A structurational perspective on leadership
in technology-supported self-organizing small groups[1]

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Abstract

In this conceptual paper, we present a structuration-based theory of leadership behaviours in virtual teams, that is to say, in self-organizing technology-supported small groups such as Free/Libre Open Source Software development teams. Such teams are often composed of members of relatively equal status or who are so disparate in background that formal organizational status seems irrelevant, reducing the usual leadership cues provided by organizational status and title. Building on behavioural leadership theory and structuration theory, we present a two-order theory of leadership. It describes four classes of first-order leadership behaviours (*task coordination*, *substantive task contribution*, *group maintenance*, and *boundary spanning*) and defines second-order leadership as behaviour that influences changes in the structure that guides group action. Specifically, we suggest that second-order leadership behaviours are those that build structures of signification in the form of interpretive schema, structures of domination in the form of role structures and structures of legitimation in the form of rules and norms. We argue that second-order leadership is enabled by first-order leadership, is therefore action embedded, and is grounded in processes that define the social identity of the group. We propose that effective teams will exhibit a paradoxical combination of shared, distributed first-order leadership complemented by strong, concentrated, and centralized second-order leadership. We conclude by suggesting future research that might be conducted to test and further elaborate our theory.

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1. Introduction

We develop a theory of leadership in self-organizing technology-supported small groups, (i.e., in networked virtual teams). Small groups or teams provide a mechanism for organizations to integrate diverse forms of specialized knowledge (Grant, 1996). Because the demand for teams is great and growing, organizational members often find themselves serving on a number of teams simultaneously. However, in many contexts, such as global firms, it is impractical to accommodate fluid, simultaneous, multi-team membership by moving people around physically. In such contexts, information and communication technologies (ICT) make such structures feasible in a virtual organizational space. As a result, technology-supported small groups (or *virtual teams*) are of great interest to organizations because of their ability to bridge discontinuities of time and geography to enable access to and transfer of knowledge across geographic and organizational boundaries, thus leveraging human and intellectual capital (Duarte & Snyder, 2001). Because they can rapidly bring together the specific expertise needed to solve immediate problems regardless of geographical location, virtual teams also permit organizations to respond quickly to unexpected changes in the environment and to non-routine problems. As a result, virtual teams are an increasingly important part of an organization's adaptive capability to respond to uncertainty and complexity.

Unfortunately, as teams broaden in scope and membership they become increasingly difficult to manage. In particular, members of virtual teams may come from a variety of organizations or sub-organizations; rather than being assigned to the team by a common manager, members often voluntarily choose to participate (a form that Stark (1999) described as a "heterarchy"). As a result, these teams are often *self-organizing*, that is, they are characterized as having a "high degree of decision-making and autonomy and behavioural control at the work group level… (such that) a much greater emphasis is placed on control from within rather than outside the group" (Manz & Sims, 1987, p. 107). Other examples of self-organizing teams include *ad*

hoc task groups that quickly form and dissolve, *voluntary learning groups* that may be informal or semi-formal (*e.g.*, *communities of practice*, *action learning groups* or *study circles*) and *self-managing work groups* within formal organizations. A particularly important example of self-organizing teams are those created in the context of inter-organizational alliances where members come from different organizations but there is no dominant partner to impose a structure. Indeed, participants in self-organizing teams may represent no organization at all, as is often the case in Internet-enabled collaborations such as Wikipedia and Free/Libre Open Source Software (FLOSS) development teams. As organizations become increasingly knowledge-based and dependent on effective coordination of specialized knowledge for competitive advantage, teams in general and these sorts of self-organizing teams in particular grow in importance.

1.1 Problem statement

The primary contribution of this paper is to develop a set of theoretical propositions about the nature of emergent leadership in self-organizing virtual teams (*i.e.*, technology-supported distributed small groups), based on behavioural leadership theory and structuration theory. We further develop these propositions by considering how structure can be instantiated in shared mental models and the specific behaviours that contribute to building such models. Finally, because there are interesting suggestions that can be gleaned from the nascent literature on leadership in virtual teams, we present propositions about patterns of emergent leadership that seem likely to be more effective. We focus on leadership in self-organizing virtual teams for two reasons: the high level of discontinuities in virtual teams seems to pose particular challenges for leadership, and, as we discuss in our literature review, existing theories of group leadership do not seem to fully account for the leadership dynamics found in such teams. In the remainder of this subsection we describe these two problems in more detail.

First, Watson-Manheim, Chudoba & Crowston (2002) suggest that virtual work is characterized by numerous *discontinuities*, defined as a lack of coherence in some aspects of the work setting. Discontinuities are created and/or exacerbated by the specific features of technol-

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ogy-supported distributed small groups: fluid organizational membership, minimized organizational context, lack of face-to-face communication, reliance on asynchronous communication and lack of formal status cues. These discontinuities are problematic for virtual teams because they hinder team members in making sense of the shared task and of communications from others (van Fenema, 2002), or produce unintended information filtering (de Souza, 1993) or misunderstandings (Armstrong & Cole, 2002). These interpretative difficulties in turn make it hard for team members to develop shared mental models of the developing project (Curtis *et al.*, 1990, p. 52; Espinosa *et al.*, 2001). A lack of common knowledge about the status, authority and competencies of participants can be an obstacle to the development of norms (Bandow, 1997, p. 88) and conventions (Mark, 2002). The separation between members may ultimately result in an ineffective team (Bélanger & Collins, 1998; Carmel & Agarwal, 2001; Jarvenpaa & Leidner, 1999; Kraut *et al.*, 1999). Researchers have suggested that team leadership is key to helping team members overcome these barriers to performance (Cascio & Shurygailo, 2003; Hart & McLeod, 2003; Zigurs, 2003).

Second, the nature of leadership in self-organizing virtual teams does not seem to be adequately described by current theories of leadership, as we will discuss in more detail as we review the literature. In the absence of formally designated leaders, members within the team lead on a "voluntary" basis, either individually or collectively. In these circumstances, leadership is said to be *emergent*. According to Berdahl (1996), leaders emerge when "one or more of a group composed initially of equal status peers… exhibits notably higher levels of leadership behaviour and thereby attains higher status in the eyes of fellow group members" (p. 26). Some teams will evolve a leadership structure in which a single member emerges who is recognized by other members as the team's leader, while other teams will evolve a less-centralized leadership structure based on interaction and influence patterns. In the latter case, leadership can be shared among two or more team members or distributed among all team members (House & Aditya, 1997; Pearce & Conger, 2003b). In these teams, a very different form of leadership seems to be at work. No single individual plays an obviously dominant role. When asked who their leaders

are, members of these teams will often say, "We have no leaders." We might call such teams *acephalous* teams (having no head). If members of a team claim to have no leaders, is it accurate to say that the team has no leadership? Such situations pose several problems for most traditional conceptions of leadership, which is the second motivation for our paper. We argue that leadership is indeed at work in these situations, but in a form that must be looked at differently than as presented by most current theories of leadership.

1.2 Setting

The contribution of our paper is conceptual rather than empirical, but to make our emerging theory more concrete, we illustrate the form of leadership in these teams with examples drawn from email transcripts of developer interactions in several FLOSS[3] (Free/libre Open Source Software) development project teams. These examples are intended to be illustrative of our propositions rather than being the source or demonstration of their correctness. Because our argument here is primarily conceptual, building on prior theory, rather than empirical, building on current data, detailed description of a data collection approach would be inappropriate for this paper.

FLOSS is a broad term used to embrace software developed and released under an "open source" license allowing inspection, modification and redistribution of the software's source code. There are thousands of FLOSS projects, spanning a wide range of applications. Due to their size, success and influence, the Linux operating system and the Apache Web Server are the most well known, but hundreds of others are in widespread use. Table 1 provides a brief description of the projects mentioned in this paper.

Insert Table 1 about here

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3   FLOSS software is generally available without charge ("free as in beer"). Some (though not all) FLOSS software is also "free software", meaning that derivative works must be made available under the same license terms ("free as in speech", thus "libre"). We have chosen to use the acronym FLOSS to accommodate this range of meanings.

FLOSS projects are a particularly appropriate source of examples for our theorizing because they are prototypical self-organizing virtual teams. FLOSS developers contribute from around the world, meet face-to-face infrequently (or not at all), and coordinate their activity primarily by means of information and communications technologies (ICT) (Raymond, 1998; Wayner, 2000). The nature of interaction in these teams and their use of ICT to communicate, collaborate, and coordinate work is consistent with Townsend and colleagues' (1998) definition of *virtual teams* as teams composed of "geographically and/or organizationally dispersed co-workers that are assembled using a combination of telecommunications and information technologies to accomplish an organizational task" (Townsend et al., 1998, p. 18). Virtual teams vary considerably in their structure and purpose and in the amount of time that they spend to complete their tasks. In structure, FLOSS teams most closely resemble what Duarte and Snyder (2001) labelled as *networked virtual teams,* characterized by fluid and diffuse membership, with members contributing to the team's work as their expertise and skills are needed. In addition, networked virtual team boundaries are permeable. In terms of time horizon, FLOSS teams also most closely resemble networked virtual teams, since they address the software development task over a relatively long time horizon, producing modifications and upgrades following the completion of the initial phase of the project.

Because of our interest in understanding the nature of leadership in technology-supported small groups, we use examples of leadership by FLOSS developers. Researchers have described FLOSS projects as having an onion-like structure (Cox, 1998; Gacek & Arief, 2004; Lee & Cole, 2003; Moon & Sproull, 2000) as shown in Figure 1, with core developers contributing most of the code and overseeing the design and evolution of the project and contributions from other developers and users.

Insert Figure 1 about here

We have chosen to draw examples primarily from interactions of core developers because FLOSS developers comprise a technology-supported small group. The developers are a group

because they have a shared goal of developing and maintaining a software product, are interdependent in terms of tasks and roles, and have a user base to satisfy. While a project may have dozen or even hundreds of contributors, the developers are generally a small group. Koch & Schneider (2002) found a core of 11 contributors to the Gnome project, Mockus, Fielding and Herbsleb(2002) suggest that the core for the Apache httpd project was generally 6–9 participants (varying over time), from a total of 249 who had submitted some code, while in an analysis of 116 successful SourceForge[4] projects, Crowston et al. (2006b) found a median of 7.5 individuals listed as core developers and a smaller number who were persistent contributors. Finally, the developers exhibit structural characteristics comparable to other groups. While contributors are typically volunteers[5], it is a mistake to conclude that the core therefore has no structure. As an analogy, a Boy Scout troop or volunteer fire department may also be all volunteer, but still highly structured. For example, acceptance of a co-developer into the core is often a formal process, involving a period of contribution that results in an invitation to join. There may be a division of labour with more or less explicit roles (*e.g.*, the release manager). The core members typically shared accepted norms for development, with informal or formal sanctions for violations. Indeed, we argue below that development of role structure and norms are an important form of leadership in these groups. However, the nature of these technology-supported groups—fluid membership, reliance on asynchronous technology-mediated rather than face-to-face interaction, lack of common organizational context—makes development of such group structures more difficult.

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[4] SourceForge (http://sourceforge.net/) is a commonly used system that provides a variety of tools to support the development of FLOSS projects.

[5] Developers are volunteers in the sense that they are not employees of the project itself, though increasingly some may be employed by other firms to contribute to the project, a situation similar to members of an alliance contributing employees to a joint team. For example, IBM employs many developers who contribute to Linux or Apache projects, though IBM in no way manages these projects.

1.3 Overview of the paper

In the following sections of this conceptual paper, we first introduce the two building blocks of our theorizing, leadership theory and structuration theory. We then develop a theory of emergent leadership behaviours in self-organizing virtual teams, as exemplified by FLOSS project teams. Our focus on emergent leadership leads us to try to characterize the process of emergence rather than to develop a static picture of leadership characteristics. The main contribution of our paper is the integration of various social theories to develop theoretical propositions about emergent leadership in self-organizing virtual teams and, secondarily, of what patterns of leadership seem to be most effective. Our paper thus provides direction for future research by suggesting what concepts and relationships to study and what kinds of data to collect. We conclude by describing directions for future research to test or further refine and extend our theory.

2. A structurational perspective on leadership in virtual teams

In the two sections that follow, we first review empirical investigations of emergent leadership in virtual teams, identify the problems these team pose for existing theories of leadership, and suggest adopting a behavioural perspective on leadership. Next, we present our rationale for adopting a structurational perspective to conceptualize the process of leadership in these teams.

2.1 Leadership theory

Leadership has been the topic of extensive research in the general management literature (Bass, 1990; Yukl, 2002). As noted above, the presence of discontinuities in virtual teams suggests that team leadership may play a particularly crucial role in enabling team effectiveness. However, there has been relatively little research that focuses on leadership in self-organizing virtual teams (Cascio & Shurygailo, 2003; Yoo & Alavi, 2004; Zigurs, 2003). Within the mainstream leadership literature, the subsets of the literature that discuss self-managing work teams and shared/distributed leadership have attempted to explain the phenomenon of "leaderless" teams (Manz & Sims, 1980; Pearce & Sims, 2000). Conceptually, these emerging views of leadership in teams depart from more "traditional" leadership theory that has focused on leader attributes (*e.g.*, trait theory), situational factors that determine the effectiveness of leader traits and

behaviors (*e.g.*, contingency and situational leadership theories), contextual factors in which leadership is embedded (*e.g.*, social exchange theory and strategic contingencies theory), and the nature of the relationship between leaders and follower (*e.g.*, vertical-dyad linkage and leader-member exchange theories). Both subsets of the literature suggest that leadership in teams differs fundamentally from leadership within formal organizational hierarchies, although the later has been the focus of the preponderance of the leadership literature (Antonakis *et al.*, 2004; Lowe & Gardner, 2001). These leadership perspectives are more directly applicable to the examination of self-organizing virtual team leadership in that they were developed to focus explicitly on team leadership as opposed to formal leadership within organizational hierarchies, and in that they explicitly acknowledge that leadership can be shared among team members and that more than one leader can emerge during the course of a team's interactions. We briefly review these theories as background to our own theorizing.

2.1.1 Leadership in self-managing teams

Although Manz and Sims (1980) introduced the concept of *self-managing teams* over twenty years ago, until now it has not received much attention in the empirical literature. Self-managing teams are characterized "by a high degree of decision-making and autonomy and behavioral control at the work-group level… (such that) a much greater emphasis is placed on control from within rather than outside the group" (Manz & Sims, 1987, p. 107). While the theoretical and empirical literature on self-managing teams might seem to be directly applicable to the study of virtual teams such as FLOSS project development teams, neither the process by which leaders emerge in self-managing teams nor how leadership is shared among team members has been a conceptual or empirical focus in this steam of literature. The literature on self-managing teams does acknowledge that team members can and do perform leadership roles that had previously been the purview of managers, however, the emphasis of research to date has been on the leadership behaviors of coordinators, facilitators, supervisors, or formal leaders external to the team itself and the actions that these external agents take to direct and support the efforts of self-managing teams and to encourage autonomous work (Manz & Sims, 1984, 1987;

Stewart & Manz, 1995). As such, it has focused on teamwork that is situated within an organization and in which leadership does not necessarily emerge organically from the interactions of team members, but rather is due to the presence of external agents that influence team activities through their own leadership behaviors.

2.1.2 Shared leadership

On the other hand, *shared leadership* is a relatively new concept in the leadership literature. Introduced in the mid-1990s, shared leadership is defined as:

> A dynamic, interactive process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both… (that) often involves peer, or lateral, influence and at other times involved upward or downward hierarchical influence (Pearce & Conger, 2003b, p. 1).

This perspective, similar to the notion of distributed leadership (Gronn, 2002), is a new model of leadership that conceptualizes leadership in terms of relational processes, shared phenomena occurring at different levels, and interdependencies among social networks or networks of influence (Fletcher & Kaufer, 2003, p. 21). It differs from conventional leadership theory by conceptualizing leadership as a group-level rather than an individual-level phenomenon. Fletcher and Kaufer (2003) note that in doing so it creates an important theoretical link between leadership research and research on teams and on groups that has been absent in prior work.

Empirically, though, shared leadership is a relatively unexplored area of inquiry. The discussions of shared leadership that have been published are primarily theoretical and conceptual (Conger & Pearce, 2003; Pearce & Conger, 2003a). Conceptually, shared leadership draws on existing behavioral leadership theory as well as emergent leadership, although Conger & Pearce (2003) note that complex and contradictory taxonomies of leadership behaviours have emerged from this research.

2.1.3 Behavioral theories of leadership

In focusing on the behavioral roles shared among team members in teams, Pearce and colleagues (Pearce & Conger, 2003a; Perry et al., 1999) argue that leadership is an inherently a behaviorally-based phenomenon, in line with *behavioral theories of leadership*. These theories

focus on the behavioral styles, orientations, or patterns that leaders manifest and include behavioral complexity theory, the leaderplex model and functional leadership theory (Denison *et al.*, 1995; Hooijberg *et al.*, 1997; Lord, 1977). We next briefly review this set of behavioral theories of leadership.

Emergent behavioral leadership theories such as *behavioral complexity theory* and the *leaderplex model* were developed to investigate the behaviors of managers in organizational settings, and much of the research conducted to date has focused on examining the behavioral differences between effective and ineffective managers (Denison et al., 1995; Hooijberg & Choi, 2000). Like "traditional" leadership theories, the focus is on the complexities of a behavioral repertoire exhibited by a single individual.[6] As a result, these theories do not really address the phenomenon of emergent shared leadership in virtual teams like FLOSS developer teams. Furthermore, both functional leadership theory and shared leadership suggest that it is unlikely that a "single multirole leader" will emerge in these contexts, contrary to the assumption of behavioral complexity theory (Bales & Strodtbeck, 1951; Houghton *et al.*, 2003). Decades of research on small group interactions, dating back to Bales' (1951) original investigations of the behavioral dimensions of leadership, support the notion that different individuals perform different leadership roles as circumstances warrant. Houghton and colleagues (2003) observe that when the task-oriented and social supportive-oriented leadership roles in small groups have been examined empirically, these leadership roles are often split between two or more individuals. They attribute this outcome to the tensions created when one individual attempts to fulfill both roles, noting that "the directive or task-oriented leader often creates tension within the group through the assignment of tasks…(and) may not be in the best position to fill the social supportive role of solving or soothing the problems created by the task-related tension" (Houghton et al., 2003, p. 126).

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6   Although Kayworth & Leidner (2002) consider their study of trust in virtual teams to provide evidence in support of behavioral complexity theory, it should be noted that leaders in their study were appointed and not emergent. As such, the study examined the behavioral repertoires exhibited by more- and less-effective appointed leaders rather than emergent leaders.

2.1.4 Functional behavioral leadership theory

Within the virtual teams literature, *functional behavioral leadership theory* has either implicitly or explicitly informed the majority of published studies of virtual team leadership (Cogburn *et al.*, 2002; Kayworth & Leidner, 2002; Misiolek & Heckman, 2005; Sarker *et al.*, 2002; Sudweeks & Simoff, 2005; Tyran *et al.*, 2003; Weisband, 2002; Yoo & Alavi, 2004).[7] Of these behaviorally-based studies, most adopted the two-factor theory of leadership derived from Bales (1950) research on small group interaction, which distinguishes between task- and relationship-oriented leadership behavior. Task-oriented behaviours are those that move the team forward in the accomplishment of its task and include such behaviours as "planning and scheduling work, coordinating subordinate activities, and providing necessary supplies, equipment, and technical assistance" (Yukl, 2002, p. 53). Relationship-oriented behaviours are those that allow the team to maintain a positive psycho-social dynamic such as "showing trust and confidence, acting friendly and considerate, trying to understand subordinate problems, helping to develop subordinates and further their careers, keeping subordinates informed, showing appreciation for subordinates' ideas and providing recognition for subordinates' accomplishments" (Yukl, 2002, p. 53).

2.1.5 Leadership in virtual teams

The nascent literature on leadership in virtual teams does provide some insights into the behavioral nature of leadership in these teams, and has considered issues including leadership structure, initiation behavior, and communication quantity and content.

- *Leadership structure.* In the absence of a formal or appointed leader, the literature suggests that different leadership structures evolve within virtual teams (Cogburn et al., 2002; Misiolek & Heckman, 2005; Piccoli *et al.*, 2004). Some teams evolve a leadership structure in which one or two emergent leaders take the initiative to structure and guide

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7   In the literature on leadership in teams, this has also been referred to as the functionalist perspective (Northouse, 2004).

the teams' work. Others evolve a more distributed structure in which the leadership of the team is shared by its members (e.g., Misiolek & Heckman, 2005; Yoo & Alavi, 2004).

- *Initiating behaviours.* While only two studies examined the relationship between emergent leadership and initiation of communication, both offer evidence that taking initiative is positively associated with being identified as an emergent leader (Tyran et al., 2003; Yoo & Alavi, 2004). This finding appears to apply to the initiation of communication with team members at the outset of a team's task, as well as to the initiation of communication that keeps the team focused on its task throughout the team lifecycle (Piccoli et al., 2004; Tyran et al., 2003; Yoo & Alavi, 2004).

- *Quantity of communication.* Findings from studies of virtual team dynamics suggest that emergent leaders communicate with team members more frequently than non-leaders (Jarvenpaa *et al.*, 1998; Jarvenpaa & Leidner, 1999; Misiolek & Heckman, 2005; Piccoli et al., 2004; Sudweeks & Simoff, 2005; Yoo & Alavi, 2004). The two studies that examined message length also suggest that emergent leaders send longer messages in terms of number of words per message than non-leaders (Sudweeks & Simoff, 2005; Yoo & Alavi, 2004).

- *Communication content.* The literature suggests that although emergent leaders may engage in both more task- and relationship-oriented communication than non-leaders, only task-oriented communication is associated with being identified as an emergent leader. Several explanations have been offered for this association that have implications for the study of emergent leadership in networked virtual teams. Pescosolido (2002) and Hart and McLeod (2003) suggest that emergent leaders will increase their task-oriented communication as well in order to reduce ambiguity, provide direction, and move the work of the team forward. This suggestion is in line with Jarvenpaa and colleagues' (1998; , 1999) observations concerning the relationship between communication content and the team lifecycle. However, while their study was conducted with intact virtual student teams, membership in networked virtual teams can be fluid. This raises the possibility

that emergent leaders in networked teams increase their relationship-oriented communi-

cation when the composition of the team changes, and particularly when new members

join the team. Similar dynamics may pertain when networked virtual team members de-

part and are no longer active participants in the work of the team.

While these studies are informative, they are also share three important limitations for our theo-

rizing: (a) the teams studied remained stable throughout the short duration of the study, (b) the

tasks were relatively short-term in nature, ranging from 2 to 15 weeks, and (c) the broad-based

distinctions between task- and relationship-oriented communication may not capture more subtle

leadership dynamics suggested by the literature.

Taking up the final point, in a distributed team where members make diverse knowledge

contributions (Grant, 1996), Misiolek & Heckman (2005) found it useful to distinguish between

two types of task roles, *task coordination* and *substantive task contribution*. Task coordination

behaviors are those involved in organizing and directing the group's work (*e.g.,* scheduling, di-

viding labor, creating processes) while substantive task contributions are those that actually ac-

complish the group's work (*e.g.,* idea generation, evaluation, integration, synthesis) Thus, leaders

may exercise their influence by means of their substantive expertise as well as through their co-

ordinating and directing activities. Finally, in addition to the task and group maintenance func-

tions which leadership must satisfy, Ancona and Caldwell (1988) argued that there are also

leadership functions involved with maintaining relations with individuals and groups outside the

team, called boundary spanning.

2.1.6 Summary

The shared leadership perspective and the results of empirical investigations of emergent

leadership in virtual teams suggest that leadership in networked virtual teams such as FLOSS

teams is both shared and emergent. Behavioral leadership theory provides additional insights into

the classes of leadership behavior that leaders in these types of teams manifest: task coordina-

tion, substantive task contribution, group maintenance, and boundary spanning. However, while

behavioral leadership theory provides a framework for identifying classes of leadership behav-

iors, it falls short in explaining changes in leadership behaviors over time in response to changes in team composition and the environment, how leadership behaviors enacted by individuals guide team interaction in these contexts and how structures for task performance and team interaction emerge in conjunction with ongoing interaction and in the absence of a formal hierarchical authority.

2.2 Structuration theory

To conceptualize the process by which individuals' actions can provide emergent leadership in virtual teams such as FLOSS development teams, we adopt a structurational perspective (Giddens, 1984). Numerous authors have used a structurational perspective to frame empirical analyses of team activities (e.g., Barley, 1986; DeSanctis & Jackson, 1994; Newman & Robey, 1992; Orlikowski, 1992; Walsham, 1993) and in particular, the development of virtual teams (e.g., Sarker *et al.*, 2001). We chose this framework because it provides a recursive view of the relations between team structure and the actions of those that live within, and help to create and sustain, this structure. In particular, it provides a framework for analyzing how the leadership behaviours of one member might shape the actions of others, even in the absence of traditional modes of authority.

Structuration theory is best described as a meta-theory: that is, rather than specifically describing the relations between particular factors of leadership, structuration theory describes the form that such a theory should take. Specifically, structuration theory suggests that a theory of leadership in virtual teams should consider structure and action in these teams and how the two are interrelated. By structure, we mean the rules and resources that influence, guide or justify individual action. Structure is "encoded in actors' stocks of practical knowledge" (Barley & Tolbert, 1997, p. 98) and "instantiated in recurrent social practice" (Orlikowski, 2000). In our work, we consider three kinds of rules and resources identified in prior work (Barley & Tolbert, 1997; Stein & Vandenbosch, 1996):

1. interpretive schema that create structures of signification,

2. authoritative and allocative resources that create structures of domination, and

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3.   norms and rules that create structures of legitimation.

Individual actions may be guided by these structures or may seek to change them, as will be discussed further below. For example, a particular process for testing software modules in a software development team may be followed by an individual developer (an individual action) because that process is the accepted norm within the team (*i.e.*, because of a structure of legitimation). It should be noted that this division into three categories of structure is an analytic convenience: in practice, the structures are overlapping and mutually reinforcing.

Structure matters because the development of a common structure leads to improved team performance if it enables more effective contributions by team members. That is, it is not a question of the presence or absence of structure, but rather its nature and the degree of agreement among team members. For example, without common interpretive schema (a kind of shared structure), individuals from different teams or backgrounds may interpret tasks differently based on their backgrounds, making collaboration and communication difficult (Dougherty, 1992). In the absence of developed team norms, team members will likely draw on norms they have acquired in other settings to guide their actions, but these diverse norms may conflict. The tendency for individuals to interpret tasks according to their own perspectives and predefined routines is exacerbated when working in a virtual environment, with its more varied individual settings and less opportunity for informal discussion.

We turn now to the question of how structure is developed. The key notion here is the "duality of structure", meaning that the structural properties of a social system are seen as both the means and the ends of the practices that constitute the social system. As Sarason (1995) explains, in structuration theory:

> The central idea is that human actors or agents are both enabled and constrained by structures, yet these structures are the result of previous actions by agents. Structural properties of a social system consist of the rules and resources that human agents use in their everyday interaction. These rules and resources mediate human action, while at the same time they are reaffirmed through being used by human actors or agents. (p. 48).

Simply put, by doing things, we create the way to do things (or as Askehave & Swales (2001) put it more poetically, "the wheels of life go round, and as they go round, they form ruts which channel the wheels of life"). For example, the norm of using a particular testing strategy is not a given, but rather itself the outcome of prior actions by developers. By following the norm, developers reinforce its legitimacy ("we always do it this way"); by taking different actions (*e.g.*, skipping testing because it is seen to be too time-consuming or using a different approach because the accepted approach seems unable to identify important problems), they undermine its legitimacy, perhaps eventually changing the norm. Indeed, as we will discuss, such behaviours may be deliberately chosen for their effects on structure.

Figure 2, adapted from Barley and Tolbert (1997, p. 101), graphically summarizes the relation between institution (which the authors use synonymously with structure) and action, and how both evolve over time. In this figure, the two bold horizontal lines represent "the temporal extensions of Giddens' two realms of social structure: institutions and action," while the "vertical arrows represent institutional constraints on action" and the diagonal arrows, "maintenance or modification of the institution through action" (p.100). For example, the influence of a team norm on a developer to use a particular testing strategy is represented by a downwards vertical arrow, while reinforcement or changes to the norm due to actions is represented by an upwards diagonal arrow. We use this model of action and structure as the basis for our theorizing about the nature of leadership in virtual teams.

Insert Figure 2 about here

3. Theory development: Emergent leadership in self-organizing virtual teams

In the following section, we develop an argument that emergent leadership in self-organizing virtual teams consists of behaviours that generate or reinforce structure (*i.e.*, the upwards diagonal arrows in Figure 2). While it might first appear that a consideration of leadership would be relevant primarily to an understanding of structures of domination, we propose that leadership in self-organizing virtual teams is expressed through all three systems of structuration:

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signification, domination and legitimation. Indeed, leaders of self-organizing virtual teams may lack formal control over authoritative and allocative resources that produce structures of domination. Instead, based on the combination of functional behavioural leadership theory and structuration theory reviewed above, we will argue that a key role of emergent leadership in virtual team is the development of the full range of structures that guide the actions of team members and overcome the challenges created by discontinuities. That is, we conceptualize leadership in self-organizing virtual teams in terms of developing structure—reinforcing existing structure or creating new—rather than just authority over resources or people. Thus our first contribution is the following definition of leadership:

> **Definition.** Leadership in self-organizing virtual teams is a process that results in the reinforcement, creation and ongoing evolution of team structures.

Based on this definition, we present five propositions that describe the specific aspects of the nature of emergent leadership in virtual teams.

3.1 A Two-Order Theory of Emergent Leadership in Self-Organizing Virtual Teams

If leadership in self-organizing virtual teams is a process that results in the reinforcement, creation and ongoing evolution of structures, how does this process operate? The structurational perspective suggests that some actions serve to reinforce existing structures, while others have the effect of modifying structures. It therefore suggests discriminating between two orders of leadership: one that influences team member behavior while maintaining existing structures (first-order) and one that influences team member behavior by modifying team structures (second-order). Thus we propose that leadership in self-organizing virtual teams operates on two, interrelated levels:

> **Proposition 1:** Leadership in virtual teams operates on two levels. *First-order leadership* is predominantly functional. It operates within the constraints of, and reinforces existing structures. *Second-order leadership* is predominantly transformational, and operates to modify or transform structures as needed.

Functional theories of leadership reviewed above identified four classes of leadership behaviours that we view as first-order leadership: 1. Task Coordination; 2. Substantive Task Con-

tribution; 3. Group Maintenance; 4. Boundary-Spanning (see section 2.1). These behaviors are especially important in self-organizing virtual teams, where formal role and hierarchical status are less available to shape expectations, and leadership is likely to be emergent. In a study of virtual student teams, Carte et al. (2006) found that more effective teams showed higher levels of production, i.e., task contribution, and monitoring, an aspect of coordination. Because such teams lack the formal, hierarchical supervisory structure that assumes much of the coordination burden in traditional groups, they are highly dependent on the emergence of effective and adaptive first-order leadership behaviors. We focus on these behaviors not only because they are important to effective team functioning, but also because of their influence effects on other team members. In self-organizing teams, first-order influence is more likely to be a process of observation and modeling rather than one of direction. Substantive task contributions that are particularly useful may influence the way others perform those tasks in the future through a process of observation and modeling. Similarly, one common manifestation of task coordination in self-organizing teams such as FLOSS teams is self-assignment. Rather than following a division of labor based on the direction of a manager, members decide for themselves what they will do (and not do), based in part on observations of what others are doing (and not doing). Most importantly, first-order leadership influences team members by reinforcing existing structures that shape and constrain team member action.

Second-order leadership, on the other hand, is a process that results in modifications to the structures of signification, domination, and legitimation. While first-order leadership influences team member behavior within the given constraints of existing structures (and thereby serves to reinforce them), second-order leadership effects change in the structures. The distinction between first-order and second-order leadership is analogous to the distinction between single-loop and double-loop learning as proposed by Argyris and Schon (1978), and the distinction between first-order and second-order change as described by Watzlawick, Weakland and Fisch (1974). In single-loop learning and first-order change the governing variables (or norms) of the system remain unchanged, while in double-loop learning and second-order change, they are

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changed. We propose that this kind of change in structure is a function of second-order leadership.

The following passage illustrates an example of the interplay of first-order and second-order leadership. In it, a member of the Plone project (who is not recognized as a leader or a member of the core) demonstrates functional (first-order) leadership by suggesting the need for standardizing the documentation process, and makes a substantive contribution toward articulating a standard (*i.e.,* he performs task coordination and substantive task contribution). But he carefully maintains the existing role and legitimation structures by deferring to "Alex or someone else core" when it comes to actually changing the rule (a structure of legitimation).

> [Plone mailing list posting by an active member] I assume that we will be pushing a lot of documentation in the next few weeks. I think it would be very helpful if documentation reviewers had a set of guidelines to follow for what to accept as-is, what to edit and publish, and what to reject. Things like Short name format, Descriptions, Style/formatting of body text, Version information, Formatting, Section organization, Comments (when to add, when to remove).
>
> Perhaps the best thing would be to produce a checklist against which submitters and reviewers could gauge a piece of documentation. Hopefully, this should remove some ambiguity and resolve any disputes on what gets edited and what gets accepted.
>
> I think it's important to do this sooner rather than later, as we want to establish PHC as a bonafide resource right from the outset. It doesn't have to be long or overly detailed, but it does have to be somewhat authoritative, which means that Alex or someone else core should produce the initial draft.

The quotation shows that the member takes part in first-order leadership by making a substantive contribution identifying the need for the rule change, but cedes to a core member the right to actually transform this structure, that is, a second-order leadership behavior.

3.1.1 Nature of first-order leadership

Positing a distinction between first-order and second-order leadership raises several interesting questions that may provide fertile ground for future research. For example, we are interested in knowing what patterns of first-order and second-order leadership are likely to emerge in

self-organizing virtual teams, and of those that emerge, which are likely to be most successful. Propositions 2 and 3 address these questions.

First, we consider the pattern of first-order leadership. Research has documented that different teams faced with relatively similar contextual and task demands often evolve very different role and leadership structures and work practices (Abdul Karim & Heckman, 2005; Brown & Eisenhardt, 1997; Misiolek & Heckman, 2005). For example, in one study (Misiolek & Heckman, 2005), virtual teams working on identical tasks within a controlled context developed very different functional leadership structures, some highly centralized, with one or two strong leaders performing leadership behaviors while others highly decentralized, with leadership behaviors widely distributed (Misiolek & Heckman, 2005). In FLOSS teams, as well, preliminary inspection shows similar differences in first-order leadership structure. FLOSS projects such as Compiere and Fire seem to have a more centralized functional leadership, while projects such as aMSN and Gaim appear to be more decentralized. Thus, we expect that systematic study will reveal both centralized and decentralized first-order leadership types in FLOSS teams. We expect that teams that say they have no leaders (*acephalous* leadership teams) may instead have a form of shared leadership where first order leadership is widely distributed among the team's members.

However, in self-organizing distributed teams, we propose that a more decentralized first-order leadership structure will be positively associated with effectiveness:

> ***Proposition 2:*** First-order leadership can be either centralized or distributed, however, it is more likely to be fluid, distributed, emergent, and widely shared in effective teams.

We offer three reasons for believing that decentralized first-order leadership will be more effective in self-organizing distributed teams. First, research on face-to-face teams (e.g., Bales, 1950) suggests that the same individual is unlikely to perform all four functional leadership roles equally well. This research suggests that the requirements of task coordination and group maintenance may have particularly contradictory demands. In FLOSS teams in particular, the need to

attract and retain volunteer members may demand effective group maintenance leadership, and those who lead through task coordination or substantive task contribution may not be best able to provide group maintenance leadership.

Second, teams that attempt to integrate diverse, specialized knowledge workers (Grant, 1996) may require many different kinds of first-order leadership in the form of substantive task contribution. For example, FLOSS projects must attract those who can contribute the diverse forms of substantive expertise needed. Similarly, in a study of project teams in a Website development company, Kellogg et al. (2006) documented distributed authority for planning and monitoring: "no single person was in charge" (p. 30).

Finally, the voluntary, self-organizing nature of many virtual teams may create other pressures for distributed first-order leadership. In the area of task coordination, for example, self-assignment is often the predominant mode in which division of labor is accomplished in FLOSS teams (Crowston *et al.*, 2005), a significant difference from the centralized, hierarchical task assignment mechanism found in traditional organizations. For example, Carte et al. (2006) found that high performing teams showed centralized task contribution, but distributed monitoring. In short, the discontinuities that characterize technology-supported distributed small groups (fluid organizational membership, minimized organizational context, lack of face-to-face communication, reliance on asynchronous communication, and lack of formal status cues) create a pressure for distributed first-order leadership.

In FLOSS teams, the question of centralized versus decentralized first-order leadership is not straightforward because the participation structure is complex. The onion-like structure described above (Cox, 1998; Gacek & Arief, 2004; Lee & Cole, 2003; Moon & Sproull, 2000), suggests that teams need members in all these roles to be successful (Moon & Sproull, 2000). An example drawn from the Plone project shows one member describing a division of labor in the production of documentation (author, reviewer, user) that involves several levels of contribution.

Another anecdotal example of decentralized first-order leadership structure can be found in the Gaim project team. In this team, one powerful developer focuses almost exclusively on substantive contribution and makes most important decisions about code. However, another performs much of the boundary spanning function, and manages interactions with the developer and user base, thus sharing leadership. In a final example from our research, two instant messaging projects, Fire and aMSN, were observed to have very different levels of participation in decisions about code changes and strategic direction, both areas of substantial contribution, a kind of first-order leadership. aMSN had broader participation (6.35 people / decision episode) while Fire's decision participation was more centralized (3.2 people/decision episode).

3.1.2 Nature of second-order leadership

We next consider the pattern of second-order leadership. First-order leadership is important on a day-to-day basis in order for teams to smoothly and effectively accomplish their work. Examples of such leadership are frequent, and relatively easy to observe because they happen so consistently. Second-order leadership, on the other hand, occurs less frequently, is more subtle, and is harder to observe. The need to modify structure is generally less immediate, and may often be strategic, with a long-term horizon. It need not be a response to an immediate stimulus, but rather may emerge gradually over a longer period of time. As with first-order leadership, we propose that groups may evolve a variety of second-order leadership structures, but in the case of second-order leadership, we propose that a more centralized or concentrated form is more likely to be associated with effectiveness in the long run. That is, we propose that the most effective

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teams will be characterized by a leadership structure that includes widely distributed and shared first-order leadership complemented by strong, centralized second-order leadership.

> ***Proposition 3*** Second-order leadership can be either centralized or distributed, however, it is more likely to be centralized in effective teams.

We argue that centralized second-order leadership is likely to be more effective because of the need for clarity and agreement among team members about the important social structures that govern and constrain their behavior. To be effective, groups must have a high degree of shared consensus about structures of signification, domination, and legitimation. This is more likely to occur in groups that have strong leaders able to clearly articulate a vision of these structures that is broadly embraced by group members.

A key argument for the importance of centralized second-order leadership is illustrated in a study by Kayworth and Leidner (2002), which found that effective team leadership was associated with the ability of team leaders to establish role clarity among team members. This finding is consistent with an anecdotal observation by Piccoli et al. (2004) that regardless of whether a team was self-directed or managerially controlled, the most effective teams were those in which one or two team members took the initiative to clarify team members' responsibilities and work process structures. Similarly, our observations of Gaim and aMSN, both successful projects, also seem to support the idea that decentralized first-order leadership complemented by centralized second-order leadership leads to effective performance. Both projects have been highly successful in attracting and engaging cohorts of developers sufficiently large to take on first-order leadership tasks in a highly distributed manner. Both, however, have a highly concentrated second-order leadership structure with a strong single leader supported by one or two senior advisers.

3.1.3 Relationship between first and second-order leadership

Whether second-order leadership is highly concentrated and centralized or widely distributed and shared, a fundamental question remains: How do those who are able to influence change in underlying group structures gain the power to do so (*i.e.,* why are some actions struc-

ture changing and others not)? We propose that the answer to this question lies in the nature of

the interrelationship between first-order and second-order leadership. Our observations suggest

that in FLOSS teams, and we suspect, in most self-organizing teams, second-order leadership is

action embedded. By this we mean that second-order leadership derives its authority not from

communication alone, but from substantive, action-oriented contribution. Such substantive con-

tribution will take different forms depending on the task and mission of any given team, but in

the FLOSS context, such contribution most often consists in the production of a significant body

of high-quality code. Individuals who are excellent, prolific programmers receive permission to

lead.

> ***Proposition 4:*** First-order leadership behavior, especially substantive task contri-
> bution, is a prerequisite for second-order leadership behavior. Members acquire
> "permission" to be second-order leaders by performing first-order leadership be-
> haviors.

In FLOSS projects, there is evidence that suggests this process at work. For example,

new members hoping to join a project sometimes begin by making suggestions about how things

should be done, or about how the software might be improved by certain changes. Such sugges-

tions have very little influence. New members are often told that if they want to join the group

they should submit code (*i.e.,* make a substantive contribution) rather than suggestions (von

Krogh, et al., 2003). Over time, the trajectory of increasing responsibility in FLOSS teams can

often be traced to the submission of high-quality code (*e.g.*, Gaim, where the most recent leader

began as an undergraduate user submitting code, and by proving his coding ability over time rose

to a current position of leadership).

This proposition about how individuals accumulate the authority to lead in self-

organizaing teams such as FLOSS teams appears to conflict with the most commonly accepted

theories of power. Most theories equate power with the capacity to influence group members.

Thus, the ability to be a second-order leader (to influence change in social structures) can be seen

as a function of the power an individual is able to accumulate. In the standard theories of power,

this capacity derives from the control of resources that are valued or desired by others. Team members are believed to be dependent on resources controlled by the influencer for need satisfaction or goal achievement, and are thus willing to grant power (Turner, 2005). However, this aproach has recently been challenged by a social identity model of leadership and power (Reicher *et al.*, 2005; Turner, 2005; van Knippenberg & Hogg, 2003), which reverses the causal sequence. Standard theories propose a causal sequence in which control of resources and resource dependence produces power, power is the source of influence, and that influence leads to the formation of a psychological group. The social identity model, however, argues that it is psychological group formation that produces influence, and that power and control of resources derives from influence (Turner, 2005). In self-organizing teams such as FLOSS teams, control of resources and dependence are problematic concepts, because team members are often volunteers who are free to work as little or as much as they like, and to leave the group at any time. Thus the social identity model appears to provide theoretical support for the action embedded nature of second-order leadership we have observed.

3.2 Shared mental models as structure

The theory we have developed above describes effective leadership in virtual teams as a process that results in the reinforcement, creation and ongoing evolution of effective structure. First-order leadership consists of reinforcement of existing structure, while second-order leadership creates and evolves structure. In the discussion above, we noted that functional leadership consists of four classes of behavior—coordination, substantive task contribution, group maintenance and boundary-spanning—that are frequent and continuous through out the work of the project team. However, we suggested that second-order leadership behaviours are much less frequent.

To further develop our theory of effective leadership in virtual teams, we seek to identify the particular second-order leadership behaviours that create and evolve structure. To do so, we need to examine in more detail the constitution of structure in small groups. Schein (1987) argues that structure as we have discussed it reflects still deeper levels of shared basic assumptions

and beliefs (which he considers the deepest levels of culture). We suggest that these shared assumptions and beliefs can be viewed as forming *shared mental models*. Shared mental models, as defined by Cannon-Bowers & Salas (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 behaviour to demands of the task and other team members (p. 228).

As with structure, the issue is not so much whether developers have mental models, but rather the degree of similarity and sharing among the models of different team members. Prior research suggests that the existence of accurate shared mental models that appropriately guide member actions are important for team effectiveness (Cannon-Bowers & Salas, 1993). Leadership in distributed virtual teams therefore can be seen as an influence process that results in the creation, maintenance, and ongoing evolution of accurate shared mental models, and effective leadership translates into creating such shared mental models. Thus, we share with Schein (1987) the notion that a primary operation of leadership is the transmitting and embedding of shared cognitions through the development and modification of shared mental models.

In the following sections, we will discuss three particular types of shared mental models that correspond to the three systems of structure described above, structures of signification, domination and legitimation. For structures of signification we consider shared mental models that take the form of <u>interpretive schema</u>—beliefs about the way things are, about what things are important, and about the relationships between causes and effects. For structures of domination we focus on the definition and shared understanding of <u>role structures</u> within a team, because the role structure is the blueprint for access to and control over resources. Finally, for structures of legitimation, we discuss the development of shared <u>rules and norms</u>, the explicit and implicit behavioral prescriptions guide the social and professional interactions of team members. In so doing, we expand the notion of shared mental models to include cognitions about these additional types of structure. To further develop our theory of effective leadership of virtual teams, we consider how these three kinds of shared mental models guide effective team action as

well as the leadership behaviours that shape them. Some of these aspects have been extensively studied (*e.g.*, communications behaviours that build structures of interpretation) while others seem to be relatively less studied (*e.g.*, the development of rule and norms that constitute structures of legitimation).

3.2.1 Interpretive schemas and structures of signification

Walton and Hackman (1986) identify an interpretive function of teams, which is to help members create a consistent social reality by developing shared interpretive schema. Zaccaro et al. (2004) similarly suggest that "a major responsibility of the team leader is to facilitate for team members an accurate shared understanding of their operating environment" (p. 461), though they explicitly focus on the behaviours of appointed leaders. The problem of developing shared schema is likely to particularly affect members of virtual teams such as FLOSS developers, since members are geographically and organizationally distributed, have diverse backgrounds, and may join at different phases of the team's life. In a study of supply chains (another virtual work environment), Hult, Ketchen and Slater (2004) found the level of shared meanings to be related to improved overall performance (specifically, reduced cycle time). Research on software development in particular has identified the importance of shared interpretive schema (Levesque *et al.*, 2001). Curtis et al. (1990, p. 52), note that, "a fundamental problem in building large systems is the development of a common understanding of the requirements and design across the project team." They go on to say that, "the transcripts of team meetings reveal the large amounts of time designers spend trying to develop a shared model of the design".

To identify specific behaviours that can help to build shared interpretive schema, we draw on the work of Brown and Duguid (1991), who identify the importance of socialization, conversation and narration, which we consider in turn.

Socialization. First, new members joining a team need to be socialized into the team to understand how their work fits into the processes being performed (Ahuja & Galvin, 2003), the expertise of other team members and the nature of the environment in which they work. Kayworth and Leidner's (2002) work on the adaptation of leadership behaviours in different phases

of a team's processes suggests that successful leaders adapt their activities to incorporate new members into teams.

Conversation. Second, conversation is critical in developing shared interpretive schema. It is difficult to build shared schema if people do not talk to one another and use common language (Bechky, 2003). Meetings, social events, hallway conversations and electronic mail or conferencing are all ways in which team members can get in touch with what others are doing and thinking. However, these kinds of conversations are less likely to occur spontaneously in highly distributed virtual teams where members communicate primarily via ICT.

Behavioural leadership theory has informed research on emergent leadership by examining the relationship between emergent leadership and communication, as noted above. Recent research indicates that quality of communication (*i.e.*, whether the communication initiated by a team member contributes toward moving the team forward in accomplishing its task in some way) is more strongly associated with being perceived as an emergent leader by fellow team members than quantity of communication alone (Bass, 1990; Yukl, 2002). Initiating communication appears to be an important factor in virtual teams whether leaders are emergent or appointed (Tyran et al., 2003; Weisband, 2002; Yoo & Alavi, 2004). Both Tyran and colleagues (2003) and Yoo and Alavi (2004) found that taking initiative was positively associated with being identified as an emergent leader. Individuals subsequently identified as emergent leaders were more often than not those that initiated communication by sending the first message to the team.

An example from the Apache httpd project mailing list illustrates a conversation between a newer member and a more expert member to clarify actions and meaning of terms. The conversation between the two members and others in that particular instance leads to shared understanding of the meaning of terms and a deeper understanding of the code and the process.

[Apache httpd: email exchange between new and expert members]

Newer member:

>I think I'm missing something. What does that comment mean in this context? Doesn't static only define these variables to be "global" in this file? I don't understand how this relates to reformatting speed, whatever that is.

Expert member:

>Yes, that's what it means in this context. What it means is that I didn't want to make them globals, but decided it wasn't so bad to do that. The reformatting speed is when you use #config timefmt to change the string version of those variables, with these globals it doesn't have to call time(NULL) again or stat().

Narration. Finally, Brown and Duguid (1991) stress the importance of narration. To keep shared interpretive schema strong and viable, important events must be replayed, reanalyzed, and shared with newcomers. The history that defines "who we are" and "how we do things around here" must be continually reinforced, reinterpreted, and updated. An example drawn from the Apache httpd project mailing list illustrates the function of narration. During this early stage in the team development, members of the Apache project were discussing their goals in terms of the product and process. In discussion of what members should include when modifications to the product were made, a member used a war story (an example of narration) to illustrate a point:

[Apache httpd email posting by a core member]

>So long as you remembered to put in the #ifdef. Sometimes, people forget. With RCS, this is not a problem. (A minor war story may be instructive, if only to let people know where I'm coming from. In the ai_httpd sources I've put up on ftp.ai.mit.edu, the nameserver cache is an option, so the code can be compiled at sites which don't do mmap(). My first cut at doing this left out an #ifdef around a line of modified code (the call to write_nameserver _cache in get_remote_host), meaning that while my modified server tested just fine, the base configuration could not be compiled after the patch. I fixed that, but this sort of human error is likely to happen again, and probably not just to me.)

Based on the discussion above, we offer the following proposition.

> ***Proposition 5.a :*** Teams with communication practices that involve higher levels of socialization, conversation and narration will develop more effective interpretive schema.

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3.2.2 Resources and structures of domination

The control of resources is the basis for power and thus for structures of *domination*. Resources include both allocative resources (control over things) and authoritative resources (control over people). As noted above, leaders in self-organizing teams may lack formal authority of people or things. However, looking at the team in general, team members do face important differences in access to expertise and in control of resources (*e.g.*, for FLOSS development teams, members have different levels of control over the system source code, *i.e.*, CVS commit rights), a primary resource and documentation, a secondary resource). As a result, structures of domination are still relevant to the team's performance. These structures of domination are inscribed in roles within the team, as team members filling different roles have different access to and control over resources.

Roles emerge from task-related activities such as task division, in which the overall task of developing the system is divided into pieces suitable for different kinds of participants. Kayworth and Leidner (2002) found that effective team leadership was associated with the ability of team leaders to establish role clarity among team members. Similarly, Kellogg et al. (2006) found that clear roles meant that "project members knew and played their part—without explicit discussion" (p. 31). These findings are consistent with Piccoli and colleagues' (2004) anecdotal observation that regardless of whether a team was self-directed or managerial controls were in place, the most effective teams were those in which one or two team members took the initiative to clarify team members' responsibilities, structure work processes, and engage in "regular, detailed, and prompt communication" (Piccoli et al., 2004, p. 373). Based on the discussion above, we offer the following proposition:

> **Proposition 5.b:** Teams with communication practices that involve role definition functions such as task division and decision process development will develop more effective role structures.

3.2.3 Rules and norms and structures of legitimation

Finally, actors' social norms and team rules embody structures of *legitimation*. The regulative function of teams, as presented by Walton and Hackman (1986), describes one aspect of team functions as the creation of rules, implicit and explicit. As the team attempts to achieve its task, team interactions lead to the development of implicit and explicit rules for social or interpersonal interaction to guide team member behaviour in achieving its goals and functions. The creation and implementation of processes and rules is a key competency for any team or organization (March *et al.*, 2000). A team or organization's ability to creatively create rules that are consistent with members' actions and represent organizational mission, values and process is critical to its effectiveness (Argyris & Schön, 1978; March et al., 2000). Grant (1996) similarly suggests that a firm (or team) creates coordination mechanisms, in the form of procedures and norms, to economize on communication, knowledge transfer and learning, thus reserving team decision making and problem solving for complex and unusual tasks.

This particular aspect of a team's function does not seem to have been extensively studied in virtual teams. In the FLOSS setting, Fielding (1999) describes the creation of decision making rules in the Apache httpd project. Research in other settings suggests the importance of developing norms and rules. Zaccaro et al. (2004) suggest that appointed leaders lead in part by structuring problem solving activities (p. 463) and setting work norms (p. 468). Barker (1993) found that self-managed teams evolve strong norms and eventually rules for control through a process of rationalization, while Arnold *et al.* (2001) found that strong values and norms were important predictors of commitment to a team. The developments of rules and norms are hypothesized to be the result of integrating the knowledge of experts, through problem solving, political negotiation, and experiential learning (March et al., 2000), into the team's structure. Based on this work, we offer the following proposition:

> **Proposition 5.c:** Teams with communication practices that involve high levels of collaborative, interactive problem solving, political negotiation, and experiential learning will develop more effective rules and norms.

3.3 Summary

In summary then, we argue that second-order leadership consists of behaviours that build accurate shared mental models in the form of commonly accepted interpretive schema, role structures and rules and norms for behaviour. The propositions above suggest that second-order leaders will be those individuals that contribute to socialization, conversation and recapitulation to build effective shared interpretive schema; to task division and decision process development to build effective shared role structures; and to collaborative, interactive problem solving, political negotiation, and experiential learning to build effective shared rules and norms.

Is such change incremental or discontinuous? Advocates of double-loop learning (Argyris & Schön, 1978) believe that change in underlying structures is only possible when groups have consciously reflected on conditions eliciting a need for change, have surfaced the group's deep assumptions and beliefs, and engaged group consensus for change. In effect, double loop learning theory requires that group members be consciously aware of team structures before they are able to change them. Before changes in theory-in-use (*i.e.*, the tacit structures that govern behavior) are possible, members "…require external references. There must be public representations of organizational theory-in-use to which individuals can refer…. These are the shared descriptions of the organization which individuals jointly construct and used to guide their own inquiry" (Argyris & Schön, 1978, p. 17).

In contrast to this highly rational, discontinuous change model, we propose that the structural change influenced by second-order leadership may sometimes also result from a more incremental, subconscious process. For example, a team's role structure may gradually evolve as the overall task of developing the system is divided into pieces suitable for different kinds of participants. The job of coordinating task assignment is an example of first-order leadership on a day-to-day basis, and much of this work will be distributed self-assignment (*i.e.,* individuals voluntarily taking on tasks for which they have particular skills or interest). But as the role structure evolves, second-order leadership will call attention to and clarify the newly emergent structure, and influence the group to embrace it. The process of consciously surfacing and describing un-

derlying structures may not be necessary in our context because in distributed teams using information and communication technology to collaborate (such as FLOSS teams) the transparent dialogues themselves, archived for subsequent viewing as they are, become the external reference called for by Argyris and Schon (1978), the public representation of organizational theory in use to which individual members can refer.

4. Discussion

In this paper we have presented a two-order theory of leadership in distributed virtual teams, using an approach built on a foundation of structuration theory and functional, behavioral leadership theory. Because functional leadership theory does not fully explain the relationship between leadership and group change, we have expanded upon it to include the notion of second-order leadership, a form of leadership that influences changes in the structure that guides group behavior. We have proposed that effective teams will exhibit a paradoxical combination of widely shared, distributed first-order leadership complemented by strong, concentrated, and centralized second-order leadership. Finally, we have proposed that second-order leadership is enabled by first-order leadership, is therefore action embedded, and is grounded in processes that define the social identity of the team.

In this paper, we have developed propositions deductively from prior theory rather than inductively from systematic empirical observations. While our propositions seem to be consistent with our observation of FLOSS teams, they need to be systematically tested in future research. As well, the theory (like all theories) is only partial. Future research should extend the framework presented here by inductively exploring the antecedents, patterns and consequences of leadership in virtual teams, that is, in technology-supported small groups.

We therefore conclude this paper by discussing several methodological issues and possible research questions to guide future systematic inquiry. We have described the process of leadership in virtual teams as an influence process leading to the development, maintenance, and evolution of accurate shared mental models. A variety of research approaches could be applied to study this process (Walsh, 1995). Use of interview data would enable exploration of the group

members' perceptions of the leadership process and allow direct comparison between different members' mental models, thus explicitly examining how shared models are developed. On the other hand, content analysis of the interactions between members of virtual teams would enable detailed analysis of the influence process as it unfolds. Such analysis infers the deep structures and processes from informed examinations of the artifacts that these surface level dialogues provide. This approach has the advantage of avoiding reliance on the recollections of team members, which may degrade over time or be unreliable in other ways. Such research is also feasible, at least in the case of FLOSS teams, because many of these interactions are publicly observable in communication forums such as SourceForge. However, two guidelines for such research should be kept in mind. First, observations should be longitudinal and dynamic, carefully observing changes that occur over time. The phenomenon of leadership is inherently rooted in the passage of time and cannot be observed in a snapshot. Rather, it is a structurational process that can only be seen through a longitudinal lens. Second, the unit of coding and analysis in such research should be the episode. Leadership is fundamentally an interaction process between leaders and followers, and such interactions are best observed episodically.

We are currently testing and extending our theory in a field study of FLOSS projects. To evaluate the concepts developed above, we are collecting a wide variety of evidence, including logs of ICT-supported interactions, bug reports, code changes and project documents, as well as interviews with developers. The anecdotal examples presented in this paper are examples of these sources. These data will be analyzed primarily through content analysis, but also by creating process maps, cognitive maps and social network maps. The two-order leadership theory and propositions we have presented suggest several specific research questions to be addressed in our future work, and these questions apply to the study of effective leadership of virtual teams more generally:

RQ 1. What are the dimensions of first-order leadership? Building on functional leadership theory, we have proposed that first-order, functional leadership consists of four classes of behavior: 1. Coordination; 2. Substantive Task Contribution; 3. Group Maintenance; 4. Bound-

ary-Spanning. Future research should assess whether these four dimensions provide a relatively comprehensive description of first-order leadership.

RQ 2. What patterns of first-order leadership emerge in distributed, self organizing, virtual teams? We have observed that very different patterns of first-order leadership can exist in different teams. We have discussed centralized versus decentralized leadership patterns, but such a distinction may prove to be too simple to fully described the leadership patterns that emerge in the complex, onion-like structures that characterize FLOSS projects. By observing a number of virtual teams, such as FLOSS projects, future research will be able to inductively classify the first-order leadership patterns that emerge, and develop valid and reliable operational definitions of concepts such as "centralized" and "decentralized" patterns.

RQ3. How do patterns of first-order leadership evolve over time? Leadership is not a static phenomenon. As groups grow and attract new members, or lose existing members, or face new environmental constraints, leadership patterns may change. We have, for example, observed growing levels of participation in decision-making in one project (aMSN) and declining levels of participation in another (Fire). Longitudinal research designs will enable future research to systematically observe and understand such dynamic changes in leadership patterns.

RQ4. What aspects of structure are most important to observe in order to understand second-order leadership, and what is the nature of this structure? We have described structures of signification, domination, and legitimation that exist in self-organizing, distributed, virtual teams, and we suggested that shared mental models underlie all three types of structures. Again, the observation of numerous virtual teams, such as FLOSS projects will allow us to inductively infer and classify these structures, better understand their nature, and their instantiation in actions.

RQ5. How does second-order leadership influence change in team structures? We have noted that some scholars (e.g., Argyris & Schön, 1978) suggest that deep structures are best modified by a rational, discontinuous change process that includes discovery of hidden beliefs and assumptions (structures), followed by a consensus-based examination of and experimenta-

tion with potential new structures. We have proposed that the change process might be less rational and more emotional, less discontinuous and more incremental, and action-embedded rather than communication-driven. Schein (1987) made a similar observation when he noted that some of the most powerful mechanisms for embedding and reinforcing culture are based on leaders' actions –what they pay attention to, reward, sanction, and their reaction to critical incidents and crises.

RQ6. How do second-order leaders gain influence? We have proposed that second-order leaders gain influence by virtue of their action-embedded first-order leadership contributions. We also suggested that this process is more consistent with the social identity model of power than with the traditional resource dependence models of power. These assertions require systematic testing that will best be accomplished through detailed longitudinal observations of numerous virtual teams such as FLOSS projects

RQ7. How do different patterns of leadership (both first-order and second-order) relate to group effectiveness? Once we have inductively classified the first and second-order leadership patterns that emerge and developed valid and reliable operational definitions of these patterns, we will be in position to test the proposition that the most effective groups will exhibit decentralized first-order leadership and centralized second-order leadership. In order to do this we will need a measure of project effectiveness or success. Recognizing that success for FLOSS projects is a complex, multivariate construct, we will build on the multivariate approach to success suggested by Crowston et al. (2006a).

RQ8. What are the boundaries to first- and second-order leadership? We have argued that first- and second-order leadership involve reliance on and changes to shared mental models. However, such models are never shared perfectly and so may present a boundary to the influence of this form of leadership. On the other hand, Kellogg et al. (2006) note that coordination does not require equivalence or similarity of interpretations; rather, different groups can agree on "general procedures of exchange even while they may have different local interpretations of the objects being exchanged" (p. 39). In particular, FLOSS teams, because of their onion-like struc-

ture, provide an interesting setting to explore this question. We expect to find that the core members have a high level of commonality in their mental models, but that this commonality decreases in less active members. The question then is how well our model describes the ways in which core project members can provide leadership for the entire project, given these limitations.

The theory and propositions we have developed represent an attempt to integrate and consolidate several previously developed theoretical perspectives on leadership and group dynamics in self organizing, distributed, virtual teams. We hope that this will provide a starting point for future research and thereby make a contribution to the study of virtual teams within the organization literature. We note that while we are particularly interested in self-organizing teams in which leadership is emergent, we believe that these propositions may also apply to case in which leadership is assigned.

5. Conclusion

The primary contribution of this paper has been to develop a set of theoretical propositions about the nature of effective leadership in self-organizing virtual teams. However, even in its nascent state, our theory has some implications for the practice of leading small groups. The theory suggests specific actions that members of technology-supported distributed small groups can take to improve performance. These include ensuring that all first-order leadership functions are performed well, and preferably by many team members, in a decentralized mode. It also suggests that there is value in centralizing second-order leadership functions. Virtual teams, such as FLOSS developer teams, might more explicitly recruit or select members who are particularly skilled at these functions and pay more attention to the on-going process of developing shared interpretive schema, role structures and rules and norms. More generally, we argue that the problems faced by FLOSS teams are increasingly shared by other kinds of technology-supported distributed small groups. As a result, educational programs for all kinds of workers might incorporate these ideas. For example, distance education classes that use technology support for instruction should provide instruction for students on the nature of leadership in virtual teams

and thus set expectations for how the work can best be accomplished, as well as requiring team projects to provide an opportunity to practice these skills.

Whether these propositions are confirmed or disconfirmed by future research, understanding how teams of independent knowledge workers can more effectively work in virtual environments will improve both the traditional and non-traditional organizations within which they exist. The results of the research we hope to stimulate will then serve as a road map to improve organizational performance and foster innovation.

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Figures and Tables

Table 1. FLOSS projects mentioned in text.

| Project	Description
aMSN	An Internet chat client.
Apache	A Web server, that is, a program that runs on a server to provide HTML documents in response to requests. The Apache project now includes numerous related projects, with the Web server referred to as httpd.
Compiere	An enterprise resource management system (ERP).
Fire	A Mac OS specific multi-protocol Internet chat client.
Gaim	An Internet chat client.
Gnome	A Unix desktop manager and associated applications (roughly comparable to the Windows graphical user interface).
Plone	A content management system, that is, a Web-based system that allows a group to manage documents.
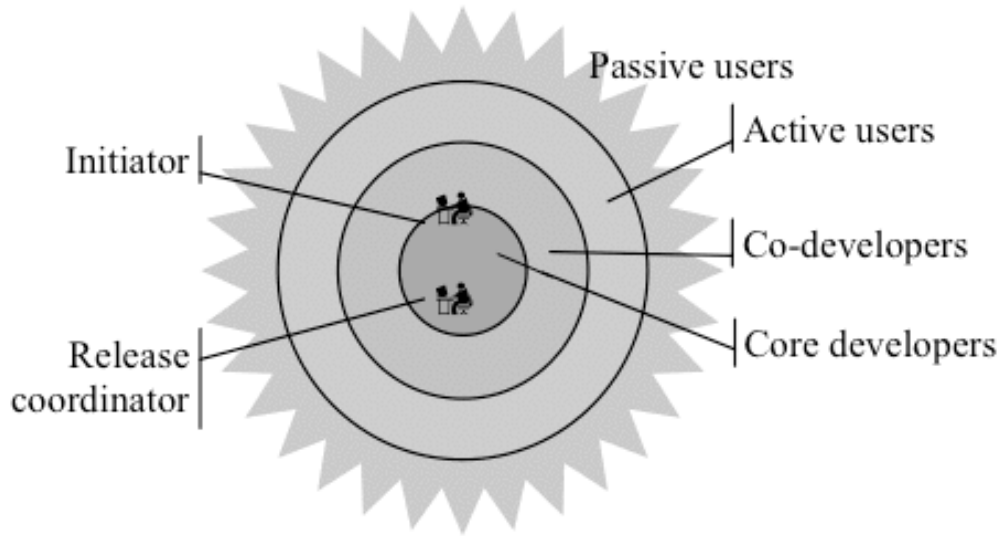
Figure 1. Typical structure of a FLOSS development project.
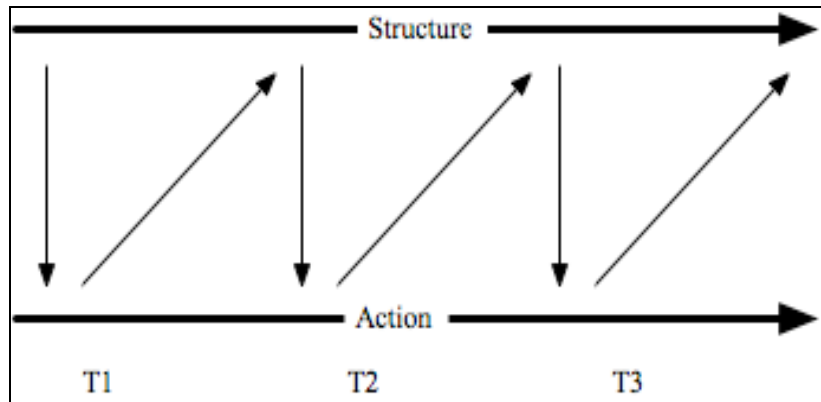

Figure 2. A sequential model of the relation between structure and action (from Barley and Tolbert, 1997).