December 2003

Learning in Distributed Groups

Hala Annabi
Syracuse University

LEARNING IN DISTRIBUTED GROUPS

Hala Annabi
Syracuse University
hpannabi@mailbox.syr.edu

Introduction

An organization's capability to learn has been recognized as a core competency necessary for survival and competition in a knowledge-based economy (Garvin 1991; Maier et al. 2001). Learning has to be present at all levels of the organization, not limited to key strategists (Senge 1990; Lin and Lin 2001). The better an organization is at learning, the better it can be at adapting to the environment, correcting for error, and innovating (Argyris, 1996). However, as work becomes more complex, due to global markets, shorter product life cycles and a diverse workforce, organizations depend increasingly on groups to perform organizational tasks and functions (Guzzo and Shea, 1992). Thus learning has to occur at the group as well as at the individual level.

The changing environment introduces further complications as new forms of organizations and groups emerge. This study focuses in particular on distributed groups (de Souza 1993), in which workers use IT to collaborate with colleagues and partners around the globe. An extreme case of this phenomenon is the virtual work group of independent employees (or even volunteers), such as groups developing Open Source Software.

Distributed groups have many potential benefits. Distributed work provides access to a larger pool of experts, better load balancing, developing and enhancing expertise and placing some work closer to the customer (Grinter et al, 1999). However, the distance between members of virtual groups present challenges such as lack or misunderstandings of communication, problems in product and process management, coordination difficulties and failures, low self-efficacy, low self-sufficiency, and knowledge management problems (Herbsleb and Montra 2001; Belanger and Collins 1998; Jarvenpaa and Leidner 1999; Kraut et al. 1999; Carmel and Agarwal 2001). These challenges for virtual groups have a direct negative effect on learning of groups (Robey, Min Khoo and Powers 1999). In order to minimize the shortcomings, and maximize learning it is important to understand the process of learning in distributed groups. As Maier, et al. say, "Knowledge about the process, or the know how, of learning facilitates corrections that simulate or accelerate learning" (Maier, et al. 2001, pg. 16).

The objective of this study is two-fold. The first objective is to develop a theoretical approach to study learning on the group level in a distributed environment. The second objective is to understand the learning processes of distributed groups by answering the following research questions:

1. What are the characteristics of the learning process by which distributed groups develop and modify norms, rules and procedures for practice?

2. What are the factors that enhance or impede the learning process?

The Context of Open Source Software

I have chosen Open Source Software (OSS) development projects as a setting for my study. OSS is a broad term used to describe software that is developed and released under some sort of "open source" license. There are many licenses with a range of different features, but all allow inspection of the software's source code. There are thousands of OSS projects, spanning a range of applications. Due to their size, success and influence, the Linux operating system and the Apache Web Server are probably the most well known, but hundreds of other projects are in widespread use, including Internet infrastructure (e.g., sendmail, bind), user applications (e.g., the GIMP, OpenOffice), programming languages (e.g., Perl, Python, gcc) and games (e.g., Paradise).
OSS development teams provide interesting examples for my study for many reasons. First and foremost, they are important examples of distributed teams of independent knowledge workers, as they operate primarily or exclusively via computer-mediated

communications (CMC), fully integrating information technology into their work practices. As well, there are a lot of them; some have been outstandingly successful in meeting the challenges of developing large and complex software systems (while others have not), and in many cases, nearly complete records of their interactions and work products are publicly accessible. As well, these teams perform a common task, software development, in a somewhat similar fashion using similar tools, so by studying them I control somewhat for variations in task and tools that might otherwise effect my ability to compare between groups. Finally, because OSS development projects are usually formed outside of a specific organizational context, project members face a particular challenge in learning to work together, making them a particularly interesting setting in which to study group learning.

Learning in Distributed Groups

For this study, I draw on Huber's definition of learning: "An entity learns if… the range of its ***potential behaviors is changed***" (Huber, 1991). The term behavioral potential emphasizes the fact that not all outcomes of learning will be observable immediately, but rather, they will be observable if and when the circumstances arise. For example, airline pilots train constantly to handle emergencies, but are rarely called upon to exhibit these behaviors. Therefore, I define group learning as a change in a group's behavioral potential.

To conceptualize a group's behavioral potential, I draw on Grant's (1996) knowledge-based view of the firm. In this view, a group is a structure for integrating knowledge. A firm (or group) creates coordination mechanisms, such as rules, procedures and norms, to economize on communication, knowledge transfer and learning to reserve group decision making and problem solving for complex and unusual tasks (Grant 1996). Thus rules, procedures and norms are guidelines by which members coordinate their tasks efficiently and effectively. One way to change the behavioral potential of a group is through changing formal rules and/or procedures and/or informal norms (Hayes and Allinson, 1998). Thus the indicators I use for group learning is changes in the group's norms, rules, and procedures. These changes are the result of integrating the knowledge of experts into the group's structure reflecting behavioral changes within a group over time, what March et al. (2000) and Hayes and Allison (1998) refer to as learning on the group level.

In addition to rules, norms and procedures, Grant (1996) identifies the importance of shared mental models. Shared mental models, as defined by Cannon-Bowers et al. (1993), "are knowledge structures held by members of a team that enable them to form accurate explanations and expectations for the task, and in turn, to coordinate their actions and adapt their behavior to demands of the task and other team members" (pg 228). Argyris and Schön (1978) and Brown and Duguid (1991) suggest that for a group to create or change norms, rules and procedures (in other words learn) it is key that its members have shared understanding or shared mental models.

The importance of shared mental models comes from the fact that for rules, procedures and norms to be effective mechanisms for coordinating members within a group, they have to be interpreted somewhat consistently on the group level but individuals from different teams or backgrounds may otherwise interpret tasks differently based on their backgrounds making collaboration and communication difficult (Dougherty, 1992). The tendency for individuals to interpret tasks according to their own perspectives and predefined routines may be exacerbated when they work in a distributed environment, with more variety in individual settings. To summarize, in my study I will be looking for two indicators of groups learning. The first set of learning indicators are explicit, in the form of changes to rules and procedures that are available to the group. The second set of indicators is implicit and inferred from the behavior of the group as norms and shared mental models.

Having defined what I mean by group learning, in the following section I discuss the learning process that exist on a group level to lead to potential behavioral changes in the group as a result of integrating the knowledge of members.

The Process of Learning

Scholars in the cognitive psychology literature have long argued that a group's capacity to store and retrieve information is greater than the capacity of the individual (Maier et al. 2001). The management literature has also argued that group knowledge is superior to that of its individual parts (Wegner, 1998; Dodgson 1993). Despite these claims, one cannot deny that there are frequently process losses in groups, which can make some of the knowledge of members inaccessible to the group and its common purpose (Diehl and Stroebe 1987; Stasser 1992, Steiner 1972). These process losses can be due to problems in coordination, communication, group culture, group norms and group cohesion. Optimal group work occurs when all the relevant information possessed by each individual member is shared and considered in making a decision or performing a task (Stasser 1992). This

however is not always the case since it is difficult for the group to retrieve all relevant information from all members and create a successful learning environment and process (Stasser et al. 1989; Larson et al. 1994, Stasser and Titus 1985). In a setting where members are independent and distributed, such as in OSS, these challenges can be exacerbated. To address these challenges, it is important to understand the processes through which learning occurs.

Unfortunately, the learning process has not yet been clearly described in detail in the organizational learning literature (Huber, 1991; Prange, 1999). The frameworks of the literature (Cyter and March, 1963; Argyris and Schon, 1978; Fiol and Lyles, 1985; Levitt and March, 1988; Huber, 1991) identify learning in a number of ways, but there is no clear explanation of the process through which the learning occurs. For example, Cyert and March (1965) describe learning as the process of adaptation of goals and rules and reduction of stress but not how that occurs. There is no single rigorous analytical or conceptual framework that explains organizational learning in general (Fiol and Lyles, 1985; Huber 1991) and organizational learning in a distributed environment in particular (Robey et al. 1999). My study attempts to fill this gap in the literature.

Figure 1 presents the learning process of a group in terms of antecedents, structuring processes, and various outcomes. The model includes implicit (norms and shared mental models) and explicit (rules and procedures) antecedents that structure the learning processes of a group. Other antecedents that might influence a group's learning include, but are not limited to, the task, technology used, and the structure of the group. These antecedents influence a set of two interdependent structuring processes, a social process and a learning process. The learning process leads to changes in rules and procedures as explicit indicators of learning, in addition to changes in norms and shared mental models as implicit indicators of learning.

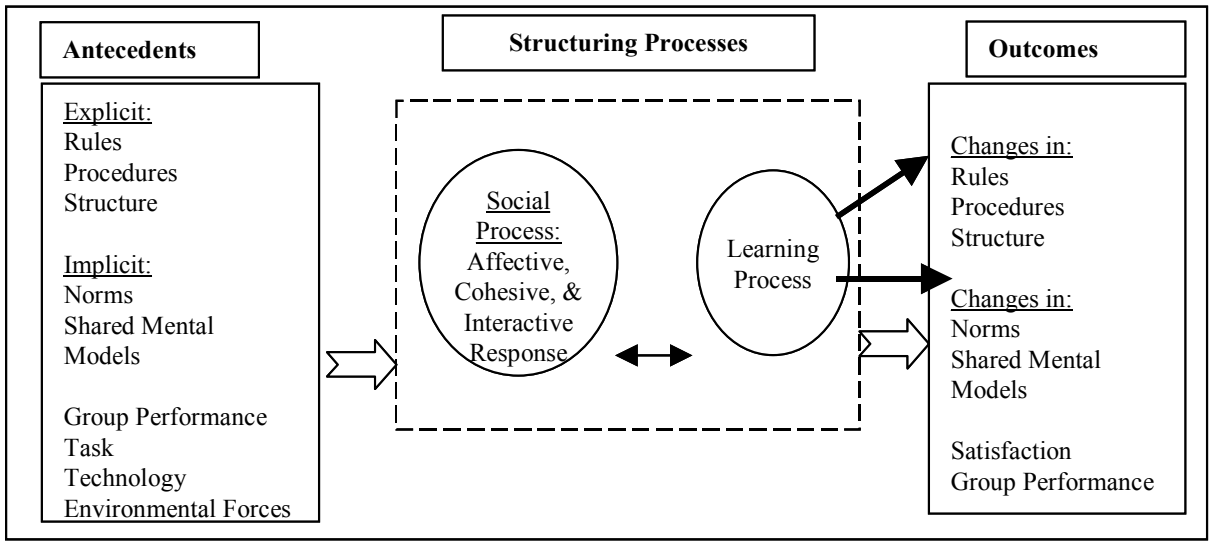

Figure 1. Conceptual Model for Group Learning in Distributed Teams

Social Process

I study the social process in the interactions, "to capture interpersonal characteristics and group cohesiveness" (Heckman and Annabi 2003). The Social Interdependence Theory of Cooperative Learning (Aviv 2000; Rourke et al. 1999) suggests that cohesiveness and positive interpersonal characteristics in a group promote knowledge sharing and learning in a group. It is especially important to study this process in OSS, as the lack of informal communication and personal characteristics have been identified as limitations to collaborating and learning in distributed groups (Heckman and Annabi 2003).

I will utilize the framework of Rourke et al. (1999) to study the nature of the group's social process and its influence of the other processes and learning outcomes. Rourke et al. (1999) identify three social sub-processes. First they identify Affective Response as interactions that include emotional/affective content. Second they identify Cohesive Response as indication of building group cohesion and having a sense of group commitment that is important for learning. Lastly they identify Interactive Response as indication of open communication, attentiveness and interaction between members. These three types of responses can enhance learning in a distributed group.

Learning Process

To study learning process, I study the process by which an organization or a group integrates the knowledge of the members into the group's rules and procedures. Borrowing from Asynchronous Learning Networks literature (Garrison et al. 2000; Heckman and Annabi 2003), I identified a number of mechanisms through which the knowledge of the members can be integrated and into group structure. Members share their knowledge with the group by identifying problems or opportunities to improve effectiveness, analyzing the situation at hand using their knowledge and building on the knowledge of the other members. This collaborative process can yield better results in the form of rules and procedures once the group integrates decisions into explicit rules and procedure.

Through this framework, I can study the shape of the process through which the group integrates independent knowledge workers' knowledge and identifying the factors that enhance or inhibit the process. Explicit indicators are a product of the learning process that is concerned with the creation, processing and interpretation of explicit knowledge to improve effectiveness, what the literature refer to as technical learning (Easterby-Smith and Araujo, 1999).

Methodology

In the following section, I will present the methodology used and present an outline of the content analytic scheme I plan to use in my study. There will also be reference to an example of a learning instance from actual data.

To understand the complex, blurred and embedded phenomenon of collective learning, the case study approach is most appropriate (Yin 1984). Yin defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (Yin 1984, pg. 23). Thus the study employs a multiple case study approach of learning instances. A learning instance is a group event that occurred over time resulting in changes in the behavioral potential of the group. The behavioral potential is operationalized in changes in rules, procedures, norms or shared mental models.

Data Collection

I plan to collect instances of learning from five different OSS groups of different sizes and stages of development. These instances will be identified in a variety of ways by searching through archives of OSS interactions through key word searches, press releases, browsing interactions, studying documentation over time, as well as through interviews with members. I will identify the learning instances in the five OSS groups and randomly select 100 instances.

My analysis of each learning instance will be based on multiple related data sources, such as documentation regarding the groups' history, procedures, culture, etc. I will also conduct email interviews with group members to ask about motivation, developer perceived learning and contribution, shared understanding about the project, description of process, perceived success of project, satisfaction, perceptions of roles/social structure, and perceived rules (and the changes).

Data Analysis

Data collected will be content analyzed using a mix of deductive and inductive approaches. The goal of the analysis is to discover the patterns in the data to reveal the nature of the two structuring processes (highlighted in Figure 1) and the factors facilitating group learning.

Expected Impact

I expect my study to have conceptual, methodological as well as practical contributions. Understanding the process of learning in a team of independent knowledge workers working in a distributed environment is important to improve the effectiveness of distributed groups and of the traditional and non-traditional organizations within which they exist. As Maier et al. suggest; "Knowledge about the process, or the know how, of learning facilitates corrections that simulate or accelerate learning" (Maier et al. 2001, pg. 16). Developing a theoretical approach consolidating a number of theories to understand the learning process

within a distributed group is a contribution to the study of distributed groups and learning within organization literature (Robey, Min Khoo and Powers 1999). Employing qualitative techniques to understand the process of learning will also be a contribution to the organizational learning methodology (Miner and Mezias, 1996).

Understanding learning in distributed groups has practical implications for OSS groups, software development groups, and distributed groups in general. An in-depth analysis of the learning process and the practices will help us identify effective practices of distributed work which will be valuable for managers that intend to implement such form of work, which is increasingly used for a wide range of knowledge work. In addition findings from the study can be used to enhance the way technologies are used in education or for scientific collaboration.

References

Argyris, C. and Schön, D. (1978) *Organizational Learning,* London: Addison-Wesley.

Argyris, C. and Schön, D. (1996) *Organizational Learning II: Theory, method and practice,* Reading, Mass: Addison Wesley.

Aviv, R. (2000). Educational performance of ALN via content analysis. *The Journal Of Asynchronous Learning Networks*, 4(2), Available at **http://www.aln.org/alnweb/journal/Vol4_issue2/le/reuven/LE-reuven.htm**.

Bélanger, F., & Collins, R. (1998). Distributed Work Arrangements: A Research Framework. *The Information Society, 14*(2), 137–152.

Brown, J. S., & Duguid, P. (1991). Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation. *Organization Science, 2*(1), 40–57.

Cannon-Bowers, J. A., & Salas, E. (2001). Reflections on Shared Cognition. *Journal of Organizational Behavior, 22*, 195–202

Cannon-Bowers, J. A., & Salas, E. (1993). Shared Mental Models in Expert Decision Making. In *Individual and Group Decision Making,* Castellan, N.J. (Ed.). Lawrence Erlbaum Associates: Hillsdale, NJ, 221-246.

Carmel, E., & Agarwal, R. (2001). Tactical approaches for alleviating distance in global software development. *IEEE Software*(March/April), 22–29.

Cyert, R.M. & March, J.G. (1963). *A behavioral Theory of the Firm*, Englewood Cliffs, NJ: Prentice-Hall.

de Souza, P. S. (1993). *Asynchronous Organizations for Multi-Algorithm Problems.* Unpublished Doctoral Thesis, Department of Electrical and Computer Engineering, Carnegie-Mellon University.

Diehl, M. and Stroebe, W. (1987) Productivity Loss in Brainstorming Groups: Toward the

Solution of a Riddle. *Journal of Personality and Social Psychology*. 53: 497-509.

Dodgson, M. (1993). Organizational Learning: A Review of Some Literatures. *Organization Studies.* 14(3): 375-394.

Dougherty, D. (1992). Interpretive Barriers to Successful Product Innovation in Large Firms. *Organization Science, 3*(2), 179–202.

Drucker, P.F. (1998). Management's New Paradigms. *Forbes*. 162(7): 152-177.

Easterby-Smith, M., Burgoyne, J. and Araujo, L. (1999) *Organizational Learning and the Learning Organization*, London: Sage.

Fiol, M.C. & Lyles, M.A. (1985). Organizational Learning. *Academy of Management Review* 10(4): 803-813..

Garrison, R, Anderson, T., & Archer, W. (2000). Critical thinking in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education.* 2(2-3): 87-105.

Garvin, D.A. (1991). Barriers and gateways to learning. In Christensen, C.R., Garvin, D.A. & Sweet, A. (eds.) *Education for Judgement: The Art of Discussion Leadership*. Harvard Business School Press. Boston. 3-14.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(Winter), 109–122.

Grinter, R. E., Herbsleb, J. D., & Perry, D. E. (1999). The Geography of Coordination: Dealing with Distance in R&D Work. In *Proceedings of the GROUP '99 Conference* (pp. 306–315). Phoenix, Arizona, US.

Guzzo, R.A. and Shea, G.P. 1992, Group Performance and Intergroup Relations in Organizations, in M.D. Dunnette and L.M. Hough (eds.), Handbook of Industrial and Organizational Psychology (Vol. 3)(2nd edn). Palo Alto, Calif.: Consulting Psychologists Press, 269-313.

Heckman, R. and Annabi, H. (2003) A Content Analytic Comparison of FTF and ALN Case Study Discussion, *Proceedings of the 36th Hawaii International Conference on System Sciences*, 2003.

Hayes, J. and Allison, C. (1998) Cognitive Style and the Theory and Practice of Individual and Collective Learning in Organizations, *Human Relation,* 51(7).

Herbsleb, J. D., & Moitra, D. (2001). Global Software Development. *IEEE Software* (March/April), 16–20.

Huber, G.P. (1991). Organizational Learning: The contribution processes and the Literatures. *Organization Science.* 2(1): 88-115.

Jarvenpaa, S. L., & Leidner, D. E. (1999). Communication and trust in global virtual teams. *Organization Science, 10*(6), 791–815

Kraut, R. E., Steinfield, C., Chan, A. P., Butler, B., & Hoag, A. (1999). Coordination and virtualization: The role of electronic networks and personal relationships. *Organization Science, 10*(6), 722–740.

Larson, J. R., Jr., Foster-Fishman, P.G. and Keys, C.B. (1994). The Discussion of Shared and Unshared Information in Decision Making Teams, *Journal of Personality and Social Psychology,* 67:446-64.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lin, F. & Lin S. (2001) A Conceptual Model for Virtual Organizational Learning, *Journal of Organizational Computing and Electronic Commerce,* Vol. 11(3), Pg. 155-178.

Levitt, B. & March, J.G. (1988). Organizational Learning. *Annual Review of Sociology.* 14: 319-340.

Maier, G.W., Prange, C. and Rosenstiel, L. 2001, Psychological Perspective of Organizational Learning, in M. Dierkes, A. Berthoin Antal, J. Child, and I. Nonaka (eds.), *Handbook of Organizational Learning and Knowledge*, New York, Oxford Press, 14-34.

Malone, T.W. & Laubacher, R.J. (1998). The Dawn of the E-Lance Economy. *Harvard Business Review*. 76(5): 144-152.

March, J.G., Schulz, M. and Zhou, X. (2000), The Dynamics of Rules: Change in Written Organizational Codes, Stanford University Press, Stanford: California.

Markus, M. L., Manville, B., & Agres, E. C. (2000). What makes a virtual organization work? *Sloan Management Review, 42*(1), 13–26.

Miner, A.S. and Mezias, S.J. (1996), Ugly Duckling No More: Pasts and Futures of Organizational learning, *Organization Science,* 7(1): 88-99.

Orr, J. (1987). Narratives at work. In *Field Service Manager* (pp. 47–60).

Orr, J. (1996). *Talking About Machines: An Ethnography of a Modern Job*. Ithaca, NY: ILR Press.

Prange, C. (1999). Organizational Learning - Desperately Seeking Theory? In M. Easterby-Smith, J. Burgoyne, & L. Araujo (eds.) *Organizational Learning and the Learning Organization*, London: Sage. 23-43.

Robey, D., Khoo, H. M., & Powers, C. (1999). Situated-learning in cross-functional virtual teams. *IEEE Transactions on Professional Communication* (Feb/Mar), 51–66.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (1999). Assessing social presence in asynchronous, text-based computer conferencing. *Journal of Distance Education*, 14(3), 51-70. Available at **http://cade.athabascau.ca/vol14.2/rourke_et_al.html**.

Senge, P. (1990). *The Fifth Discipline: The art and practice of the learning organization*. London: Random House.

Simon, H.A. (1991). Bounded Rationality and Organizational Learning. *Organization Science*. 2: 125-134.

Stasser, G. (1992). Pooling of Unshared Information During Group Discussion, in S.

Worchel, W. Wood, and J.A. Simpson (eds.), *Group Process and Productivity*, Newbury Paerk, California: Sage, 48-67.

Stasser, G. and Titus, W. (1985) Pooling of Unshared Information in Group Decision

Making: Biased Information Sampling During Group Discussion, *Journal of Personality and Social Psychology*. 48: 1467-78.

Stasser, G., Taylor, L.A. and Hanna, C. (1989). Information Sampling in Structured and

Unstructured Discussions of Three- and Six-person Groups, *Journal of Personality and Social Psychology*, 57: 67-78.

Steiner, I.D. (1972) *Group Process and Productivity*, New York: Academic Press.

Walsh, J.P. and Ungson, G.R. (1991). Organizational Memory. *Academy of Management Review*, 16(1): 57-91.

Wenger, E. (1998). *Communities of Practice: Learning, Meaning, and Identity*. New

York: Cambridge University Press.

Yin, R. (1984). *Case Study Research*. Beverly Hills, CA: Sage Publications Inc.

Appendix: Example Learning Instance

The following is an **example** of a learning instance identified from Apache Web Server at Apache.org (an OSS development team **http://marc.theaimsgroup.com/?l=apache-docs&m=95961396704606&w=2**). The example instance was identified through a key word search. The group underwent a change in procedure as to how to submit and organize documentation submissions from developers and users.

A member proposed a change to the documentation submission aspect of the group's work:

> *"Okey, here's another attempt, now that I have some time to write it up.*
> *What:*
> *I propose to create new CVS modules on the Apache system, and move the existing server documentation into them and out from under the source modules."*

He explained the objective for the change to be to increase participation from non-developers who would like to assist with the documentation aspect of software development. Other developers in the group commented on the proposal and its elements and provided suggestions for the change. A couple of responses are illustrated below.

Comment 1

> *"Ken,*
> *>What:*
> *>I propose to create new CVS modules on the Apache system, and move the existing server*
> *>documentation into them and out from under the source modules.*
> *+1*
> *> How:*
> *>I propose that two new modules, httpd-docs-1.3 and httpd-docs-2.0, be created. The current*
> *>src/htdocs/ directory trees in the apache-1.3 and apache-2.0 CVS modules, and the apidoc/ tree*
> *>in the apache-devsite module, would be tagged, and then the files in those trees either copied*
> *>or moved to the appropriate httpd-docs-* tree.*
> *Copied. They must continue to exist in the old locations so that we can*
> *rebuild releases based on previous tags.*
> *Personally, I'd "cvs add" copies of the HEAD of these areas, with a*
> *checkin comment pointing to their old location. But if the choice is going*
> *to be copy or move... take copy."*

Comment 2

> *"> Okey, here's another attempt, now that I have some time to write*
> *> it up.*
> *+1*
> *> Concerns and other items:*
> *When the new module is created I would like to see all current apache-cvs subscribers added to the new list.*
> *I don't expect so much traffic that this will be a real issue, and it is a subtle reminder that we are all responsible*
> *for docs. :-)*

Learning Outcomes

The discussion led to creation of a separate CVS tree for documentation submission and resulted in participation from other members to this function of the group. New guidelines were created for the group as well.