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TITLE OF PROPOSED PROJECT: **Group Maintenance to Support Innovation by Cyber-infrastructure-supported Distributed Groups**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **298,857**	**24** months	**07/01/07**	

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Project Summary: Group Maintenance in Cyber-infrastructure-supported Distributed Groups

We propose a study of the ways in which members of distributed groups create and maintain a social environment that enables and motivates members to work together when using cyber-infrastructure [4, 11]. Distributed groups are networks of geographically-dispersed individuals working together over time towards a common goal. Cyber-infrastructure is an emerging concept that refers to the constellation of systems designed to support the communication, coordination, collaboration, data collection, storage, analysis and dissemination needs of distributed groups. As a result of these technical innovations, distributed groups are becoming more common in all kinds of organizations [86]. However, the limitations of the media and the distance between group members—geographic, organizational and social distance—challenges members to maintain the social relationships necessary for the group to be effective [95]. A substantial and growing knowledge base exists for understanding geographically-distributed collaboration in science and in the workplace [41, 121] and for group maintenance for face-to-face teams. However, much less is known about the social aspects of teamwork in distributed groups. To fill this gap, the proposed research addresses the following two general research questions:

What kinds of group maintenance behaviors occur and are effective in cyber-infrastructure-supported distributed groups?

How do these behaviors interact with factors such as task design to influence group effectiveness and innovation?

Expected intellectual merit

The intellectual merit of the proposed research is that it addresses a fundamental problem in organizational behavior, namely group maintenance, in a novel setting, namely distributed groups working together using cyber-infrastructure, to advance our understanding of the effects of interpersonal relationships on the functioning, effectiveness and innovation of groups who rely on innovative applications of computer-mediated communications (CMC). To address the research question, a conceptual model of group maintenance behavior is developed and applied to the study of functioning distributed groups in three related but distinct empirical settings, namely 1) scientific research collaboratories; 2) transnational advocacy networks; and 3) FLOSS (free/libre open source software) development groups. These types of groups have been chosen because each involves collaborations between geographically and organizationally separated members, carried out primarily via cyber-infrastructure, in order to accomplish shared tasks that produce some kind of innovation, but with varying task designs. A novel aspect of our proposal is the application of Natural Language Processing (NLP) approaches to facilitate the qualitative social-science analysis of large-scale digital data to assess group maintenance behavior.

Expected broader impacts

The proposed research will have broader impacts of several types. First, the project will benefit society by providing generalizable knowledge to improve the effectiveness of distributed groups. Distributed groups are increasingly common in a variety of settings, including multi-disciplinary university centers and industrial research departments, and are used for a variety of tasks, including research, development and engineering. As a result, the project results should be particularly pertinent to the effective organization and management of innovation projects that involve shared technological resources, particularly cyber-infrastructure resources. To ensure that our study has a significant impact, the project results will be broadly disseminated through journal publications, conferences, workshops and on our Web pages, as well as through interaction with the leaders and members of distributed teams. Findings from the study might also be used to enhance the way CMC tools are used to support distance education, scientific collaboration or product development. Finally, the project will promote teaching, training, and learning by providing an opportunity for students to work on research teams, utilize their competencies and develop new skills in data collection, model development and data analysis.

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Group maintenance in cyber-infrastructure-supported distributed groups

We propose a study of the ways in which members of distributed groups create and maintain a social environment that enables and motivates members to work together using cyber-infrastructure [4, 11]. Distributed groups are networks of geographically dispersed individuals working together over time towards a common goal. Distributed work has a long history [e.g., 91], but recent advances in computer-mediated communications (CMC)—from email, instant messaging and presence awareness systems, to web conferencing and easy-to-use content management systems—have been crucial enablers for development of this organizational form [1]. Cyber-infrastructure is an emerging concept that refers to the constellation of systems designed to support the communication, coordination, collaboration, data collection, storage, analysis and dissemination needs of distributed groups. As a result of these technical innovations, distributed groups are becoming more common in all kinds of organizations [86]. However, the limitations of CMC and the distance between group members—geographic, organizational and social distance—challenges members to maintain the social relationships necessary for the group to be effective [95]. A substantial and growing knowledge base exists for understanding geographically-distributed collaboration in science and in the workplace [41, 121] and for group maintenance for face-to-face teams. However, much less is known about the social aspects of teamwork in distributed groups and their contribution to teams' performance. To fill this gap, our proposed research addresses the following two research questions:

What kinds of group maintenance behaviors occur and are effective for cyber-infrastructure-supported distributed groups?

How do these behaviors interact with factors such as task design to influence group effectiveness and innovation?

Expected intellectual merit

The intellectual merit of the proposed research is that it addresses a fundamental problem in organizational behavior, namely group maintenance, in a novel setting, namely distributed groups working together using cyber-infrastructure, to advance our understanding of the effects of interpersonal relationships on the functioning, effectiveness and innovation of groups who rely on innovative applications of CMC. To address our research question, we develop a conceptual model of group maintenance behavior and apply it to the study of functioning distributed groups in three related but distinct empirical settings. A novel aspect of our proposal is the application of Natural Language Processing (NLP) approaches to facilitate the social-science analysis of large-scale digital data to assess group maintenance behavior. The first two aspects of the study are briefly introduced here and expanded on in the following sections of the proposal.

Theoretical foundation. Though different research streams have used different labels, researchers have commonly differentiated between two broadly defined types of group behavior: *task-oriented* behavior and *relational* or *group maintenance* behavior. Group maintenance behavior is discretionary, pro-social, relation-building behavior that enables group members to more easily trust and cooperate with one another, based on the expectation of the future cooperation of others [102], what game theorists call the "shadow of the future" [6]. Such behavior is closely related to an array of prosocial behaviors that have been identified by organizational theorists in various contexts: consideration, expressive behavior, or relational behavior in leadership research [59, 123, 124]; social presence in community of inquiry literature [43, 104]; social-emotional behavior, face work, or social presence in CMC research [47, 88, 92]; and organizational citizenship behavior (OCB), relation-oriented behavior, supportiveness, conflict management in organizational research [45, 55, 98].

Whatever the label, group maintenance behavior is important because it is believed to be associated with a number of desirable group and organizational outcomes. Voluntary groups, whether part of businesses, societal communities or research communities, will not last long if members are dissatisfied and ineffective collaborators. Groups that last over time develop a social environment that is conducive to accomplishing group tasks, and to the social needs of individual members. This social environment includes open communication among the group members, support of the group members' needs, an effective conflict-resolution process and commitment by the group to minimize process losses [i.e, group synergy, as defined by 51]. The development of a supportive social environment is particularly problematic in distributed groups in which members have few opportunities to meet and work together face-to-face.

Empirical settings. The proposed study is set in the context of cyber-infrastructure-supported distributed groups, an increasingly common organizational form enabled by technological advances and driven by the need for collaboration within distributed industry, policy and scientific communities. We focus in particular on distributed groups whose goal is creating a collective innovation, since this type of group requires intensive collaboration and decision making that can benefit from access to distributed knowledge and expertise. However, the distance between distributed members and the limited opportunities for interaction provided by cyber-infrastructure suggest that many of the traditional tactics of group maintenance will be difficult to apply, even though "the social glue of good relations among participants" is still critical [10]. To develop generalizable findings, we will compare and contrast group maintenance in three different types of distributed groups that rely on cyber-infrastructure: 1) scientific research collaboratories; 2) transnational advocacy networks; and 3) free/libre open source software (FLOSS) development groups. The rationale for our choice of these types of distributed groups will be described in detail below in the section on study design.

Expected broader impacts

In addition to the expected intellectual contributions described above, the proposed research will benefit society by providing generalizable knowledge to improve the effectiveness of distributed groups. Distributed groups are increasingly common in a variety of settings, including multi-disciplinary university centers, industrial research departments, and civil-society and non-governmental organizations, and are used for a variety of tasks, including research, development and engineering (see, for example, the attached letters of support from the directors of research collaboratories expressing their interest in the proposed research). In addition, the proposed project will have an impact by promoting teaching, training, and learning by students involved in the research project (indeed, the majority of the requested funding supports students).

The remainder of this proposal is organized into four sections. In section 1, we develop a conceptual model for our study, drawing on various research literatures that address the phenomenon of group maintenance. In section 2, we present the study design, with details of the data collection and analysis plans, and describe how our research will integrate social science and natural language processing (NLP). In section 3, we present the project management plan. We conclude in section 4 by sketching the intellectual merits and expected broader impacts of our study and by reviewing results of prior NSF support.

1. Conceptual Development

In this section we develop the conceptual framework for our study, building on and adding to existing literature drawn from multiple disciplines. We define group maintenance behavior as discretionary, pro-social, relation-building behavior that is not explicitly task oriented. While such behavior may be closely intertwined with task-oriented behavior, and while both functions may even be evident in a single act, it is possible to distinguish between group maintenance and task-oriented functions. Schutz identified three functions critical to the effectiveness of a group as a social system: the group's relations with other people and other groups; members' relations with each other; and members' interdependent work toward a shared goal. Integrating and building on Schutz [108] and Roby [103], Walton and Hackman [115] identified five main work-group functions: social, interpretive, regulative, agency and task management functions. The functions of the group can be summarized as coordinating efforts, resources and other entities to perform group tasks (the regulative, agency and task management functions), while at the same time creating a social and humane work environment that meets members' social needs (the social and interpretive functions), which we include as group maintenance.

While there is no comprehensive theory of group maintenance behavior, researchers have identified an array of discretionary, pro-social behaviors that contribute to the creation of an environment that supports a work group's task-related activities. Though different labels have been used to describe these behaviors, they share several characteristics that will be important to the research we propose here. We will examine these characteristics by reviewing several streams of literature that shed light on their commonalities. We first discuss research in group leadership and organizational citizenship behavior that helps us to understand the general nature of group maintenance behavior. We then turn to research that more specifically addresses group maintenance behavior that might be expected to occur via cyber-infrastructure, as in distributed groups. Finally, we consider group performance literature to address our second research question.

Group leadership theory. The group leadership literature provides a first perspective on the nature of group maintenance behaviors. Most group leadership studies have adopted a two-factor theory of leadership derived from Bales [8] research on small team interaction, which distinguishes between task- and relationship-oriented leadership behavior. Task-oriented behaviors are those that move the team forward in the accomplishment of its task, such as "planning and scheduling work, coordinating subordinate activities, and providing necessary supplies, equipment, and technical assistance" [123]. Relationship-oriented behaviors, on the other hand, 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" [123], which we consider as group maintenance. In research on self-organizing teams, group leadership has often been described as shared [99] or distributed [50]. Thus, in such groups, we expect that group maintenance leadership behaviors will be performed by a number of group members with a variety of targets, not just leaders to subordinates.

Organizational citizenship behavior. An additional source of ideas about the nature of group maintenance behaviors is the work on organizational citizenship behavior (OCB), which has been defined as "individual behavior that is discretionary, not directly or explicitly recognized by the formal reward system, and in the aggregate promotes the efficient and effective functioning of the organization" [98]. Several dimensions of OCB have been identified, including *helping* (behavior in which the immediate beneficiary is a specific individual person), *compliance* (general adherence to the spirit of the rules or norms that define a cooperative system), *sportsmanship* (putting up with minor grievances and inconveniences without complaining), *civic virtue* (responsible, constructive involvement in governance processes) and *courtesy* (avoiding practices that make other people's work harder) [48, 65, 97, 109, 119]. This research suggests that OCB is closely related to positive attitudes such as job satisfaction. Theorists have also proposed that dispositional traits (i.e., personality) predict OCB, but the bulk of the empirical research on this issue does not support this relationship [98].

In summary, research on group leadership theory and organizational citizenship behavior suggest that group maintenance behaviors may be widely performed and has identified a variety of behaviors that may contribute to the development and preservation of a positive environment. However, in distributed groups, the opportunities for group maintenance behavior are limited because interactions are predominantly mediated by CMC. Heckman and Annabi [53] suggest that the lack of informal, face-to-face communication presents challenges for collaboration and learning in distributed groups, since not all of these behaviors translate to the new environment. In the remainder of this section, therefore, we turn to research that has attempted to identify group maintenance behavior carried out via CMC, in order to address our first research question. We first briefly review research on *virtual teams* before turn to research on computer-mediated asynchronous discourse, specifically, *community of inquiry* and *politeness theory* research.

Research on virtual teams. Martins, Gilson & Maynard [86] recently surveyed the growing body of research on virtual teams (VT), which they defined as "teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task" (p. 808). They found that the "majority of VT research pertaining to interpersonal processes… focused on conflict, uninhibited behavior…, informality of communication among group members, interpersonal trust, and group cohesiveness" (p. 814). Trust (one of the outcomes of group maintenance behavior) in particular has a rich literature. For example, Jarvenpaa and Leidner [63] identified what they called "swift trust" that formed in temporary distributed groups. However, Martins et al. note that much of this work has been done in a lab setting with student groups [86, p. 822], which is consistent with a focus on temporary teams. Such research needs to be followed up with studies of longer-standing functioning distributed groups, in particular because experience working together may be a key factor in developing relationships. They further note that "interpersonal processes represent an area in which major gaps exist in the literature on VTs." (p. 821), suggesting a need to consider the specific behaviors that help build relationships and which are feasible in CMC-mediated interaction.

Research in computer-mediated communications. To help identify behaviors that might support group maintenance in a CMC-supported group, we turn now to work that has examined CMC interaction in more detail. The notion of a *community of inquiry* has its antecedents in the work of the American pragmatists in general, and especially John Dewey [38, 93], and the term achieved wider usage through Matthew Lipman's Philosophy for Children movement [85]. A community of inquiry is characterized by trust and an open, critical, collaborative search for meaning and truth. Anderson, Archer, Garrison and Rourke [2, 43, 44, 104] have developed and validated a content analysis scheme to evaluate the learning process of individuals using asynchronous technology to collaborate in a community of inquiry. Building on social interdependence, critical thinking, and constructivist learning theories [43, 52, 58, 90, 94, 118] they presented a model that integrates cognitive presence, social presence, and teaching presence. Their framework identifies the intellectual content of messages (*cognitive presence*), the instructional role (*teaching presence*), and interaction among members (*social presence*.) Aviv [5] also developed a framework to analyze the content of messages and the nature of interactions. His framework identifies three processes in asynchronous learning network discussions: *social process*, *response process* and *reasoning process*. These frameworks provide a useful starting point for the identification of group maintenance behavior in asynchronous communication.

Politeness theory. A second stream of research that provides useful insights into group maintenance behavior embedded in speech is *politeness theory*. Politeness theory considers the role of *face*, the positive self-image claimed and presented to the social world by each individual [46]. The theory posits that face-threatening acts (FTA) are an inherent and unavoidable aspect of any human interaction using language. Politeness in language represents an effort to support and preserve the self-esteem, or face, of others, to minimize the impact of face-threatening acts. Politeness tactics can be either specifically positive or negative [12]. Negative tactics attempt to avoid negative face by demonstrating distance and circumspection to the other [88]. Positive tactics indicate an appreciation of the other's wants in general [88]. Positive politeness tactics help group members to bond and to locate common ground whereas negative politeness tactics prevent group members from coming too close or intruding by keeping appropriate distance. Based on the work of Brown and Levinson [12], Morand and Ocker [88] developed a set of indicators of positive and negative politeness tactics for use in analyzing CMC transcripts.

We plan to build explicitly on both the community of inquiry and politeness theory frameworks because prior research in these areas has identified linguistic markers that enhance the social dimension of collaboration. As an example, we present in Table 1 a preliminary set of group maintenance indicators identified for research on community of inquiry and politeness theory that we expect to see expressed in cyber-infrastructure supported communications. The table includes a range of indicators that make different tradeoffs between reliability and validity, i.e., some are very explicit and easy to recognize but perhaps only indirect indications of group maintenance, and vice versa. The indicators in the table represent a starting point for our research to address research question 1, but we recognize that a number of critical technology imposed factors (e.g.. anonymity, contextualization, shared presence, etc.) might have significant impacts on group maintenance in distributed virtual environments. Thus we have designed our study to build on existing theory, but also to remain sensitive (through qualitative inductive analysis) to the possible need for new theories to explain group maintenance in a virtual context.

Table 1. Initial constructs and indicators of group maintenance behavior.

Category	Indicators	Definition
Emotional expression [43, 104]	Expression of emotions	Conventional expressions of emotion, or unconventional expressions of emotion, includes, repetitious punctuation, conspicuous capitalization, emoticons.
	Use of humor	Teasing, cajoling, irony, understatements, sarcasm.
	Self-disclosure	Presents details of life outside of group activity, or expresses vulnerability
Interaction/open communication [43, 104]	Continuing a thread	Replying rather than starting a new thread.
	Quoting from others' messages.	Using software features to quote others entire message or cut and pasting selections of others' messages.
	Referring explicitly to others' messages [104]	Direct references to contents of others' posts.
	Asking questions	Ask others a question
	Complimenting; expressing appreciation [104]	Complimenting others or contents of others' messages.
	Expressing agreement	Expressing agreement with others or content of messages.
	Draw in participants [2]	Calling on other members to participate and including everyone in the discussion.
	Address individual member	Part of the message addresses a specific member(s)
Group cohesion	Phonological slurring [88]	Phonological slurring to convey in-group membership
	Colloquialism or slang [88]	Use colloquialism or slang to convey in-group membership
	Use ellipsis (omission) [88]	Use ellipsis (omission) to communicate tacit understandings
	Vocatives [104]	Addressing or referring to participants by name to insinuate familiarity
	Making personal connection [3]	Revealing commonalities with others in the group; raise or presuppose common grounds; express agreement
	Give reasons [88]	Assert reflexivity by making activity seem reasonable.
	Inclusive	Use inclusive forms (we or lets) to include both speaker and hearer in the activity (we, our, us)
	Reciprocal exchange [88]	Assert reciprocal exchange or tit for tat
	Sympathy, understanding	Give something desired: sympathy, understanding
	Apologies	Make apologies for doing something wrong
	Phatics, salutations [104]	Communication that serves a social function; greetings, closures.
	Encouraging others [3]	Encouraging others to do work
	Common and symbolic language [2]	Members use of shared language/terms, analogies, symbols or metaphors specific to the group
Face protection [88]	Conventionally indirect	Be conventionally indirect; inquire into the hearer's ability or willingness to comply.
	Use hedges	Use hedges: words or phrases that diminish the force of a speech act.
	Subjunctive	Use subjunctive to express pessimism about hearer's ability/willingness to comply.
	Minimize imposition.	Use words or phrases that minimize the imposition.
	Honorifics	Give deference by using honorifics: Sir, Mr., Ms., Dr.
	Formal word choices	Use formal word choices to indicate seriousness and to establish social distance.
	Apologies	Apologize: admit the impingement, express reluctance.
	Impersonalization	Impersonalise the speaker and hearer by avoiding the pronouns "I" and "you."
	Past tense	Use the past tense to create distance in time.
	Nominalization	Nominalize (change verbs & adverbs into adjectives or nouns) to diminish speakers' active participation.
	General rule	State a face-threatening act as a general rule.

Group effectiveness. To answer our second research question, we plan to evaluate the relationship between group maintenance behavior and group effectiveness. The group performance literature suggests the importance of group maintenance and its relation to other group processes. Research has empirically linked group maintenance behavior in face-to-face groups with several indicators of positive group or organizational performance. OCB has also been associated positively with performance quantity and quality, financial efficiency, and good customer service [98]. For example, organizational citizenship behavior has been associated positively with performance quantity, performance quality, financial efficiency, customer service, and attitudes such as job satisfaction [98]. Thus we find a large body of research that associates discretionary pro-social organizational behavior with desirable group outcomes and characteristics. Because the majority of this research has been cross-sectional and correlational, theorists have been careful to point out that we cannot say with certainty whether variables such as job satisfaction are antecedents of these behaviors, outcomes of these behaviors, or, together with these behaviors, caused by a third variable. Nevertheless, evidence for a relationship between this form of group maintenance behavior and positive group outcomes continues to grow.

Hackman [51] and Gladstein [45] argue that what we are calling group maintenance behaviors promote group effectiveness because they satisfy the social needs of group members and thus contribute to group synergy. Hackman's model, shown in Figure 1, describes group synergy as a primary moderator that improves group effectiveness. An environment that offers a high level of group synergy will facilitate individual contribution to tasks and goals. Hackman [51] described group synergy as the group finding ways of avoiding coordination and motivation losses and creating shared commitment to the group. Others have noted the importance of trust, particularly between distributed team members [e.g, 63, 64]. Aviv [5] and Rourke et al., [104] suggested that cohesiveness and positive interpersonal characteristics in a group promote information sharing and learning. Such behavior may also improve the group's ability to attract and retain high-quality members, and may improve performance by enhancing morale, group cohesiveness, job satisfaction, and the sense of belonging to a group [98]. Therefore, we can assess the effectiveness of group maintenance behaviors by looking for evidence of group synergy. For example, Gladstein [45] identified supportiveness, conflict management, and open communication as processes that create group synergy, suggesting these as aspects of group maintenance behavior. Without individuals' contributions to group maintenance behavior, synergy will be low and the group ineffective.

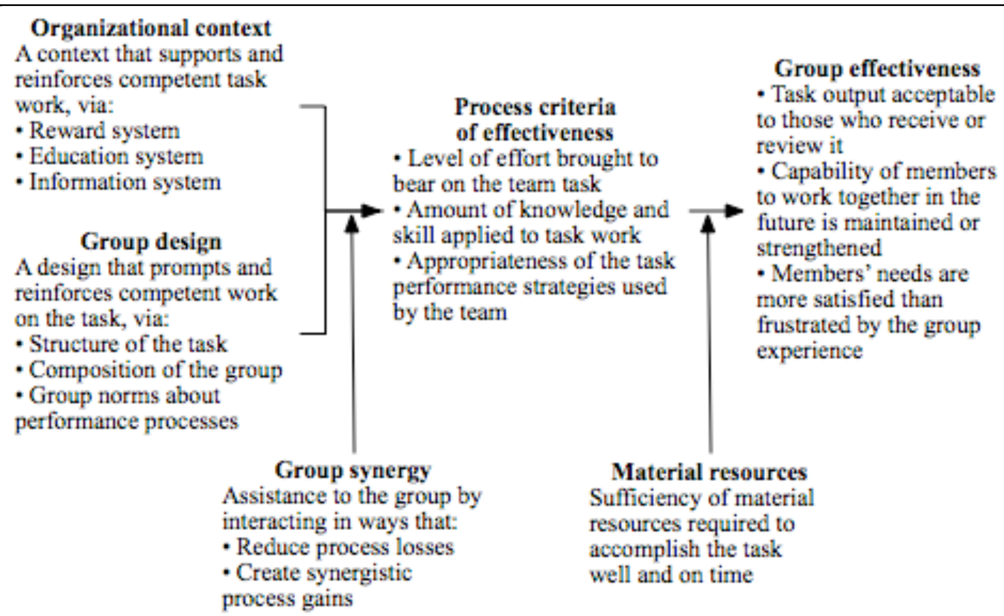

Figure 1. Hackman's [51] normative model of group effectiveness

However, as Hackman's model (Figure 1) suggests, the impact of group synergy on performance may not be direct. Rather, we expect it to interact with other factors, such as group design, organizational context and group process. In other words, it seems likely that group synergy, enabled by group maintenance behaviors, matters more in some kinds of groups than in others. For example, if work is designed to be highly modular and individual task performance is easy to gauge or control, trusting relationship may be less critical for effectiveness [42]. We are particularly interested in the potential effect of task design on the need for group maintenance behavior in self-organizing distributed groups, since that factor may be more amenable to design or control. To investigate the interaction of task design with group maintenance, we plan to examine three types of voluntary, self-organizing groups with a range of task designs (scientific research collaboratories; transnational advocacy networks; and FLOSS software development groups). Because the groups are composed of voluntary, self-organizing knowledge workers, they have relatively similar reward structures and organizational contexts, thus controlling this dimension. But since their tasks vary considerably in terms of the interdependence required between members to coordinate their work (see below), their comparison will provide the opportunity to observe the interaction between task design and group maintenance behavior.

In order to measure effectiveness, we will consider outcomes along the three dimensions suggested by Hackman [51] as shown in Figure 1 above: task performance, as measured by evaluations by recipients of the output (which may include the team members themselves), individual group member satisfaction and continued group performance. For the FLOSS setting in particular, Crowston et al. [25] have developed a set of indicators of effectiveness, including releases and bug fixes as measures of task performance, individual developer satisfaction with the project, and number of developers involved and level of activity as indicators of continued group performance. We anticipate that the effects of group maintenance behavior will be more visible in certain of these outcomes, e.g., we expect it to have a large impact on the group's ability to retain members, though the nature of and mechanisms for the relationship are the subject of the proposed study. We plan to adapt similar measures to evaluate other distributed groups.

2. Research Design

In this section, we discuss the design of the proposed study, addressing the basic research strategy, concepts to be examined, sample populations and proposed data collection and analysis techniques. We first discuss the goals and general design of the study. We then present the details of how data will be elicited and analyzed.

We envision our project as having two overlapping phases for each of the group domains studied. Each phase will last roughly 16 months. In the first phase (year 1 and the first part of year 2), we will use computer-assisted qualitative data analysis software (CAQDAS) to examine project data (e.g., e-mail archives, computer logs, primary and secondary documents and source material) manually for evidence of the concepts identified in Table 1 to determine what kinds of group maintenance seem most important in our groups and to elucidate the connection between group maintenance behavior and antecedents and outcomes in order to propose more specific hypotheses for further study. We will also examine how these concepts are linguistically realized in text in order to determine feasible candidates for identification using NLP techniques, by delineating the predictable linguistic features on which algorithms to detect the research-relevant features can be based. In the second phase (the second part of year 1 and year 2), we will develop NLP approaches to extract the identified research-relevant features from the datasets. Applying NLP tools will allow us to more fully explore the large-scale digital datasets developed in the project, to compare the NLP results with the CAQDAS results and to gauge the generalizability of the proposed hypotheses.

2.1 Sample

We will start each phase by identifying promising distributed groups for study. During the first phase, we will focus on a small number of groups (on the order of six). In the second phase, the size of the sample will be limited by the available data and processing power (computer and human). In choosing these groups we will apply the previously developed effectiveness assessments (described above) as a theoretical sampling filter to ensure that we have groups of different types with varying degrees of effectiveness. We will also take into consideration some pragmatic considerations, such as selecting only projects where we have access to the needed data. We plan to identify distributed groups in three domains: 1) scientific research collaboratories, 2) transnational advocacy networks and 3) FLOSS software development groups.

These types of groups have been chosen because each involves collaborations between geographically and organizational separated members, carried out primarily via cyber-infrastructure, in order to accomplish shared tasks that produce some kind of innovation. Scientific collaboratories have an express mission to generate scientific innovation. FLOSS software development groups exist to create and distribute innovative software. Transnational advocacy networks exist to create innovative policy solutions to problems not easily addressed through traditional governmental structures. These three domains were also chosen because they vary systematically in terms of the interdependence necessary to successfully coordinate their work. Tasks in FLOSS groups are the most loosely coupled. Modular software design and version control systems allow members to work relatively independently. Scientists working together in collaboratories have a greater need to coordinate their work through reciprocal interdependence. Transnational advocacy networks require the highest level of reciprocal interdependence and coordination because of their need to reach agreement on sensitive and controversial policy questions. Thus studying these three domains will allow us to examine the interaction between the effects of task design and group maintenance on group effectiveness. In the remainder of this section, we discuss each setting in turn.

Scientific Research Collaboratories. The first form of distributed group we plan to study is a scientific research collaboratory. The collaboratory concept combines the words collaborate and laboratory to refer to "a center without walls" in which the nation's researchers could be geographically distributed and yet collaborate as if they were in the same physical location [120]. More recently, the definition of research collaboratories has been refined to see it as "an organizational entity that spans distance, supports rich and recurring human interaction oriented to a common research area, and provides access to data sources, artifacts and tools required to accomplish research tasks" [39]. The number of collaboratories has increased immensely since their inception in the 1980's [40, 41], as the concept has been applied in settings from education to astrophysics, from genomics to manufacturing [14-16, 96]. Much of the research on collaboratories has focused on designing and developing the technologies or the technical infrastructures for the collaboratories [e.g., 7, 13, 110], so a study of the social aspects will be a contribution to this area. Because of our interest in cyber-infrastructure-supported distributed groups, we plan to focus our attention on research collaboratories that rely primarily on CMC to support interactions. The NSF funded Science of Collaboratories (SOC, http://www.scienceofcollaboratories .org/) project has compiled an inventory of collaboratories of various types, and provides summaries, links to their websites and detailed analysis of a limited number of collaboratories. Using this inventory as a sampling frame, for Phase I we will draw a small purposive sample of collaboratory projects willing to provide data for the study, or who make their data publicly available. Ideally, we will identify collaboratories working in similar areas to ensure comparability. For example, NIH has funded a number of collaboratories in structural genomics. We have attached letters of support from leaders of two such collaboratories, indicating their interest in our research question and willingness to negotiate a working relationship: the Northeast Structural Genomics (NESG) Consortium and the Berkeley Structural Genomics Center.

Transnational Advocacy Networks. The second kind of distributed group we plan to study are Transnational Advocacy Networks (TANs), such as those associated with the recently concluded United Nations World Summit on the Information Society (WSIS). TANs are distributed groups of individuals and organizations with the shared goal of influencing national or international policy. In the case of WSIS, its structures were designed to explicitly involve governments, the private sector, and civil society. By definition, the WSIS civil society is transnational in scope, with hundreds of individuals (sometimes representing organizations) participating in one or more of its many organically emerging structures [14]. At last count, the WSIS civil society had the following major self-organizing components: the civil society bureau; the civil society plenary; the content and themes group; and a further twenty-two working groups, caucuses and task forces. Each of these components involves the collaboration of a geographically distributed group. While some prominent members of these TANs do meet face-to-face periodically during preparatory meetings for the WSIS or related conferences, their work is supported primarily by CMC tools, specifically e-mail lists [14]. For this aspect of the project, we plan in Phase I to focus on two of these groups. The first is the WSIS Civil Society Plenary (CSP), which is seen within the civil society structures as the most "legitimate" structure; however, it is also the largest and most unwieldy of the various structures. The second is the Internet Governance Caucus (IGC). This caucus is important because of its significant input into the most important policy debate of the WSIS processes, which centered around a transformation of the international regime to provide global governance for the Internet.

Free/Libre Open Source Software (FLOSS) development groups. Our final set of distributed groups are FLOSS development teams. 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. 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 and related projects are the most well known, but hundreds of others are in widespread use, including projects on Internet infrastructure (e.g., sendmail, bind), user applications (e.g., Mozilla, OpenOffice) and programming languages (e.g., Perl, Python, gcc) and even enterprise systems (e.g., eGroupware, Compiere, openCRX). Key to our interest is the fact that most FLOSS software is developed by self-organizing distributed groups comprising professionals, users [112-114] and other volunteers working in loosely-coupled groups. These groups are close to pure virtual groups in that developers contribute from around the world, meet face-to-face infrequently if at all, and coordinate their activity primarily using a cyber-infrastructure [101, 116]. The groups have a high isolation index [91] in that most group members work on their own and in most cases for different organizations (or no organization at all). While these features place FLOSS groups at one end of the continuum of distributed work arrangements, the emphasis on distributed work makes them useful as a research setting for isolating the implications of this organizational innovation. For Phase I, we will chose two projects that produce comparable systems in order to control for the nature of the program, thus allowing a more direct comparison of the groups' effectiveness. For example, in other work, we have compared projects developing Internet Messaging clients [54].

2.2 Data collection and cleaning

To explore the concepts identified in the conceptual development section of this proposal (Table 1), we will collect and analyze a range of data (e.g., e-mail archives, computer logs, primary and secondary project source documents and possibly supplemented with interviews with members of the initial projects). The most voluminous source of data will be collected from archives of CMC tools used to support the groups' interactions [56, 69]. These data are useful because they are unobtrusive measures of the group's behaviors [117]. In particular, mailing list archives will be a primary source of interaction data that illuminates the role of social maintenance, as email is one of the primary tools used to support group communication [68]. In the FLOSS setting, such archives are the primary mode of communication and so contain a huge amount of data (e.g., the Linux kernel list receives 5-7000 messages per month, the Apache httpd list receives an average of 40 messages a day). The TANs involved with the WSIS civil society also have large archives of email available for analysis (e.g., more than 8000 messages over 18 months for the WSIS Civil Society Plenary). Most scientific collaboratories also rely on CMC for day-to-day interactions, so we anticipate being able to identify comparable sources of data.

While in some cases the raw data are already available, significant effort is needed to extract scientifically useful information from them. The initial processing to prepare the data for analysis will be to download the data from the message archives, clean the data (e.g., by removing unnecessary coding from attachments), provide descriptive metadata on each archive, and extract the date, sender and any individual recipient' names, the sender of the original message, in the case of a response, and text of each message. In this preparatory stage, we will record available demographic data such as gender, region, organization and role within the group. Some of this manual coding will be facilitated by limited auto-coding within the computer-assisted qualitative data analysis (CAQDAS) tools used in the study (e.g., Atlas/ti or Hyper-research).

2.3 Data analysis

While voluminous, the raw data described above are at a low level of abstraction. The processed data will be analyzed using a variety of techniques to raise the level of conceptualization to fit our theoretical perspective and thus answer our research questions.

Phase I. In phase I, we will use CAQDAS tools to conduct content analysis to reduce the large amount of raw data to more specific codes and measures. Content analysis of computer-mediated communication has been an active area of research [9, 57]. Data will be content analyzed following the process suggested by Miles and Huberman [87], iterating between data collection, data reduction (coding), data display, and drawing and verifying conclusions—increasingly supported by the evolving NLP content analysis tools as the project progresses. A proportion of messages (ideally 100%) will be coded by two individuals to enable calculations of reliability. The initial (deductive) framework will be based on the conceptual development reviewed above, but we plan to evolve this framework based on our experiences with the data. As such, the research will also engage open code instances of group maintenance and other social support mechanisms. We plan to examine the relationship between different aspects of group maintenance and group synergy, as well as other aspects of the group process. For example, sender and recipient data could be used for social network analyses of the projects, as we have done in previous studies [e.g., 24, 62]. In addition, this phase will allow us to develop hypotheses about the relationship between group maintenance behavior and group performance across various settings, based on a developing understanding of the processes of group maintenance and its role in the life of the groups.

As an example, the content analysis approach was applied to one FLOSS project, Apache httpd, in a PhD thesis by a student in our group at Syracuse [3]. Though her main focus was on group learning, Annabi identified instances of group maintenance behavior that affected the social atmosphere in the group. For example, developers almost always referred to the group with inclusive pronouns and addressed each other by name. They shared limited personal stories (e.g., wedding and honeymoon news) such as:

> "If someone could implement this since I *swear* this is the last time I'm logging in before the wedding (haha) feel free–at the very least comment out the code relating to "experts" until that's implemented."

Humor and other forms of emotional expression were also common (e.g., "oop ack!" or "RTF owes RH beer"). There was little 'flaming'—escalating email hostility—in group interactions, even when frustrations and strong feelings were shared. In Annabi's study, group maintenance behavior were performed by all members on a small scale, instead of just by the group leader. Only in conflict resolution did the two leaders of the group show higher levels of group maintenance behavior. However, studies of a single project cannot identify how these phenomenon relate to project effectiveness, hence the need for the proposed study.

In another example, a similar approach to content analysis, albeit using different constructs, was taken by a doctoral candidate in the School of Information Studies studying a sub-set of the WSIS plenary e-mail archive for her doctoral dissertation. Although not yet completed, Zakaria has been able to develop some important findings on the impact of communication style on decision-making in the WSIS civil society [125]. She has also been able to develop innovative methods for training the coders, to test for inter-coder/rater reliability and to manage remote access to the coding database and software, techniques that will be employed in the management of this larger project. These two examples demonstrate two things: first, the feasibility of our planned approach and second, the nature of the phenomenon we will study.

Phase II. In the second phase of the project, we will utilize and extend current NLP technology to assist in identifying important semantic patterns that can then be translated into the codes developed in Phase I. Turner et al. [111] similarly used some simple NLP approaches to analyze bug reports, though our proposed work goes well beyond this initial effort. Use of NLP techniques supports researchers in looking for patterns with greater reliability and across larger amounts of data and a wider range of projects. These techniques can identify patterns that would be tedious for human coders (e.g., frequency of particular words, categories of word, such as vocatives or inclusive forms or sentence forms, such as questions), or more subtle indications of implicitly conveyed concepts (e.g., the initiator of particular kinds of behavior). In some cases, the NLP techniques can replace manual coding, but we expect them also to be useful in combination with human coding. For example, NLP techniques might be used to identify candidate examples of the use of humor (one of our indicators), which a human coder could then assess.

Because the use of NLP techniques is one of the major innovations of this proposal and the foundation for further analysis, we will explain its application in more detail. Application of NLP-based text processing to CMC transcripts (e.g., chat room conversations or emails) has been a challenge given the nature of these interactions. These texts are known for their use of specialized language patterns, as well as informal grammar and spelling rules [100]. To effectively meet the challenge of understanding these stylistically diverse and grammatically inconsistent texts, our NLP technology will leverage theoretical and empirical advances in research on Sublanguage Analysis and Discourse Structure. A sublanguage is defined as the particular language usage patterns that develop within the written or spoken communications of a community that uses this sublanguage to accomplish some common goal or to discuss topics of common interest.

The fact that a sublanguage deals with a restricted domain and is used for a specific purpose results in useful restrictions on the range of linguistic data that needs to be accounted for by the system. At the lexical level, the sublanguage excludes large parts of the total vocabulary of a language; for those words in the sublanguage vocabulary, the number of senses actually used for each word is limited. At the syntactic level, a sublanguage is characterized by predictable surface structures, utilizes a limited range of verbs, and makes extensive use of domain-specific nominal compounds, which reflect the specialized nature of the sub-field. The discourse level of a sublanguage deals holistically with units of language larger than a sentence, relying on the predictable structure of communications in this sublanguage. The discourse level model of a particular communication type consists of semantic categories (reflecting the purpose of communication) and the relations among those categories. The NLP system's recognition of these semantic categories handles the great surface variety in terms of lexical and syntactic choices in how entities (e.g., people, organizations), events (e.g., updates, requests), and relations amongst them (e.g., who requests an action by whom) are realized in text. As a result, the sublanguage analysis is able to abstract up from these individual instances that indicate presence of the underlying concepts to reveal the features of the model (e.g., politeness, community of inquiry) under study.

Communication types that have been analyzed and for which sublanguage grammars have been developed include abstracts, news articles, arguments, instructions, manuals, dialogue, instructions, email, and queries [84]. Early research in Sublanguage Theory [49, 83, 84, 105] has shown that there are recognizable linguistic differences amongst various types of discourse (e.g., news reports, email, manuals, requests, arguments, interviews) and that discourses of a particular type that are used for a common purpose within a group of individuals exhibit characteristic linguistic (lexical, syntactic, semantic, discourse, and pragmatic) features. Humans use these characteristic features to extract meaning, and these human processes can be simulated by a full-fledged NLP system in order to extract levels of meaning beyond the simple surface facts.

In the proposed research, the sublanguage analysis framework will be applied to automatically identify the important linguistic patterns in the text-based electronic communications that will be processed by the NLP system, and to annotate them with initial content categories, which will then be refined by the project group to reflect the conceptual framework emerging from the data. The NLP-based software developed at the Center for Natural Language Processing (CNLP) at Syracuse University analyzes naturally occurring texts (e.g., documents, transcribed interviews, email, chat) for the explicit and implicit meanings which are conveyed (and which usually only a human would recognize). The resulting NLP annotations will be used as initial codes representing the items such as the events, roles, intentions, goals or expectations reported and/or hinted at in the text (e.g., names, popular abbreviations, special terms, time expressions and other phrases with particular semantic values relevant to the research agenda). Some of the group maintenance features identified in section 2 are explicit and thus straightforward to identify (e.g., use of inclusive pronouns or past tense); others are more implicit (e.g., use of humor, self-disclosure or emotion) and will thus require careful analysis and extension of the current NLP tools to identify. (It should be noted that such features are often also problematic for human coders to reliably identify.)

As an example of this approach, we have conducted a small pilot study using NLP tools in a semester-long doctoral seminar, wherein students wrote rules to identify the politeness behaviors (or strategies) used in two FLOSS projects: Bibdesk, a graphical bibliography manager for the Mac OS X operating system, and GAIM, a multi-platform instant messaging and Inter-Relay Chat application. The students analyzed nearly 10,000 email messages from the Bibdesk and GAIM developers' list for evidence of both positive and negative politeness behavior (i.e., using just one of the frameworks discussed above). They made progress on identifying several of the indicators, such as politeness and hedges, but found that indicators such as personal connection or impersonalization were much more difficult. This initial effort demonstrates that the NLP techniques do have promise for coding group maintenance behavior expressed via cyber-infrastructure. However, this initial effort has clearly only scratched the surface of what is possible, and demonstrates the need for more intensive effort in specializing the NLP technology to capture more complex group maintenance behavior, as well as the need to test the rules on a variety of different datasets.

The tools developed by CNLP (e.g., Vanilla Extract, Knowledge Base Builder) for use by human coders will support a positive synergy between the manual and NLP coding, as each suggests indicators for further analysis. However, we also anticipate learning from the differences in coding approaches. For example, with human coders, coding reliability must be assessed by double coding, while automation offers the possibility of 100% reliability. On the other hand, we need to carefully examine what is and is not coded to assess the validity of the automated coding (though this is an issue with manual coding as well). Another example of a difference in approach is in the choice of unit of coding. In manual coding, it is common to use the semantic unit as the unit of coding, but for automated coding, the unit needs to be unambiguously identifiable, e.g., the sentence or message.

3. Management plan

Based on preliminary assessment of the effort required, we are requesting funding for two graduate students, some support for a professional research staff member and a small amount of summer support for 4 PIs (approximately 0.4 summer months per PI). All four PIs, Drs. Derrick L Cogburn, Kevin Crowston, Robert Heckman and Elizabeth D. Liddy, will work during the summer on project management and research design, and devote 10% of effort during the academic year to project management and oversight (1/2 day per week). All four PIs will share in project selection, overall project design and report writing. Each PI will be responsible for designing specific aspects of the project and overseeing those aspects:

- Dr. Crowston will direct the project and be responsible for project oversight and reporting.
- Drs. Heckman and Crowston will lead the research on the FLOSS groups.
- Dr. Cogburn will lead the research on scientific collaboratories and TANs.
- Dr. Liddy will lead the computer/information science research team in NLP tool development and integration. Dr. Liddy has extensive leadership experience in successful delivery of innovations in NLP based on 60+ funded R&D projects.

The graduate students will support the principal investigators in sample section, definition of constructs and variables, and will have primary responsibility for data collection and analysis, under the oversight of the PIs. Manual content analysis is extremely labor intensive. Our experience using this technique in other projects suggests that a student working with a PI will be able to code a project's worth of messages in a semester during the initial phase of code book building, and somewhat faster after that. Therefore, to support Phase I, we are requesting funding for two students working full time during the first semester and summer, 1.5 students during the second semester and 1 student during the third semester. This level of effort should be sufficient to double code the six projects we plan to analyze in the Phase I (though if necessary, we can double code a subset of messages to assess the reliability of the code book and single code remaining messages).

For Phase II, we plan to have a professional research staff member begin working with the students doing the manual coding during the second and third semester and intervening summer. The focus of this work will be developing NLP rules for identifying group maintenance behavior During the final semester and summer, we will have two students combining manual and NLP-supported coding. Note that Phase I and Phase II will overlap, meaning that we will finish the manual coding of the six initial groups in parallel with developing NLP rules. We will start Phase I by working on the TAN and FLOSS groups, for which we already have raw data that we can begin coding, and continue with the research collaboratories as the raw data becomes available. A time line is included as part of the budget justification to show how the requested resources will be employed.

We will employ two main project management techniques. First, we will have regular meetings of the project members to share findings and to plan the work. Initially, these will be every other week, but the frequency of meetings will be adjusted depending on our experience and the pace of the work being carried out at the time. These formal meetings of all project participants will augment the regular interaction of the teams of PIs and students working on the data analysis and expected frequent interactions of the students as they analyze data from the same projects. The NLP development team, all of whom are co-located in CNLP, will meet semi-weekly during the design phases and then weekly during implementation. The experience of this team on the existing toolset bodes well for an accelerated process of iterative requirements, implementation, usage, and new requirements. Second, an initial project activity will be the development of a more detailed timeline (based on the initial one in the budget justification section) against which progress will be measured. The budget includes support during summer and academic year to support these activities.

4. Conclusion

In this proposal, we develop a conceptual framework and a research plan to investigate group maintenance functions within distributed groups, using a combination of manual and NLP content analysis of interactions carried out via cyber-infrastructure. The proposed project will have both intellectual and broader impacts.

Expected intellectual merits

The project will contribute to advancing knowledge and understanding of distributed groups by identifying the role of group maintenance for distributed groups. We expect this study to make conceptual, methodological as well as practical contributions. Understanding the role of group maintenance in a group 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. Developing a theoretical framework consolidating a number of theories to understand the role of group maintenance behavior within a distributed group is an important contribution to the study of distributed groups.

Expected broader impacts

The project has numerous broader impacts. The project will benefit society by identifying the role of group maintenance in distributed groups, focusing on groups that are responsible for developing innovative outcomes. Such groups are an increasingly important approach to needs such as software development, scientific research and policy development. Understanding the role of group maintenance in these settings and the relation to group performance will help us develop guidelines to improve performance and foster innovation. Distributed work groups potentially provide several benefits but the separation between members of distributed groups creates difficulties in building social relations, which may ultimately result in a failure of the group to be effective. For the potential of distributed groups to be fully realized, research is needed on how to make these groups engaging and motivating to members.

To ensure that our study has a significant impact, we plan to broadly disseminate results through journal publications, conferences, workshops and on our Web pages, as well as through our interaction with the leaders and members of distributed teams. Our results could also be incorporated into the curricula of the professional degrees of the Syracuse University School of Information Studies, as well as improving the pedagogy of our courses and degree programs, as these programs are offered on-line and thus involve distributed groups. The project will promote teaching, training, and learning by students in the research project, providing them the opportunity to develop skills in model development, theory application, data collection and analysis.

Results from prior NSF funding

Three of the PIs for this grant, Drs. Crowston, Heckman and Liddy, have been jointly funded by one NSF grant within the past 48 months, HSD 05–27457 ($684,882, 2005–2008), *Investigating the Dynamics of Free/Libre Open Source Software Development Teams*. This project was funded at the end of 2005, and work on it is underway. The current proposal differs from the HSD project in its focus on the role of social maintenance rather than task-oriented behavior and its inclusion of other kinds of distributed groups, in particular, scientific and policy collaboratories supported by cyber-infrastructure. Nevertheless, the PIs' experience working together will be beneficial for the management of the current proposal. As well, we expect substantial synergies between the projects that will facilitate the proposed research.

Dr. Crowston has been funded by an additional three NSF grants in the past 48 months. The two most closely related to the current proposal are IIS 04–14468 ($327,026, 2004–2006) and SGER IIS 03–41475 ($12,052, 2003–2004), both entitled *Effective work practices for Open Source Software development*. These grants have provided support for travel to conferences (e.g., *ApacheCon* and *OSCon*) to observe, interview and seek support from developers and to present preliminary results, and for the purchase of data analysis software and equipment. This work has resulted in six journal papers [23-25, 31, 34, 60] with others under review [26], multiple conference papers [e.g., 18, 20, 21, 32, 33, 35, 62, 70] and workshop presentations [17, 19, 20, 22, 61]. These grants support a total of four PhD students; several others have been involved in aspects of the work.

Crowston's third grant is IIS 04–14482 ($302,685, 2005–2006, with Barbara Kwasnik), for *How can document-genre metadata improve information-access for large digital collections?* The grant partially supported work on conference papers, a conference mini-track and journal special issue [67]. Earlier work by the PIs on genre has appeared in journals [e.g., 27] and conference papers [e.g., 66]. The grant funds two PhD students; two others are involved in aspects of the research. Earlier support came from IIS–0000178 ($269,967, 2000–2003), entitled *Towards Friction-Free Work: A Multi-Method Study of the Use of Information Technology in the Real Estate Industry*. The goal of that study was to examine how the pervasive use of information and communication technologies (ICT) in the real-estate industry changes the way people and organizations in that industry work. The project resulted in several journal articles [28, 30, 37, 89, 106, 107] and numerous conference presentations [e.g., 29, 36]. One PhD student is finishing a thesis based on this work.

The Co-PI of this proposal, Dr. Liddy, has received NSF funding for six projects in the past five years. One is listed above (with Crowston and Heckman), a second is briefly described here, while the remaining four form a cohesive research program, which is described in more detail below. The second grant was DUE-0241856 ($2,519, 166, 2002-06), entitled *Multidisciplinary Systems Assurance Education.* As a Co-PI on this Federal Cyber Service Scholarship for Service Program grant, Liddy serves as mentor for Masters students in both the Information Management and Telecommunication & Network Management degree programs. Liddy has been able to involve the students actively in appropriate funded research projects underway at CNLP that address issues of information systems security and insider threats. Efforts have been established to enable these students to have summer internships with local companies whose expertise is in R & D on information systems security. The contribution to human resources is the main goal of this project and it is showing promising results.

The remaining four projects are funded by NSF's National Science Digital Library Program and involve research, implementation, and evaluation of NLP technology for automatic metadata generation for educational objects, most typically teachers' lesson plans and activity guides. The four grants are DUE-0085837 ($366,000, 2000-02) *Breaking the MetaData Generation Bottleneck*, DUE-0121543 ($475,000, 2001-03), *Standard Connection: Mapping Educational Objects to Content Standards*, DUE-0226312 ($374,938, 2002-04), *MetaTest: Evaluating the Quality & Utility of MetaData* and DUE-0435339 ($634,218, 2004-2006*), Computer-Assisted Standard Assignment & Alignment*. Two of the projects center around content standards, either their automatic assignment to resources or the automatic mapping amongst multiple national standards and the fifty state standards. Over the life of these four projects, Liddy and group have: 1) adapted their existing NLP methods and technology to the task of extracting from learning resources the values for the 23 metadata elements used for representing learning objects in digital libraries (15 Dublin Core + 8 GEM); 2) proven in end-user empirical evaluations that the metadata elements assigned automatically using NLP are equally good as those assigned by humans, and; 3) extended the metadata capability to map individual resources to the relevant content standards in Math and Science, key to standards-based education, and automated state-to-state and state-to-national alignment of content standards. Results were evaluated by experts in standards and by classroom teachers. The grants have resulted in numerous publications [71-82, 122]. Four PhD students and three Masters students have been active participants, learning both about the research and evaluation process and the wider field of digital libraries. They have presented the projects' findings jointly or singly and interacted substantively with this research community at relevant conferences.

The fourth co-PI on this proposal, Dr. Cogburn, has received NSF funding for 3 projects in the past 5 years. The most recent project, *Transnational Non-Governmental Organizations and Dynamic Change*, NSF HSD 05–27679, ($500,000, 2005-07, with Margaret Herman), was awarded in the fall of 2005. This grant supports a large-scale, systematic study of transnational Non-Governmental Organizations (TaNGOs) as agents of social change. Using a concurrent mixed-methods design (e.g., interviews, surveys, comparative case studies, and web-based archival research), the study is investigating the impact of leadership, structure, communication, and collaboration on the effectiveness, and accountability of these organizations at national, regional, and international levels. This project will provide synergies for the proposed study of TANs.

Dr. Cogburn served as senior personnel on two NSF grants while at the University of Michigan. The first, ITR/SOC+IM-0085951 ($2,400,000, 2001-05), *Sustainable and Generalizable Technologies to Support Collaboration in Science*, focused on identifying socio-technical factors that affect the development of scientific collaboratories, and ways to apply those lessons to new collaboratory development (see http://www.scienceofcollaboratories.org/). Ten publications and numerous scholarly presentations were supported in part by his association with the SOC project. Knowledge from these projects informs the research in this proposal. The second grant, IGERT-0114368 ($2.7 Million, 2001-05) entitled *Socio-Technical Infrastructure for Electronic Transactions (STIET)* (http://www.si.umich.edu/stiet/index.htm), explored the institutional and technical mechanisms that support the development of electronic commerce. For this project, Dr. Cogburn mentored doctoral students participating in the STIET program and participated in weekly seminars. Knowledge from the project strengthened the approach to the socio-technical infrastructure to support geographically distributed collaboration now used within Cogburn's research group.

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Curriculum Vitae

Education

1980–1984 A. B., *magna cum laude,* June 1984, Applied Mathematics (Computer Science), Harvard University.

1984–1991 Ph. D., January 1991, Information Technologies, Sloan School of Management, Massachusetts Institute of Technology.

Appointments

1991–1996 Assistant Professor of Computer and Information Systems, School of Business, University of Michigan.

1996– Professor of Information Studies (Assistant 1996–2001, Associate 2001–2006), School of Information Studies, Syracuse University.

Publications (from a total of 48 peer reviewed journal and conference papers)

Crowston, K. & Howison, J. (2006). Hierarchy and centralization in Free and Open Source Software team communications. ***Knowledge, Technology & Policy***. *18*(4), 65–85.

Crowston, K., Howison, J. & Annabi, H. (2006). Information systems success in free and open source software development: Theory and measures. ***Software Process—Improvement and Practice (SPIP)***, *11*(2), 123–148.

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Other significant publications

Crowston, K. & Myers, M. D. (2004). Information technology and the transformation of industries: Three research perspectives. ***Journal of Strategic Information Systems***, *13*(1), 5–28.

Watson-Manheim, M.-B., Chudoba, K. M. and Crowston, K. (2002). Discontinuities and continuities: A new way to understand virtual work. ***Information, Technology and People***, *15*(3), 191–209.

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Crowston, K. (1997). A coordination theory approach to organizational process design. ***Organization Science***, 8(2), 157–175.

Synergistic activities

1. **Maintainer** of ISWorld Website on Information-Related Doctoral Programs, http://isphd.syr.edu/
2. **Invited participant**, Schloss Dagstuhl Perspectives Seminar 04051: "Empirical Theory and the Science of Software Engineering", 25–29 January 2004.
3. **Co-program chair**, IFIP Working Group 8.2 Working Conference on *Virtuality and Virtualization*, Portland, OR, July 2007.

Collaborators in the past 48 months

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APPOINTMENTS

2004- present *Assistant Professor,* School for Information Studies, Syracuse University, Syracuse, NY.

2004- present *Senior Research Associate,* Moynihan Institute of Global Affairs, Maxwell School of Citizenship & Public Affairs, Syracuse, NY.

2000—7/2004 *Assistant Professor of Information,* School of Information, University of Michigan, Ann Arbor, MI.

2000—7/2004 *Assistant Professor of African Studies,* Center for Afroamerican & African Studies, University of Michigan, Ann Arbor, MI.

1999—present *Adjunct Professor,* American University, School of International Service.

1999—2000 *Visiting Assistant Professor of Information,* University of Michigan, Ann Arbor, MI.

1998—present *Visiting Professor,* University of the Witwatersrand, Graduate School of Management.

FIVE RELATED PUBLICATIONS

Cogburn, D.L. *Diversity Matters, Even at a Distance: Evaluating the Impact of Computer-Mediated Communication on Civil Society Participation in the World Summit on the Information Society*, Information Technology and International Development. (Vol. 2, Issue 1, Summer, 2004).

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Cogburn, D.L.; N. Levinson; "US—Africa Virtual Collaboration in Globalization Studies: Success Factors for Complex, Cross-National Learning Teams" *International Studies Perspectives*, Vol. 4, Issue 2 (May 2003).

Cogburn, D.L.; Zhang, L; and Khothule, M. Going Global, Locally: The Socio-Technical Influences on Performance in Distributed Collaborative Learning Teams, *ACM International Conference Proceedings Series , 2002*

Olson, G.M., Teasley, S., Bietz, M.J., and **Cogburn, D.L**., Collaboratories to Support Distributed Science: The Example of International HIV/AIDS Research. *ACM International Conference Proceedings Series, 2002*

FIVE OTHER PUBLICATIONS

Cogburn, D.L., and L. Zhang (2004) "Still Going Global, Locally: The Impact of Team Mode in a Distributed Collaborative Learning Environment (Extended and updated version)," *IADIS International Journal on WWW/Internet*, Vol 1.1., pp. January 2004.

Cogburn, D.L., Governing Global Information and Communication Policy: Emergent Regime Formation and the Impact on Africa, *Telecommunications Policy,* Vol. 27, Issue 1-2 pp 135 – 153 (2003)

Cogburn, D.L. "HCI in the Developing World: What's in it for Everyone?" Invited article, *Interactions* (Vol. 10, Issue 2, March-April, 2003)

Cogburn, D.L. 2002 "Understanding Distributed Collaborative Learning Between the United States and South Africa" *Proceedings of the 2002 World Congress on Networked Learning*, ICSC Academic Press, Canada/ The Netherlands

Cogburn, D.L., "Globalization and state autonomy in the Information Age: Telecommunications sector restructuring in South Africa," *Journal of International Affairs*, 51, no 2 (1998)

Synergistic Activities

Developed and direct the *Global Graduate Seminar on Globalization and the Information Society*, a geographically distributed web-based course which consists of graduate students from Syracuse University, the University of Michigan, American University, in the US; and the University of the Witwatersrand, University of Pretoria, and the University of Fort Hare, in South Africa.

Helped to found the Global Information Infrastructure Commission (www.giic.org) and founded its first regional organization GIIC Africa (www.giic.org/giicafrica), to promote a global dialogue and consensus formation on GII policy and applications development amongst leading CEOs in the global information and communications technologies industries.

Appointed by the United Nations to several expert and advisory positions, including the High-Level Advisory Panel for the Global Alliance on ICT and Development (http://www.un-gaid.org/), High-Level Working Group on Information and Communications Technologies in Africa, which in 1995-96, under the auspices of the United Nations Economic Commission for Africa developed and launched the *African Information Society Initiative*, and helped to launch the coalition of development agencies to support the initiative called the Partnership for ICTs in Africa

Appointed by the Secretary General of the International Telecommunication Union (ITU) to serve on the 1998 Africa Telecom (http://www.itu.int/AFRICA2001/exhibition/africa98.html) program committee, held in Johannesburg, South Africa. In this role, worked with program committee members from around the world to conceptualize and structure the leading telecommunications policy conference in Africa.

Appointed by the World Bank to serve on the Board of the World Links for Development Program (WorLD), a program designed to Internet access and training for teachers and students in the developing world (http://www.worldbank.org/worldlinks/english/). Worked with educational and ICt experts from around the world, to advise this initiative of WBI.

Collaborators & Other Affiliations

Collaborators & Co-Editors:Catherine Nyaki Adeya UNU/INTECH; Daniel E. Atkins Michigan; Peter Benjamin Wits; Sandra Braman Wisconsin; Brent Chrite Michigan; Morton Falch Technical Univ of Denmark; Benjamine Fouche Stellenbosch; Linda Garcia Georgetown; Alison Gillwald Wit; Nancy Hafkin UNECA; Margaret Hedstrom Michigan; Anders Henten Denmark; Magda Ismail Harvard; Brian Kahin Michigan; Nanette Levinson American; Milton Mueller Syracuse, Derek Mulenga Penn State; Mary Mulvihil Notre Dame; Gary M. Olson Michigan; J.P. Sing Georgetown; Knud Erik Skouby, Denmark; Michael Traugott, Michigan

Graduate and Postdoctoral Advisors: Ronald Walters (Maryland); Richard Seltzer (Howard); Joseph P. McCormick, 3rd (Pennsylvania); John Cotman (Howard); Ernest J. Wilson, III (Maryland); Robert Cummings (Howard); Hilbourne Watson, (Bucknell)

*Dissertation/Thesis Advisor (**completed**): **Norhayati Zakaria,** Benjamin Addom, K. Matthew Dames, Raed Sharif, Sarah Webb (Syracuse); Lingling Zhang, Kevin Hill, **Margaret Wheeler**, Rowena Martineau (Michigan); Gordon Onyeamo (Witwatersrand); Sherif Adam (Univ of the Witwatersrand); Lubabalo Matinca (Fort Hare); **Griselda Baquedan**o (American).*

Robert Heckman
School of Information Studies
Syracuse University
Syracuse, NY 13244-4100
315 443 4479
rheckman@syr.edu

PROFESSIONAL PREPERATION

University of Pennsylvania: BA - June 1969 (English Literature)
University of Pittsburgh: Ph.D.- December 1993 (Information Systems)

APPOINTMENTS

2000 - present Director, MS Program in Information Management
1998 - present Associate Professor, Syracuse University, School of Information Studies
1992 - 1998 Assistant Professor, Syracuse University, School of Information Studies
1990 - 1992 Visiting Assistant Professor, Duquesne University, A.J. Palumbo School of Business Administration

PUBLICATIONS DIRECTLY RELATED TO THIS PROPOSAL

(from a total of 44 peer reviewed journal and conference papers)

Heckman, R. and Annabi, H. (2006) Cultivating Voluntary Online Learning Communities in a Blended Learning Environment. *Journal of Asynchronous Learning Networks.*

Heckman, R. and Annabi, H. (2005) "A Content Analytic Comparison of Learning Processes in Online and Face-to-Face Case Study Discussions," *Journal of Computer Mediated Communication*.

Heckman, R. and Misiolek, N. (2005). Leaders and Followers in Student Online Project Teams. *Proceedings of the 38th Hawaii International Conference on System Sciences – 2005*. Kona, Hawaii.

Misiolek, N. I. and Heckman, R. (2005). Patterns of Emergent Leadership in Virtual Teams *Proceedings of the 38th Hawaii International Conference on System Sciences – 2005*. Kona, Hawaii.

Heckman, R., Li, Q., Xiao, X. (2006.) How Voluntary Online Learning Communities Emerge in Blended Environments. *Proceedings of the 39th Hawaii International Conference on System Sciences – 2006*. Kauaii, Hawaii.

OTHER SIGNIFICANT PUBLICATIONS

Heckman R. and Annabi, H. (2006) "How the Teacher's Role Changes in Online case Study Discussions." *Journal of Information Systems Education*

MacInnes, I, Kongsmak, K. and Heckman, R. (2004)"Vertical Integration and the Relationship Between Publishers and Creators." *Journal of Electronic Commerce Research*, Vol. 5, No.1, pp. 25-37.

Heckman, R., Finneran, C. and Marshall, T. (2003) "The Power of Narrative in Asynchronous Learning Networks." *Proceedings of the 9th Sloan-C International Conference on Online Learning.* Orlando Florida

Heckman, R., Maswick, D., Rodgers, J. Ruthen, K., Wee, G. (2000). "The Impact of Information Technology on Roles and Role Processes in Small Groups." In *Case Studies on Information Technology in Higher Education: Implications for Policy and Practice.* Ed. Petrides, L.A. .Idea Group Publishing. Hershey PA.. p. 157-167.

Eschenfelder, K, Heckman, R. and Sawyer, S. (1998). "The Distribution of Computing: The Knowledge Markets of Distributed Computer Support Specialists," *Information Technology & People* (11:2), 84-103.

SYNERGISTIC ACTIVITIES

Invited Presentation "Cultivating Voluntary Online Learning Communities." SLOAN-C Workshop: *Online Course Development Basics*. September 17, 2006.

Editorial Board, *Journal of Computer Mediated Communication*

Association for Information Systems, Society for Information Management, Charter member SIM IT Procurement Working Group, Treasurer, Central New York Chapter, Society for Information Management (1996 - 1997)

Regional Editor for North America, *International Journal of Information Management* (1997 - 2000)

Reviewer for the International Conference on Information Systems, Association of Marketing Theory and Practice Conference, American Marketing Association Winter Educators Conference, Technology Studies, International Journal of Information Management, MISQ, Journal of Information Technology and People, Journal of Computer Mediated Communication.

COLLABORATORS WITHIN THE PAST 48 MONTHS

Nor Shahriza Abdul Karim
Eileen Allen
Hala Annabi
Charmaine Baretto
Kevin Crowston
Michael D'Eredita
Kristen Eschenfelder
U. Yeliz Eseryel
Christina Finneran
James Howison
Kasama Kongsmak
Qing Li
Ian MacInnes, I.
Todd Marshall
Nelson Massad
Nora Misiolek
Steven Sawyer
Kangning Wei

Thesis advisors: William R. King (Pittsburgh), Dennis Galletta (Temple), Vivek Choudhury (Cincinnati), Audrey Guskey (Duquesne), Louis Pingel (Pittsburgh)

Advisees: Nor Shahriza Abdul Karim (International Islamic University Malaysia), Charmaine Baretto (Florida Atlantic), Kristen Eschenfelder (Wisconsin), Nelson Massad (Florida Atlantic), Houria El Figuigui, Yeliz Eseryel, Eleonara Misiolek (all of Syracuse University),

Elizabeth DuRoss Liddy
School of Information Studies
Syracuse University

Education:

Daemen College	English Literature	B.A.	1966
Syracuse University	Information Studies	M.L.S.	1977
Syracuse University	Information Transfer	Ph.D.	1988

Appointments:

1999-	Director, Center for Natural Language Processing, Syracuse University
1998-	Professor, Syracuse University
1993-1998	Associate Professor, Syracuse University
1987-1992	Assistant Professor, Syracuse University

5 Related Publications:

Lee, J., Gay, G., Davidson, B.D., Ingraffea, A. & Liddy, E. (In Press). Social Psychological Factors Affecting Technology Acceptance. IEEE Journal on Educational Technology and Society .

Symonenko, S., Rowe, S. &Liddy, E.D. (2006). Illuminating Trouble Tickets with Sublanguage Theory. In Proceedings of the Human Language Technology / North American Association of Computational Linguistics Conference.

Yilmazel, O., Symonenko, S., Balasubramanian, N. & Liddy, E.D. (2005). Leveraging One-Class SVM and Semantic Analysis to Detect Anomalous Content. In IEEE International Conference on Intelligence and Security Informatics Proceedings. Lecture Notes in Computer Science. Springer-Verlag.

Rubin, V. L., Liddy, E.D. & Kando, N. (2005). Certainty Identification in Texts: Categorization Model & Manual Tagging Results. In Shanahan, J., Qu, J. & Wiebe, J. (Eds.). Computing Attitude and Affect in Text. Springer, Dordrecht, Netherlands.

Turner, A.M., Liddy, E.D., Bradley, J. & Wheatly, J. (2005). Modeling Public Health Interventions for Improved Access to the Public Health Grey Literature. Journal of the Medical Library Association, 93(4): 487-94.

5 Other Publications: (selected from 111 publications)

Yilmazel, O., Symonenko, S., Balasubramanian, N. & Liddy, E.D. (2005). Improved Document Representation for Classification Tasks For the Intelligence Community. Proceedings of the AAAI Stanford Spring Symposium.

Diekema, A.R., Yilmazel, O., Chen, J., Harwell, S., He, L. & Liddy, E.D. (2004). Finding Answers to Complex Questions. In Maybury, M. (Ed.) New Directions in Question Answering. AAAI-MIT Press.

Liddy, E.D., Diekema, A.R., & Yilmazel, O. (2004). Context-Based Question-Answering Evaluation. In Proceedings of 27th Annual ACM-SIGIR Conference. Sheffield.

Liddy, E.D. (2002). How a Search Engine Works. In Mintz, A. (Ed.). Web of Deception: Misinformation on the Internet. Information Today, Medford, NJ.

Liddy, E.D., Paik, W., Yu, E.S. (1994). Text Categorization for Multiple Users Based on Semantic Information from a Machine Readable Dictionary. ACM TOIS.

Synergistic Activities:

Founding/current advisor of Women in Information Technology, a student group in

IST. Successfully guided students through 4 years of increasing membership, activity level, and number of female students admitted to and succeeding in IST.

Founder and Director of the Center for Natural Language Processing in the School of Information Studies which supports full time researchers and PhD students from Information Science and Computer Science. The Center provides Internship and Independent Study opportunities for undergraduate, masters, and PhD students.

Active pursuer of support for under-represented students in science & technology by receipt of GAANN fellowships for women & minority doctoral students from US Education Dept.

Actively working with master student recipients of our Scholarship for Service Program to incorporate them into federally funded research projects.

Recipient of 60+ funded R&D projects from government, foundation, and industry. Projects have included numerous doctoral and masters' students in the research process, who gain the experience to become researchers in their own right.

Selected Recent Research Grants Received:

2006-2009 Co-P.I. Improving Public Health Grey Literature Access for the Public Heath Workforce. *National Library of Medicine*. $448,821.

2005-2008 Co-P.I. Investigating the Dynamics of Free/Libre Open Source Software Development Teams. *NSF*. $684,882.

2004-2006 Co-P.I. Computer-Assisted Standard Assignment & Alignment. *NSF-National Science Digital Library Program*. $634,218.

2003-2005 Co-P.I. A Context, Role, and Semantics Based Approach for Countering Malicious Insider Threats. Information Assurance for the US Intelligence Community. *ARDA*. $822,683.

2003-2004 P.I. Cross-Language Information Exploitation of Arabic. *Department of Homeland Security*. $496,000.

2003-2005 Co-P.I. Multidisciplinary Systems Assurance Education. *NSF Federal Cyber Service: Scholarship for Service Program*. $2,519,166.

2001-2003 Co-P.I. Modeling Public Health Interventions for Improved Access to the Grey Literature. *Robert Wood Johnson Foundation*. $390,000.

2001-2004 P.I. Advanced Capabilities for Evidence Extraction. *DARPA*. $800,000.

Non-SU Collaborators & Other Affiliations (2000-2006):

Cyr, Martha – Worcester Polytechnic
Devaul, Holly – DLESE/UCAR
Feldman, Sue – IDC Corp.
Gay, Gerri – Cornell University
Ingraffia, Tony – Cornell University
Lagoze, Carl – Cornell University
Marchionini, Gary – UNC
Shneiderman, Ben – University of Maryland
Sutton, Stuart – University of Washington
Turner, Anne – University of Washington

Graduate Advisors:

Jeffrey Katzer (deceased)
Susan Bonzi – Syracuse University
Robert N. Oddy – Syracuse University (Emeritus)
Joseph Grimes – University of Hawaii
Peter Mosenthal (deceased)

Thesis Advisor (of 9 PhD Advisees and 30 Masters Advisees). PhD Graduates are:

Jiangping Chen – U. of North Texas; Anne Diekema – CNLP, Syracuse U; Jeffrey Pomerantz - U of North Carolina; Corinne Jorgensen – U of Florida

Budget Justification

A. Salaries and Wages – Senior Personnel

The PIs, Drs. Derrick Cogburn, Kevin Crowston, Robert Heckman and Elizabeth Liddy will work during the summer ($4,500 per PI per summer, approximately 0.4 summer month). Summers will be devoted to sample selection, detailed project design, integration of data analysis and publication of results. All PIs will devote 10% of effort during the academic year to project management and oversight (1/2 day / week, supported by Syracuse University). Dr. Crowston will be responsible for overall project direction and coordination, for assuring successful project completion, including submission of NSF progress reports, as required. The PIs will jointly be responsible for the review of the data and preparation of manuscripts for publication.

B. Salaries and Wages – Other Personnel

66% of the direct funding is requested to support PhD student tuition and stipends. Stipends are requested for two Ph.D. students as shown in the table below. The graduate students will support the principal investigators in sample section and will have primary responsibility for data collection and analysis, under the oversight of the PIs. We are also requesting funding for a professional research staff member to work on development of NLP coding rules, also shown in the table.

<table>
<tr><th></th><th></th><th>Ph.D. students</th><th>Research staff</th></tr>
<tr><td rowspan="3">Year 1</td><td>Semester 1</td><td>2 x 100%</td><td></td></tr>
<tr><td>Semester 2</td><td>2 x 75%</td><td rowspan="3">0.15 CY</td></tr>
<tr><td>Summer</td><td>2 x 100%</td></tr>
<tr><td rowspan="3">Year 2</td><td>Semester 1</td><td>2 x 75%</td></tr>
<tr><td>Semester 2</td><td>2 x 100%</td><td></td></tr>
<tr><td>Summer</td><td>2 x 100%</td><td></td></tr>
</table>

C. Fringe Benefits

Fringe Benefits are calculated as direct costs in accordance with Syracuse University's indirect cost rate agreement (Department of Health and Human Services, 17 % for faculty during the summer; 31.7% for faculty during the academic year and full time staff, 17.2% for graduate students and 6.7% for undergraduate students and temporary staff). Actual rates in place during the time of the award would be charged.

E2. Travel:

Travel support is requested for students and PIs to disseminate results at academic conferences (one trip each, $1500/trip).

G. Other Direct Costs

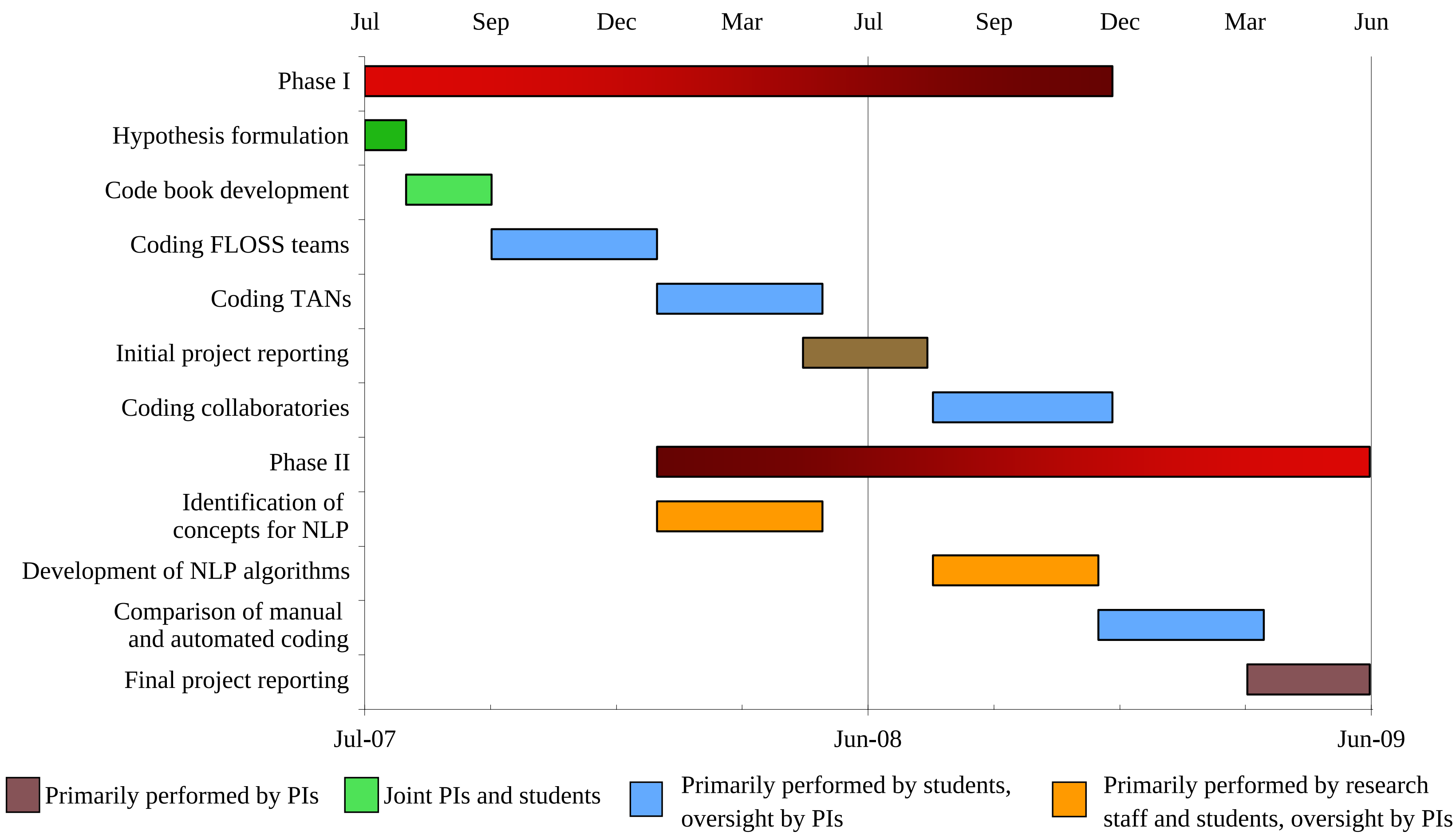
6. Other:

A total of $25,164 is requested for partial support of tuition for two graduate students (12 credit hours per year at $1,018/credit for Year 1 and $1,079/credit for Year 2).

I. Indirect Costs

Indirect Costs are calculated in accordance with Syracuse University's federally negotiated indirect cost rate agreement (Department of Health and Human Services, effective 06/15/06), which is currently 47.5% of modified total direct costs (MTDC). Syracuse University's threshold for equipment is $5,000.

The following proposed timeline for the project indicates how the requested resources will be applied.



Facilities, equipment and other resources

Syracuse University is one of the largest and most comprehensive independent universities in the United States. Founded in 1870, Syracuse offers excellent facilities, equipment and other resources for research and study in many academic and professional disciplines.

The **School of Information Studies** is a leading center for innovative programs in information policy, information behavior, information management, information systems, information technology and information services. Its approach stands out from other institutions that offer computer science, management, information science and related programs in that our focus is on users and user information needs as a starting point for integrating information and information technology into organizations. The faculty of the School crosses disciplinary boundaries to integrate the common elements of information management in business, government, education, and nonprofit settings, including the relationship of information and knowledge, electronic and traditional libraries, information systems and technology, information resources management, information policy and services, and the study of information users.

The School has seven active research centers, of which one, the **Center for Natural Language Processing**, will be central in this research. CNLP advances the development of human-like language understanding software capabilities for government, commercial, and consumer applications. It is situated in its own lab facilities in Hinds Hall at Syracuse University. The Center for Natural Language Processing has five servers, and twenty-one computers. In addition to its own lab space and equipment, the Center has access to the meeting rooms, labs, and classroom space of the School of Information Studies. The Center also has access to technical and administrative resources within the greater University.

The Center has been successful at attracting top student talent for its many Research Assistantships, including two PhD students who have won the prestigious ISI Doctoral Dissertation Proposal Award and the ProQuest Doctoral Dissertation Award presented by the American Society for Information Science and Technology

The School's other research centers are:

- Center for Digital Commerce. Conducts research and provides strategic analyses in all areas of digital and electronic commerce.
- Center for Emerging Network Technologies. Performs hands-on testing and provide industry analysis of products and services in emerging technology markets.
- The Convergence Center. Supports research on and experimentation with media convergence to understand the future of digital media and to engage students and faculty in the process of defining and shaping that future.
- The Systems Assurance Institute, a collaboration among Engineering and Computer Science, Information Studies, the Newhouse School of Public Communications and the Maxwell School of Citizenship and Public Affairs. Advances the understanding and state-of-the-practice of systems assurance.
- The Center for Digital Literacy. Supports collaborative research and development projects related to understanding the impact of information, technology and media literacies on children and adults in today's technology-intensive society.
- The Information Institute of Syracuse (IIS) (http://iis.syr.edu/). The umbrella organization for a number of highly visible and widely successful digital education information services to improve learning and teaching in the U.S. and throughout the world.

The School of Information Studies space plan includes providing (1) a space for a community of learning, research, and education for students and faculty; (2) space that supports economic development and growth in Central New York: (3) space that supports research, development and economic growth through the School's research centers; (4) common spaces that are inviting to students and visitors; (5) space that supports communication and connections between floors to preserve the strong feelings among students, faculty, and staff of being on the IST team; (6) a building that supports state of the art technology including broadband and wireless in offices, classrooms and centers; (7) space with the flexibility to change to meet the needs of a changing networked economy, changing technology, research, and faculty and student needs; (8) classroom space that supports student access to technology and/or classroom discussions in a room such as a case management classroom; (9) sufficient conference and meeting room space for a school enriched by its faculty and staff commitment to team meetings, service, and collaborative research; and (10) space that supports a collaborative learning environment for students.

SU's library system serves the information and research needs of the academic community. The collections exceed 2.6 million volumes, 11,330 serials and periodicals, and 3.4 million microforms, located in several libraries on campus. Library services include information and reference, online database searching, access to bibliographic and other data on CD-ROM and interlibrary loan.

Computing Services helps researchers, faculty and students use computing by providing personal computers, mainframe computers, data communication networks, software, training and advice. Most equipment and services are available without a direct charge.

CENTER FOR ADVANCED BIOTECHNOLOGY AND MEDICINE
RUTGERS UNIVERSITY

679 Hoes Lane Piscataway New Jersey 08854-5638

December 4, 2006

Kevin Crowston
School of Information Studies
Syracuse University
348 Hinds Hall
Syracuse, NY 13244-4100

Dear Dr. Crowston,

I am writing on behalf of the Northeast Structural Genomics (NESG) Consortium to offer our support for your proposal to the National Science Foundation. The proposed comparative study of the nature and function of group maintenance functions sounds like an interesting and valuable project we would be very interested in the results of.

The NESG is comprised of Rutgers University, Columbia University, Cornell University, Hauptman Woodward Research Institute, Pacific Northwest National Laboratories, The State University of New York at Buffalo, UMDNJ Robert Wood Johnson Medical School, University of Toronto, and Yale University. Supporting and promoting divergent yet equally effective management styles within the consortium, and ensuring a consistent flow of communication from all avenues are a few of the group maintenance challenges we face on regular basis. Should you receive support for your proposal, we look forward to exploring further collaboration on this study.

Gaetano T. Montelione

Gaetano Montelione, Ph.D.
Director, Northeast Structural Genomics Consortium
Professor of Molecular Biology
and Biochemistry, Rutgers University
Resident Member, CABM

BERKELEY LAB
PHYSICAL BIOSCIENCES DIVISION

COMPUTATIONAL CRYSTALLOGRAPHY INITIATIVE,
LAWRENCE BERKELEY NATIONAL LABORATORY,
BLDG 64R0121, BERKELEY, CA 94720.

TEL: 510.486.4225 FAX: 510.486.5909

December 12, 2006

Kevin Crowston
School of Information Studies
Syracuse University
348 Hinds Hall
Syracuse, NY 13244-4100

Dear Dr. Crowston,

I am writing on behalf of my research group to offer my support for your proposal to the National Science Foundation. Group maintenance is an important issue for us in managing our distributed research collaboration, and so would be interested in the results of your study. We are developing a new software package for automated X-ray crystallography, called PHENIX. This software is being developed as part of an international collaboration, funded by NIH and headed by my research group. Those currently involved are: Tom Terwilliger (Los Alamos National Laboratory), Randy Read (University of Cambridge, U.K.), and Jane & David Richardson (Duke University).

Should you receive support for your proposal, we are willing to explore further collaborations.

Yours sincerely,

Paul D. Adams (Ph.D.)
Principal Investigator & Senior Staff Scientist, Lawrence Berkeley National Laboratory
Head, Berkeley Center for Structural Biology
Deputy Principal Investigator, Berkeley Structural Genomics Center

COLUMBIA UNIVERSITY

CIESIN
CENTER FOR INTERNATIONAL EARTH SCIENCE
INFORMATION NETWORK

1 February 2007

Kevin Crowston
School of Information Studies
Syracuse University
348 Hinds Hall
Syracuse, NY 13244-4100

Dear Dr. Crowston,

I am writing on behalf of CIESIN, the Center for International Earth Science Information Network, to offer our support for your proposal to the National Science Foundation. Group maintenance is an important issue for us in managing our distributed research collaborations, and so we would be most interested in the results of your study. Should you receive support for your proposal, we are willing to explore further collaborations.

CIESIN is a research unit of the Earth Institute at Columbia University and is a collaborator in a number of cyberinfrastructure projects in the geosciences and other fields. We also work on cyberinfrastructure activities at national and international levels.

Sincerely,

Dr. Robert S. Chen
Director and Senior Research Scientist

cc: M. Levy

OFFICE OF THE DIRECTOR
P.O. Box 1000 61 Route 9W Palisades, NY 10964-8000 845-365-8988 Fax 845-365-8922