GDOT that exhibit many of the properties of a CoP (i.e. strong CoP): the GIS community, and the Practical Design Training community. Only 7% of the knowledge exchanges exhibited all five of the characteristics of a CoP.   In both the interviews and the surveys, these two communities were the most frequently identified by GDOT managers as examples of existing CoP.

Among managers engaged in weak CoP, there was strong consensus that the chief costs are associated with locating validated and applicable knowledge. GDOT managers experience this cost in several different forms. The most common narrative is when managers go in search of knowledge that can solve a problem. The nature of work within the PDP and the serial reorganizations have made this highly problematic for managers whose network of working relationships does not include the appropriate sources.   This is particularly true among managers attempting to learn the duties associated with a new position.   One manager described the problem in the following manner:

> *The communication I've described takes place with my boss, … and my own*
> *efforts to learn a new job without pestering him to death. This would be easier if*
> *"The Source" were updated so you could find needed standard specifications or*
> *special provisions without "just knowing" where they are. A CoP would beat the*
> *Psychic Reference System any day. (Yes, I am frustrated today....)*

The hunt for "the source" is exacerbated by the length of time of GDOT projects and the intergovernmental nature of the many sources of authority with which GDOT projects must

align. Thus, lessons learned by one project team at one time may be out of date by the time a manager goes looking for answers. At present GDOT does not maintain an inventory of expertise across the agency. The search for the source is one of the most common issues identified by managers. The amount of time devoted to this activity can take hours out of a manager's day. In the most extreme cases, managers report the process taking weeks of effort.

The hunt for the source can also be experienced in reverse as senior managers try to track down the source of poor practice that has taken root within the agency or amongst the strategic partners of an agency. One manager described the problem in the following terms:

> *A few years ago we had to incorporate a change in our practice due to a new regulation…We wrote the guidance, adjusted our forms, and alerted everyone about the change. But I am still chasing down people that have "missed the email". I hate to think of the hours that I have spent herding the cats across the districts, counties and cities.*

When managers search for the source, they tend to rely upon communication channels that are rich in the use of interpersonal communication (phone, in-person, and email) between managers who have known each other for years. Rich communication channels can be highly effective as a means for quickly conveying great bodies of information that allow for acquiring both technical information and tacit knowledge. Because this type of interpersonal communication is so powerful, GDOT managers report investing time and effort in maintaining the quality of their professional network. Managers indicate a willingness to absorb the transaction costs of developing their professional networks as it frequently reduces the amount of time devoted to "searching for the source".

The frequency with which senior managers report the need to hunt down erroneous sources of knowledge suggests that GDOT managers are substituting interpersonal trust for certainty that the knowledge has been validated. Managers are engaging in a risky balancing

act when they rely upon their interpersonal professional networks for key information. It is likely, given the level of reliance on networks reported by GDOT managers, that much of the knowledge exchanged is accurate. However, the interview data suggests that this belief can often be misplaced as the risk of erroneous sources remains high.

There are two factors that tend to reinforce the reliance upon interpersonal professional networks as a source of knowledge. First is the nature of knowledge within GDOT. As was noted in the previous Task, the knowledge that GDOT managers use is comprised of a mix of engineering content, authority content (i.e. rules, policies and standards), and adaptive content. Some of the most challenging circumstances confronted by GDOT managers occur when these three elements of knowledge are in conflict or not easily aligned. For example, advances in engineering knowledge can pose challenges to the current sources of authority and it takes time for the authority content to catch up with the engineering content. Similarly, a change in engineering content can create the need for learning alternative approaches to adapt this engineering advance to local conditions.

During the course of this study, GDOT managers described scenarios where each of these three elements of knowledge moved out of alignment causing dissonance within the agency. Knowledge exchanges through professional networks that exhibit few of the qualities of a CoP are particularly vulnerable during times when knowledge dissonance prevails. The most common missing attributes of a CoP are the lack of motivated professionals, limited relationships with fellow employees in other offices or divisions throughout the organization, or limitations in the willing of the group of professionals to work on a type of problem   In contrast, as we will see in the cases below, strong CoP can mitigate the costs of addressing dissonance and bring knowledge elements back into alignment.

GDOT managers report that a second factor reinforcing the reliance upon interpersonal professional networks is the positive reinforcement that comes from becoming an expert on a body of knowledge. This can lead to prestige amongst peers (though not necessarily organizational rewards in the current budgetary climate) and can be perceived as a source of power and security within the organization. Managers may seek out opportunities to become a source for a body of knowledge within GDOT. A key question is how well connected a source is to the larger community of professional networks. Managers participating in a weak CoP often report difficulty in connecting to a source, particularly when the source is newly developed. Similarly, sources who participate in a weak CoP may have difficulty connecting with the larger community of managers in GDOT and among GDOT's strategic partners.

Interpersonal professional networks can serve as a foundation for creating CoP. However, when associated with a weak CoP, they often lack the organizational reach necessary for being an effective conduit of knowledge. Our two examples of strong CoP operating within GDOT provide alternative models for how CoP might be developed within GDOT. However, there are two attributes that the cases share in common. First, in both cases, the interpersonal professional networks of participants are augmented and focused by resources and direction provided through GDOT. Second, the most common costs associated with strong CoP are the costs of validation and application of knowledge. GDOT managers participating in strong CoP knowledge exchanges have found that this can be a means of mitigating search costs.

The Development of the Geographic Information Systems CoP

Building a highway requires significant levels of awareness of the geographical characteristics associated with the location of a road project. Not surprisingly, this has led many units within GDOT to develop a demand for geographic information systems (GIS). This suite of

technologies facilitates the linking of global positioning systems, digital imaging systems, digital mapping technology, databases and sophisticated algorithms used in computational statistical analysis.

GDOT has approximately 450 installations of an agency approved GIS software package with approximately 200 active users of the software at any one time. There is also an individual IT officer whose job description includes supporting GIS uses and applications within GDOT. The initial funding for this position was supported through external funds to the agency. The IT officer provides training on GIS software, advises on adapting GIS to local problems, and communicates best practices throughout the agency. Toward these ends, the IT officer organized a SharePoint site to facilitate communication amongst GIS users. It is a Web platform aimed at facilitating greater interaction across groups and teams by creating a single focal point for collaborative web applications, database sharing, document management, and electronic communications. Approximately 180 GDOT employees currently have permissions to access the SharePoint site. The IT support components of the GIS application are similar to those found in software user groups.

GIS applications are distributed across the agency; however, there are clusters of intense users in the offices of transportation data, environmental services, planning, and traffic operations. There has also been strong growth in the number of applications of GIS as offices find new uses for geographic data. The IT support officer reports that this is evident in the number of solicited presentations and consultations that he has given across the agency. This has not translated into sustained high levels of activity associated with the SharePoint site.

Participants in the GIS community do experience costs associated with exchanging knowledge. However, these costs are focused on validating and applying knowledge. When

new knowledge sources are required, the community is able to move forward in an expedited manner. As an example of how this works, we consider a specific knowledge exchange. In recent years, participants in the GIS community noticed that several offices needed information on floodplain maps. When projects required flood hazard boundary maps, offices searched for maps developed in earlier and similar projects. Through their interactions with the GIS IT support officer, managers began to develop lists of requirements that their individual offices have with regards to floodplains. In essence, the community has commenced a search for a comprehensive list of requirements for floodplain maps across the agency. The community is also seeking to pool existing information sources from across the agency. It is too early to tell if this type of collaboration will result in strategies of enhancing or buffering environmental influences. There are two notable aspects of the behavior of this community. First, it is aimed at providing a more coordinated and effective response to these environmental pressures. Second, it is an example of a community taking a proactive response to assembling required information rather than waiting for a hierarchical direction related to floodplains.

The Development of a Practical Design Training CoP

The introduction of the Office of Design Policy and Support in 2009 represented a significant effort by senior management to formalize what had heretofore been relatively informal processes governing the communication and adoption of standards. Three key domains—standards and policies, engineering software support, and surveying (i.e., location standards and technologies)—were assigned to this office. Different units within GDOT had been responsible for these domains in the past; however, they had other major functions to serve, so the topics had been neglected for some time. The new office is also responsible for reviewing the engineering literature, reducing it to a form that can be communicated, and deciding whether GDOT needs to implement it.

The Office of Design Policy and Support has opted to build upon the existing system of informal workshops built by engineers in the various design offices. It has developed a series of seminars aimed at "practical design training" in which senior engineers teach changes in standards. The seminars involve no more than six engineers at a time. The small class size is intended to give the design engineers plenty of attention to answer questions about the application of standards to the projects on which they work. Officers from the Office of Design Policy and Support also participate in the best practice workshops hosted by design engineering offices within GDOT. This provides a second avenue to introduce issues related to engineering standards. The combination of formal training seminars, informational resources regarding standards, and participation and presentation in informal best practice workshops is intended to infuse the community of design engineers with greater awareness of standards.

This approach introduces a much more formal voice into the ongoing dialog on best practices. It is intended to provide a strong reinforcement of procedures. It is also structured to

ensure that design engineers and engineers working in district and construction sites are sufficiently knowledgeable about changes in standards so that they can implement such changes quickly.

As with the GIS community, the Practical Design Training CoP is designed to mitigate the costs of validating knowledge. Design engineers within GDOT have long been responsible for pursuing their own professional development. The agency has supported their continued training and development through a mix of internal workshops and training programs from external groups. However, these activities are secondary resources for learning when compared to the hierarchic structure of GDOT. One of the chief places that GDOT engineers complete on-the-job training is within their work units, learning from their superiors and from individuals and resources to which their superiors may direct them during the course of a project. Once a pattern of work is established within an office group, it is difficult to persuade engineers that a new approach is better. According to one respondent, this is true even when the better approach is required under the law or according to industry standards.

There are considerable benefits in both the GIS case and the Practical Design Training case in terms of the reduction of costs associated with searching for knowledge and in terms of reducing the uncertainty associated with the quality of the knowledge. There are obvious costs associated with the validation of knowledge that both of these cases illustrate. In the GIS case, there are costs of dedicating an IT officer to providing support to the community. In the Practical Design Training case, there are costs associated with the validation of standards, the organization and implementation of training programs and the on-going support to professional development amongst design engineers. These costs are real and more visible than the costs currently incurred by the majority of GDOT managers in their search for sources.

Table 16. Summary of Benefits and Costs

SUMMARY OF BENEFITS	SUMMARY OF COSTS
Weak CoP • No Observed Benefits	**Weak CoP** • Search costs of finding sources for knowledge • Search costs of identifying erroneous sources and correcting distributed information • Uncertainty in the quality of knowledge due to reliance upon interpersonal professional networks
Strong CoP • Reducing the time devoted to searching for sources for knowledge • Providing means for identifying knowledge needs • Providing a means for validating and updating knowledge • Providing a means for efficiently disseminating knowledge on a scale greater than the reach of current reliance upon interpersonal professional networks • Aiding in addressing knowledge dissonance	**Strong CoP** • Costs associated with identifying knowledge needs • Costs associated with organizing information into usable formats • Costs associated with maintaining information over time/updating

Task 4: Developing a Strategy for the Application of SharePoint to Support CoP

From the characterization of the knowledge flows presented under Tasks 1, 2 and 3, it is clear that there is a role for some sort of infrastructure support that could facilitate and enhance knowledge exchanges. Both the GIS case and the Practical Design Training case exhibit significant staff time and IT support. However, it is not obvious that there might be a single sort of infrastructure or tool that would address all the needs of a CoP. Nor it is likely that a single strategy for developing CoP will serve the variety of categories of knowledge exchanges that we have identified.

We collected evidence on the use of SharePoint during interviews, in the communication log survey and during workshops with groups of potential members of communities of practice. The log survey directly included SharePoint as one of the modes of communication that might have been used for the knowledge exchanges. Only 3 of 588 responses indicated SharePoint had been used as the mode of communication during a knowledge exchange.

During the workshops we addressed the issue of support for increasing the effectiveness of knowledge exchanges or encouraging more of them when they seemed productive. The groups addressed the existence of SharePoint in the organization and showed awareness of it. However, they did not have a clear idea of the way in which it might help them in their need for access to knowledge dispersed in the organization. Discussion in the groups also raised the issue of barriers to entry for getting familiar with the system and expressed the idea that there was need for more specific introduction to its potential and applicability to their specific patterns of work in order to consider it as a resource for their work. In sum, the system seems

to be perceived as a "black box" of tools and subsystems that is cognitively distant from groups' work routines.

As a result, the crucial point to notice is that SharePoint is actually a suite of tools that needs tailoring to particular needs and groups before it is actually of practical use. The tailoring process may require some close IT support that is not trivial in its design and implementation for a period of time because the informal nature of these communications makes most of the knowledge associated with giving this support a tacit knowledge that is difficult to communicate. It might require significant attention and personnel hours from IT support and some members of the relevant groups to get to understand what configuration of SharePoint tools is optimal to encourage the development of a community of practice from that group and support it so that it will gain critical mass.

On the positive side, the various tools that SharePoint does offer could be introduced to targeted groups in order to offer proof of utility and overcoming the barriers for initial adoption in a carefully programmed way. Some groups might benefit from the use of some specialized repository for which SharePoint could be the framework suite, or a bulletin board or threaded message forum, and so on, but not a list of tools in the abstract left for each group to pick up on its own.

More specifically, the "Communities" component of SharePoint offers tools for some of the needs that were mentioned in the workshops. It enables the creation of lists of experts and profiles that facilitate access to those who have the needed information. Workshop participants echoed the challenges identified in Tasks 2 and 3 associated with knowing who to go to not being always easy and the time to get to the right person. One of the first solutions proposed in the knowledge management literature is precisely a directory of people and their expertise to

make this process more effective. Groups that manifest interest in this sort of tool could be convened for a tailored introduction to this set of tools.

The "Content" component of SharePoint may serve to address another need mentioned in workshops, namely, access to rules and procedures and proper forms for specific tasks that change often. Many GDOT personnel find out about the changes when they get to a point in a project when using the version they know is no longer possible and they have to redo work in order to comply and must get acquainted with the new forms and procedures. The "Content" component allows for teams, groups and sets of groups that may resemble a COP to have a common source for such content that changes allowing for coordinated maintenance and easy search. The component includes the automatic application of compliance policies for documents and content which would address an often heard concern about the validity of what might be posted on an IT site for widespread use. Identifying the groups or the community with this specific need may facilitate the introduction to the tool since the support would be designed with actual input from the users' needs.

Even though SharePoint has more capabilities, these are the ones that seem closest to actual needs expressed by workshop participants and interviewees. In sum, it may be a worthwhile investment of scarce support time and GDOT end-users' time to target the unpacking of SharePoint tools to specific groups of users to obtain buy in progressively and in a focused way paying attention to the specific knowledge exchanges of each target group.

We posed questions about the application and use of SharePoint to the one existing CoP inside GDOT that makes extensive use of this tool: the GIS community. Respondents from the GIS community indicated that the development of a CoP should not focus on applications of SharePoint. This approach is akin to a tail wagging the dog problem. In the GIS community, the

focus is upon identifying end-user needs. Only when there is a match between an end-user need and one of the many tools available through SharePoint, an effort is made to introduce the tool. In this way, members of the community can test out the application of a tool in the context of an identified need.

Needs assessment begins with a review of the current knowledge needs of GDOT managers. A diagnostic of the elements of the knowledge need is made through discussions between groups of managers and the IT officer assigned to support the GIS community. Knowledge needs typically have three major components. First, there are the engineering and/or other technical standards applicable to a problem or practice. Second, there are the demands of public authority as embodied in guidance documents, codes, policies and law. Third, there are the demands of the local site where professional practice is being applied. The challenge for most GDOT managers is to use knowledge in such a way that it aligns with standards and complies with authority while preserving the capacity to adapt to local conditions.

A second component of the needs assessment is a review of the networks of information that GDOT managers are employing in the acquisition and use of knowledge. Because GDOT managers rely upon interpersonal communication and trusted relationships, this part of the needs assessment often includes a review of the interpersonal professional networks of the participating managers. The IT officer assigned to the GIS community often is engaged in linking groups of managers who are confronting similar challenges or who may benefit from sharing knowledge and enriched professional networks.

A third component of the needs assessment comes in the form of meetings between managers who may participate in the knowledge exchange to reflect on the types of knowledge

needed and the means for exchanging and using knowledge. This part of the process is important as it gives the managers a way to understand and buy into the findings from the needs assessment.

SharePoint tools have often been put to use within the GIS community. But these applications are only introduced after the needs assessment is initiated. Tools are not introduced until there is an obvious match between the functionality of the tool and the needs of the practitioners engaged in the knowledge exchange. This needs assessment practice employed in the GIS community serves as an important model for the development of CoP within the agency. Responses from members of the GIS community indicate that this process is accepted and effective as a means for identifying and responding to knowledge needs. It can also serve as a strategy for the development of CoP.

We can get a flavor of the range of needs associated with existing knowledge exchanges. Here, we review some of the knowledge needs that are pertinent to tools available through SharePoint.

Grouping 1: Formal Communications – The knowledge exchanges in this grouping tend to be associated with formal work contained in a single office within GDOT. There are significant knowledge needs of these respondents; however, there is little evidence of an interest in seeking out knowledge from other professionals throughout the agency. Consequently, these exchanges are not good candidates for a CoP. GDOT might focus on trainings and the development of SharePoint-based forums to increase the awareness of these respondents concerning their professional environment. They are likely to be excellent candidates for SharePoint applications to organize the knowledge needed by a unit or office.

Grouping 2: Informal knowledge exchanges that are not practice aware -- These knowledge exchanges are centered on gathering information on rules, guidelines and procedures and knowing where to identify this information. Respondents indicate that GDOT might develop and enhance the efficiency of these communications through SharePoint by creating a centralized chart of personnel and expertise.   The use of profiles and communities in SharePoint could help individuals identify sources of knowledge, either for guidelines or for individual expertise. The website should enhance institutional awareness of and presentation of sources of knowledge and nodes of expertise. Most respondents expressed a preference for communicating personally with others they know. So rather than developing websites, GDOT might search for good forums of exchange (perhaps through other agencies like FHWA) and enhance awareness of these forums and encourage use within GDOT.

Grouping 3: Informal knowledge exchanges that are practice aware, but not spread across the organization -- These knowledge exchanges are similar to grouping 2 but seem to be less urgent and more about building long term stocks of knowledge, extending communication networks and sharing best practices within teams or perhaps even between offices.   Here, knowing other individuals and getting to know other individuals is a strong facet of the tacit knowledge that is exchanged. GDOT might better sponsor these communications through inter-department social meetings.

Grouping 4: Informal knowledge exchanges that are practice aware, spread across the organization, but not motivated to improve a particular practice -- These knowledge exchanges are focused on sharing procedures across organizations and outside of the agency, as well as on evaluating projects. These communications are quite specific and infrequent, and could be enhanced by GDOT through informational awareness and presentation of sources as well as

nodes of knowledge. It is most likely program evaluators who are in need of and using this type of information. Because the communications are infrequent, SharePoint might be a useful vehicle for preserving the institutional memory of the agency. A centralized chart or website (similar to the recommendation for grouping 2) could help GDOT facilitate and enhance the efficiency of these communications.

Grouping 5: Knowledge exchanges that are practice aware, spread across the organization, motivated to improve practice but not through frequent communication -- There were very few (2%) communications that fell under this grouping. Respondents described communications as being very technical and focused on things like surveying, completing training external to the organization, and completing IT work. The lack of frequency of these communications suggests that SharePoint may be a useful means for assuring institutional memory.

Grouping 6: Knowledge exchanges that have all five (informal, practice aware, spread across organizations, motivated to improve practice and frequent) attributes of a CoP – These exchanges frequently include more senior personnel within GDOT. As other data from our interviews and communications logs suggest, these communities are built over years of experience and through strong interpersonal networks. SharePoint is unlikely to replace established communication patterns between participants. However, it may play an important role for mid-level managers if the tacit knowledge of senior managers is organized in a manner that is accessible and updated.

Conclusions

This research project has examined existing patterns of communication and knowledge exchange within GDOT in order to determine factors influencing the development of CoP. Our goal in doing so is to identify strategies to assist the development of CoP building out of the patterns of existing knowledge exchanges.

Our first step (associated with Task 1) was to identify the incidence of CoP within GDOT by determining the number of CoP attributes that are being exhibited in a knowledge exchange. From this analysis, we identified six distinct groupings amongst current knowledge exchanges:

- **Grouping 1:** Formal exchanges (i.e. knowledge exchanges are required by standard operating procedures)

- **Grouping 2:** Informal knowledge exchanges that are not practice aware

- **Grouping 3:** Informal knowledge exchanges that are practice aware, but not spread across the organization

- **Grouping 4:** Informal knowledge exchanges that are practice aware, spread across the organization, but not motivated to improve a particular practice

- **Grouping 5:** Informal knowledge exchanges that are practice aware, spread across the organization, motivated to improve practice but not frequent

- **Grouping 6:** Informal knowledge exchanges that have all five attributes of a CoP as defined in the literature (informal, practice aware, spread across organizations, motivated to improve practice and frequent)

We found that the majority of knowledge exchanges (65%) consist of few attributes of a CoP and fall into Groupings 1-3. We described these knowledge exchanges as weak CoP since many of the attributes remain to be developed. The attributes most frequently missing in these exchanges are 1) communication patterns among participants in the knowledge exchange tend to be unmotivated by prospect for improving their abilities with a practice; 2) the interpersonal professional networks of participants in weak CoP exchanges do not extend beyond the

stovepipe of their office; 3) participants in knowledge exchanges indicate that there is no group in the network attempting to improve practice. The chief costs associated with the knowledge exchange are associated with searching for sources of information.

The research literature indicates that fully functioning CoP can be developed upon knowledge exchanges exhibiting weak CoP patterns of communication. Many GDOT managers in groupings 1-3 expressed a strong interest in developing a CoP as a means of mitigating costs and reducing frustration associated with searching for sources of knowledge.

Strategies for developing a weak CoP into a strong CoP would benefit from accurately identifying the starting point of these knowledge exchanges and begin building specific attributes that address the highest costs confronting managers. For example, we observed considerable resistance from GDOT managers in interviews and workshops to the notion that training in SharePoint might serve as an antidote for the high search costs characteristic of a weak CoP. Because SharePoint is a relatively new technology within the agency, it was often viewed as answering a frustration with an additional frustration. Even if a manager invests in learning the technology, the content of the information available is not sufficiently mature to be of immediate benefit. This is particularly true with regards to the identification of validated sources of knowledge.

A more productive strategy is to build from a needs assessment of the knowledge exchange (as described in Task 4) in terms of the nature of the knowledge content that is being pursued and the nature of the interpersonal professional networks that individual participants have developed. This will provide a baseline of information about the nature of the knowledge being sought and the baseline of sources currently being accessed, and a baseline of communication networks being used to access knowledge. This exercise provides a forum for

groups of managers seeking knowledge to become aware of their shared need and a firmer understanding of the nature of the knowledge exchange that they are pursuing.

The needs assessment exercise can also provide information useful for identifying channels for communicating and exchanging knowledge. As a group of managers gain greater awareness of shared knowledge needs, a climate can be created for considering IT tools that may assist in the exchange. In effect, the needs assessment can be useful in creating a climate for targeted learning in which the group explores whether a specific tool from a resource such as SharePoint can be usefully applied. Targeting learning by a group that applies a specific IT tool to a shared need is more likely to produce quick returns and create a virtuous circle between learning, application, and reward. As the group successfully learns one tool and gains confidence with the capabilities of a program such as SharePoint, they are more likely to explore other tools.

Because managers in groupings 1-3 are most likely to experience challenges in the location of sources of knowledge, applying and developing tools that facilitate that search are likely to be high yield and lay a foundation for building community. SharePoint tools for organizing communities have the ability for conducting contextual searches and can achieve high levels of refinement.

GDOT already has profiles of employees available through SharePoint. Profiles could be expanded to include more detailed areas of expertise. GDOT might also consider making transparent the informal system of subject matter experts into a database of experts. In doing so, it could make use of SharePoint capabilities for distinguishing between organization sanctioned tags and end-user tags as a means of indexing expertise within the agency. This would allow for both top-down and bottom-up forms of validation of expertise over time. In

workshops, GDOT managers suggested that a more powerful form of this directory would include links from expert's pages to sites dedicated to maintaining information on standards and processes associated with an area of expertise. Such a system would include audio and video clips as well as training presentations that could be used to convey the tacit knowledge and best practices that are learned over time by agency personnel. Such a system would require the organization to commit resources to the creation and maintenance of a directory of expertise.

GDOT managers associated with groupings 4-6 are more likely to experience challenges and costs related to validating and applying knowledge. These groups of managers are more likely to be working in an environment where they are aware of a group of managers who share their motivation in improving practice.   Their professional networks are more likely to extend beyond the bounds of their office hierarchy and extend into other parts of GDOT and beyond GDOT to other professional associations.

The needs assessment procedure described above and in Task 4 also can be usefully applied to groups of managers working in a strong CoP environment. We observed examples of this in the GIS community as the group sought solutions to the need for floodplain maps.   A strong CoP does not eliminate search costs, but it can aid in minimizing these costs and aid a group in moving forward to solutions on knowledge sourcing, access and application.

The challenges of validation were the most clearly articulated by senior GDOT managers and managers involved in the Practical Design Training CoP.   Several senior managers, while acknowledging that many of their knowledge exchanges exhibited attributes of a CoP, were very skeptical of the value that CoP would hold for GDOT. Their chief concern is with a system that relies too greatly on social connectivity would be vulnerable to the diffusion of knowledge that is not in line with current engineering standards or the requirements under laws and

regulations. These managers were the most likely to experience the reversing sourcing problem, i.e. tracking down sources that had disseminated incorrect information. In their view, GDOT already suffers too greatly from a lack of knowledge management controls. Any developments associated with CoP should be accompanied by strong validation procedures.

The Practical Design Training CoP provides an example of efforts to instill validation processes into the training of design engineers. What began as informal sessions devoted to lessons learned and best practices has been augmented with formal training programs and official documents detailing policies, guidelines and standards organized through the Office of Design Policy and Support. The strategy pursued in this CoP is to use a combination of social networking, face-to-face training, on-line documentation of official policy statements and standards, and the dissemination of information and training sessions as changes occur in standards. The goal is to create a dense network of knowledge resources that design engineers can interact with through social networks connecting them with subject matter experts and with other design engineers.

For those knowledge exchanges where validation is a critical source of concern and cost, this model represents a possible strategy. However, it is important to note that the Office of Design Policy and Support takes a significant role in organizing and supporting on-going knowledge exchanges. SharePoint has begun to be used by this CoP for the organization of participants and for the dissemination of information. However, participating managers stressed that in the context of this CoP, SharePoint is a tool for knowledge organization not validation. The validation exercise can only occur with human judgment regarding problems and information.

It is unlikely that GDOT can dedicate the type of resources associated with Office of Design Policy and Support to every form of knowledge exchange within the PDP where validation is a critical exercise. One procedure used in the private sector accounts of CoP is the use of information management consultants during times when there are significant changes in policies and procedures that affect knowledge validation throughout the agency. Consultants can be used to organize the knowledge changes, prepare materials for dissemination throughout the agency, and assist in the dissemination using SharePoint and other channels such as workshops and training sessions. The effective use of such consultants can be enhanced through the building of CoP which would serve two functions: 1) provide a means of reaching the population of GDOT personnel engaged in a knowledge exchange, and 2) provide a means of identifying leaders within the CoP that can be called upon in determining validation standards for the knowledge exchange.

The current state of knowledge exchanges within GDOT could benefit from the systematic development of CoP. This could be an effective means of addressing the concerns of the majority of managers who presently struggle with searching for the right source of knowledge. GDOT already is home to knowledge exchanges that exhibit all the attributes of a CoP. Lessons learned from these groups indicate that CoP can be an effective means for identifying solutions to common problems as well as accessing, storing, and retaining knowledge. In these activities, the functionality of IT applications such as SharePoint can be a powerful tool. CoP can also be a powerful means to achieve knowledge validation in support of accurate dissemination and application. When CoP are focused on validation issues, IT applications can play a supporting role but the validation decision remains in the hands of organizational leaders working with the community of practitioners.

Appendix: Research Protocols

SEMI-STRUCTURED INTERVIEW PROTOCOL

Job Description

Could you describe your job?

- Probe: How long have you worked at GDOT? Where have you worked within GDOT?
- Probe: How many people report to you? Who are they?
- Probe: What did you do this morning? What about yesterday?

Office Description

Could you describe the functions of your office?

- Probe: What sorts of tasks do you perform?

Could you describe the structure of your office?

- Probe: What does your organizational chart look like?
  - o Probe: How many assistant office heads are there?
  - o Probe: Who do the assistant office heads supervise?
- Probe: How many floors does your office occupy?
- Probe: Where are workers' cubicles? Are they together or spread out across a wide area?

Communication Patterns

Who do you talk to within your office on a regular basis?

- Probe: How do you usually approach them? (Phone, email, in person, formal meeting)
- Probe: How did you meet them? How long have you known them?
- Probe: Are you usually talking about projects or something else?

How does this compare to your experience in other GDOT offices?

- Probe: How do the Office of Roadway Design and the Office of Design Policy and Support differ in terms of communication?

- Probe: Could you tell us about the Knowledge Sharing Program you started in the Office of Roadway Design?
  - Probe: Each month, a group of design engineers presents material to other groups.

Who do you talk to outside of your office on a regular basis?

- Probe: How do you usually approach them? (Phone, email, in person, formal meeting)
- Probe: How did you meet them? How long have you known them?
- Probe: Are you usually talking about projects or something else?

When you have a new problem to solve, who do you contact?

- Probe: How do you usually approach them? (Phone, email, in person, formal meeting)
- Probe: How did you meet them? How long have you known them?
- Probe: Are you usually talking about project problems or other problems?

Communities of Practice (CoP)

Are you familiar with the term communities of practice?

- If yes: What is your understanding of the term?
- If no: In the academic literature, CoP are groups of professionals from different offices who share best practices for common tasks.

Do you know of anything that sounds similar to a community of practice?

- Probe: Could you tell us more about that example? Who is involved? How did they meet? What do they collaborate on?

If you could participate in a community of practice, would you?

- Probe: Why or why not?

Are you familiar with FHWA's online communities of practice?

- If yes, how often do you access these sites? What do you use them for?
- What are the benefits of the sites? What are the drawbacks?

Communication Needs

What are the communication needs of your office?

- Probe: How do you work with documents?
- Probe: How do you manage projects?
- Probe: Does everyone in the office know what everyone else does? Can each employee identify subject matter experts?

SharePoint

Are you familiar with SharePoint?

- Probe: Do you consider it useful? Why or why not?
- Probe: How have you used it?
- Probe: How does your office use it? Who are the users?

Do you think SharePoint could facilitate communities of practice?

Do you think SharePoint could address other needs in your office?

[If interested:] What are the barriers to implementation?

[If interested:] What are the next steps for your office?

References

Who else should we contact?

Thank you for your time.

Communications Log Survey Protocol

Key

Instructions are in bold italics.
Survey skip logic is noted in italics.
Questions are in bold.
Answer options are in normal text.

Study of Communities of Practice in GDOT
Georgia Institute of Technology
The Daily Communication Log

Welcome

The purpose of this research project is to improve GDOT's ability to retain and share information and knowledge across the organization. More specifically, the project aims to discover the patterns of communication and knowledge exchange related to areas of expertise and professional practice within GDOT.

This research project is sponsored by GDOT and is conducted by a team of Georgia Tech researchers. We will send this log to you once a day for the next five workdays. Please fill out the log each day. Please do not skip a day during the week. However, if you do miss a day, please do not attempt to recall a communication from the previous day. Simply continue to participate with a communication from the current day. For technical issues associated with completing the survey or problems with the connection to the survey, please contact Kirsten Bandyopadhyay, Graduate Research Assistant (kirstenb@gatech.edu, 404-385-7500).

If you have any further questions regarding the purpose of the study, please contact Gordon Kingsley, Associate Professor in the School of Public Policy, (gordon.kingsley@pubpolicy.gatech.edu, 404-894-0454), or Rick Smith, Deputy HR Director in HR-Training and Development (rsmith@dot.ga.gov, 404-651-6509).

Instructions

Please fill out this log once a day for the next five workdays. Please do not skip a day during the week. However, if you do miss a day, please do not attempt to recall a communication from the previous day. Simply continue to participate with a communication from the current day.

Main Objective and Instructions:

The purpose of this exercise is to record a daily exchange of knowledge of a technical or professional nature by GDOT employees. Please select and report on a single instance of communication where knowledge was exchanged today.

By "knowledge," we mean the substantive technical content that one associates with expertise used in professional practice. This would be distinguished from the incidental information one has as a conduit of information (such as being in the right place at the right time, knowing the right people, having privileged access to something, and so on).

Many jobs are complicated and require multi-tasking. You may find that you are drawing on a different area of professional expertise from one day to the next. That is perfectly acceptable. You may find that your communications to exchange knowledge during the course of a week are related to one area or many areas of practice or expertise. You have discretion to choose the exchange of knowledge to report on each day.

For technical issues associated with completing the survey or problems with the connection to the survey, please contact Kirsten Bandyopadhyay, Graduate Research Assistant (kirstenb@gatech.edu, 404-385-7500). If you have questions about these instructions, please contact Associate Professor Gordon Kingsley at 404-894-0454 or gordon.kingsley@pubpolicy.gatech.edu.

The following questions appeared every day of the log: Days 1, 2, 3, 4, and 5.

Did you seek out any information about a substantive technical knowledge issue today?
- Yes
- No

If yes:

Which sources did you consult? Please check all that apply.
- A database
- A map
- A website
- A SharePoint resource
- An electronic file
- A book
- A paper file
- A person

Please provide the following information about the knowledge you accessed or exchanged.

What was the topic of the knowledge exchange?

Was the purpose of the communication related to a design or construction project?
- Yes
- No

If yes:

Did you need this information for completion of the task?

Does this sort of task always require technical expertise from outside the project?

Could the task or process be redesigned so that seeking this knowledge is not necessary?

What was the purpose of the access or exchange? Please check all that apply.
- Resolve an engineering problem
- Choose an appropriate procedure
- Determine applicable rules for a task
- Find an expert for a component of a task
- Determine the most useful tools for a component of a task
- Other _____

What type of knowledge did you access or exchange?
- Standards and rules
  - Information on standards
  - Information on rule compliance
  - Information on federal rules and procedures
  - Information on GDOT rules and procedures
- Advice on process
  - Information on adapting to local conditions
  - Information on projects
  - Information on partner organizations
  - Information on personnel
- Data
  - Maps
  - Databases
  - Performance metrics
- Other
  - Other _____

In what ways was this knowledge important to you? Please check all that apply.
- It allowed me to complete my task
- It allowed me to save time in my work
- It allowed me to save money in my work

- It allowed me to work efficiently
- It allowed me to work effectively
- It allowed me to solve a problem
- It enhanced my creativity
- This information was not important for my work
- This information did not help me in the performance of my task

Did you get or give all of the knowledge you sought?
- Yes
- No

With whom did you communicate?

Where does this person work?
- Inside GDOT

    In which GDOT office does this person work?

- Outside GDOT

    For which company does this person work?

What is this person's job title?

How long have you known this person?
- New contact
- Months
- Years
- Decades

How did you communicate with this person throughout the day? Please check all that apply.
- Phone
- Email
- Informal in person chat
- Formal meeting
- Letter
- Fax
- SharePoint
- Text message

Who initiated the contact?
- Me
- Someone else

Does this person share responsibility for the completion of the task?
- Yes
- No

Does this sort of task always require technical expertise from people outside the team?
- Yes
- No

Could the task or process be redesigned so that seeking this knowledge from others is not necessary?
- Yes
- No

Is this your first time to fill out the log?
- Yes
- No

If yes:

Please tell us a little bit about yourself. This section only appears on your first log.

How many years have you worked at this organization?

Where have you previously worked within GDOT? Please check all of the divisions that apply.
- Division of Planning
- Division of Admin / General Counsel
- Division of Local Grants and Field Services
- Division of Engineering
- Division of Intermodal
- Division of Construction
- Division of Permits and Operations
- Division of Finance
- Division of P3
- Senior Administration
- Other _____

Where do you currently work within GDOT?
- One Georgia Center
- Traffic Operations: 935 East Confederate Avenue
- West Annex: 276 Memorial Drive
- District 1
- District 2
- District 3
- District 4

- District 5
- District 6
- District 7
- Other

What is your job title?

What is your age?

What is your race?
- African American/Black
- Hispanic/Latino
- White/Caucasian
- Asian/Pacific Islander
- Native American
- Multiracial

What is your gender?
- Male
- Female

What is the highest degree you have obtained?
- High school diploma
- Certification
- Associate's degree
- Bachelor's degree
- Master's degree
- Doctorate

The following section was shown only on Day 5.

Communities of practice are groups of professionals who often work in different divisions and offices but whose work shares common practices and knowledge needs. People participate in communities of practice because they are highly motivated to learn how to do their jobs better. The community of practice is a resource for gaining and sharing knowledge and expertise.

Some key features of communities of practice include:
- ***Informal interaction between members (i.e., the communication is not required by procedures or the organization's reporting structures)***
- ***Participants are highly motivated to improve their professional capabilities in a practice or skill set***
- ***Participants are drawn from across the organizational chart, or even across organizations***
- ***Participants are aware that there is a group of individuals that shares its interest in a practice or skill set***

- *Participants share information and exchange knowledge through the group more than once a year*

Please reflect on the communications that you've reported this week. Do you believe that any of these communications were with a group that has many of the attributes of a community of practice?
- Yes
- No

If yes:

> **Please describe the communication log entry, or entries, which strongly resemble communication with a community of practice.**
>
> **Reflect on the communication from this week that most strongly resembles communication with a community of practice. Please check which attributes are consistent with a community of practice.**
> - Informal interaction between members (i.e., the communication is not required by procedures or the organization's reporting structures)
> - Participants are highly motivated to improve their professional capabilities in a practice or skill set
> - Participants are drawn from across the organizational chart, or even across organizations
> - Participants are aware that there is a group of individuals that shares its interest in a practice or skill set
> - Participants share information and exchange knowledge through the group more than once a year
>
> **How frequently do you communicate with this group?**
> - Daily
> - Weekly
> - Monthly
> - Quarterly
> - Yearly
>
> **Do you know of any groups within GDOT that have many of the attributes of a community of practice?**
> - Yes
> - No
>
> *If yes:*
>
> > **Are you a participant in any of these communications with these groups?**
> > - Yes
> > - No

How frequently do you communicate with any of these groups?
- Daily
- Weekly
- Monthly
- Quarterly
- Yearly

What are the topics of knowledge which lead these groups to communicate?

Workshop on Communities of Practice
Georgia Department of Transportation

September 23rd, 2011
Small Group Instructions

All the participants in the workshop have responded to the Survey Log of Knowledge Exchanges in GDOT. Therefore, you have already had a chance to think exchange of knowledge of a technical or professional nature with colleagues. By "knowledge," we mean the substantive technical content that one associates with expertise used in professional practice. This would be distinguished from the incidental information one has as a conduit of information (such as being in the right place at the right time, knowing the right people, having privileged access to something, and so on).

In this group exercise, we would like to probe further the nature of these exchanges and the opportunities for leveraging them to improve GDOT's ability to retain and share information and knowledge across the organization.

The exercise has two activities. The second will build on the conclusions you reach in the first.

I.   Moderator and Record keeping of group activity

Please name a member of the group to lead/moderate the group discussion and another to keep notes of your discussion and observations

II.   Activity 1: Knowledge exchange description

The first activity is devoted to understanding how to identify communities of practice, the patterns of knowledge exchanges, and strategies for supporting the development of these communities. Groups can draw upon examples discussed in the opening session or they can discuss potential communities that resonate within the small group.

a. Take a few minutes for each member of the group to recall and think of one important instance of knowledge exchange.

b. Once everybody in the group is ready, take turns relating it to the group. Before going to the next member's case, the rest of the group should ask questions to try to understand the case and capture the key features of the exchange. For example, key features might be:

Content;
Who the person or contact is;
The network of other possible contacts for similar purposes;
The mode of communication;
The frequency with which this type of exchange occurs;
The knowledge or information resource access that was facilitated;
The potential that was opened up for future knowledge needs
Other: please point out.

c. The group can now compare and contrast the exchanges shared:

    i. Consider whether the exchanges you are party to would benefit from direct leadership or some organization

    ii. As a group, discuss suggestions on how to make these more valuable to your own work

    iii. As a group, provide suggestions on how to make these more valuable to GDOT as an organization

III.   **Activity 2: Communities of Practice as a means of improving productive processes at GDOT**

The group can now discuss ways in which the opportunities and benefits of these exchanges might be enhanced. You could consider among other things:

1. What are the costs associated with the COP?
2. What are the benefits associated with the COP?
3. How might this COP improve project work?
4. How might this COP improve the working relationships with key GDOT partners?
5. How might this COP facilitate achieving the policies and standards of GDOT?

    i. How would knowledge validation be assured?

    ii. Stimulation of knowledge exchange and collaboration

    iii. Access to right sources for most critical knowledge needs

    iv. Infrastructure support that would be most helpful:

1. Tools for meetings
2. Tools for open-ended conversations
3. Tools for collaborative projects
4. Tools for content repositories
5. Tools to access expertise
6. Tools for networking and professional relationships
7. Tools for individual participation (individual learning style and needs)

8. Tools for community coordination and cultivation

b. Finally, consider what adjustments might be made in GDOT practices given what you discussed on these knowledge exchanges: How can GDOT as an organization learn from the knowledge exchanges you have discussed?

IV. **Conclusions:**

Organize your notes to share with the other groups.

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