Patterns for Effective Management of Virtual Projects: Theory and Evidence

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ABSTRACT

The management of virtual projects is fundamentally different from that of traditional projects. Furthermore, the research in this area comes from different reference disciplines and perspectives, and a unified view or theory of best practices does not yet exist. Being able to combine perspectives in a seamless way with skills and technology could provide integrative blueprints for best practices in virtual projects. We use the theoretical frame of patterns to propose such a view. We focus on three concepts as the underlying theoretical elements for identifying patterns of effectiveness in virtual project management: (1) coordination, (2) communication, and (3) control. As a first step in the identification of specific patterns, we conducted a series of virtual focus groups with participants from industry who had real experience with virtual projects. The brainstorming data from the focus groups was analyzed to develop an initial set of patterns. The study represents a first step in an iterative and evolutionary process.

Keywords: *computer-mediated communication; distributed project management; electronic collaboration; IS project teams; pattern theory; virtual projects*

INTRODUCTION

Project management is a challenging activity in the best of circumstances, and it has become even more so in the virtual world. The increasingly popular use of virtual teams for dispersed projects has resulted in new challenges for both research and practice. We use the term "virtual projects" to refer to any project in which team members are geographically dispersed, and rely on information and communication technologies to accomplish their work. The project team may be dispersed on other dimensions as well, for example, culturally

or organizationally, but geographic dispersion is a minimal condition. The challenge in virtual projects is to go beyond a simple transfer of knowledge from traditional environments by developing a theoretically sound set of practices that are relevant to the virtual domain.

We use the theoretical frame of patterns to address this challenge in a novel way. Pattern theory was introduced in architecture (Alexander, 1965; Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, & Angel, 1977) and was later applied to software design (Gamma, Helm, Johnson, & Vlissides, 1994), as a way of developing accepted solutions for specific problems in a defined context. We propose that patterns of effective management for virtual projects can be identified. We focus on three concepts as the underlying theoretical elements for identifying such patterns, namely communication, coordination, and control. Different types of projects can be expected to have different patterns for successful project management. The key research question for the study is: *What patterns of communication, coordination, and control can be identified for the successful management of virtual projects?* The answer to this question is important because it advances theory in a significant research domain while also providing practical advice to managers on a question of real importance.

Based on the theoretical foundation just described, we conducted an empirical study in order to identify patterns. Brainstorming comments and questionnaire data from a series of virtual focus groups provided the data for textual analysis. Themes in the text were identified and related to the theoretical model. This analysis was used to extract patterns of effective virtual project management. The next section provides the theoretical development of patterns and the definition and background of key concepts. The method is then described, followed by the data analysis and results. The paper concludes with implications for research and practice.

THEORETICAL FOUNDATION

The management of virtual projects is a complex phenomenon, and the relevant theory and concepts that govern that phenomenon come from different domains. We begin with a definition of key concepts in order to set the boundaries for the research. First, projects are defined and characterized in terms of a parsimonious typology. Second, virtuality is defined, and the role and nature of technology are developed. Third, key factors for managing virtual projects are presented. Fourth, the concept of patterns is defined. Each of these separate pieces is built on existing literature and presented in the context of our overarching theoretical frame.

Typology of Projects

Projects are the lifeblood of organizational activity. A project can be defined as a "temporary endeavor undertaken to create a unique product or service" (PMI Standards Committee, 1996, p. 4). Projects vary on many dimensions including purpose, size, time span, urgency, scope, and complexity, and these dimensions are often overlapping. For example, are scope and complexity two independent characteristics of projects, or do they interact, or does one lead to or contribute to the other? These are not mere semantic arguments, since a coherent characterization of projects is the first step to understanding and managing them.

A number of different typologies of projects exist, based on dimensions such as cultural differences (Carmel & Agarwal,

2001), uncertainty vs. scope (Shenhar, 1998), type of coordination structure (Gassmann & Von Zedtwitz, 2003), and organizational characteristics (Evaristo & Munkvold, 2002). Three consistent themes can be observed in much of the literature on characterizing projects, and we use these three themes as dimensions that characterize projects for the current study. First is *complexity*, which in general we define as the issues that have to be managed for successful completion of a project. Specifically, complexity is affected by team attributes such as size, culture, language, gender composition, personal characteristics, complementarity of resources, and nature of project knowledge (Gassmann & Von Zedtwitz, 2003; Grant, 1996; Powell, Piccoli, & Ives, 2004; Royce, 1998). The second dimension is project *scope*, which we define as the boundaries of a project, including its duration and level of innovation (Gassmann & Von Zedtwitz, 2003). The third dimension is project *risk*, which encompasses unanticipated events that may affect successful completion. Risk may be programmatic, technical, quality-related, logistical, or deployment-related (Christensen & Thayer, 2001; IEEE, 2004).

If each dimension is characterized as low, medium, and high, the resulting typology of projects would have 27 different types. Our interest is in a more parsimonious examination, so that we can ascertain key differences among the types that are at either end of the continuum vs. somewhere in the middle. Thus, we define three types of projects based on extreme and mixed values of each of the three dimensions. Table 1 shows the project typology for this research.

Table 1. Project typology

Project Type/ Dimension	Complexity	Scope	Risk	Example
Lean	Low	Narrow	Low	In-house software development project with multiple segments, within one organization though across multiple locations, clarity of goals and resource allocation, relatively established teams.
Hybrid	Mixed levels of complexity, scope, and risk			Significant enhancement of customer relationship management application, using systematic development approach, but with global heterogeneity in outside partnerships.
Extreme	High	Wide	High	Multinational implementation of global supply chain application, involving multiple units, varied cultural orientations, conflicting goals, different personalities, varied resource infrastructures.

Virtuality and Technology

The term "virtual" is generally defined in degrees or extent of virtuality, rather than as a binary condition (Fiol & O'Connor, 2005). The greater the dispersion on various dimensions, the greater is the virtuality of the entity, whether it is a team, a project, or an organization. Dimensions of dispersion include such factors as geography, time, function, organizational affiliation, culture, continuity of the relationship, or technology used for communication (Dubé & Paré, 2004; Espinosa, Cummings, Wilson, & Pearce, 2003; Katzy, Evaristo, & Zigurs, 2000; Watson-Manheim, Chudoba, & Crowston, 2002). Consistent with these generally accepted views, we define *virtuality* as the extent to which project members are dispersed on geographical and other dimensions, and rely on information and communication technologies to carry out project goals.

Virtuality is not possible without information and communication technologies and the nature and capabilities of those technologies vary widely. Media richness theory defines technology in terms of fixed characteristics (Daft & Lengel, 1986). Channel expansion theory suggests that perceptions and use of a channel can evolve over time based on such characteristics as team members' knowledge of one another and the task context (Carlson & Zmud, 1999). Adaptive structuration theory views technology as being malleable through group interaction (DeSanctis & Poole, 1994).

It seems that both fixed and emergent characteristics should be accommodated in any definition of technology. In addition, the main function of communication, process structure, and task support need to be provided (McGrath & Hollingshead, 1994; Nunamaker, Dennis, Valacich, Vogel, & George, 1991; Zigurs & Buckland, 1998). Hence, we define *technology* for virtual projects as consisting of an integrated and flexible set of tools for communicating among project members, structuring process, and supporting task analysis and performance.

Factors for Management of Virtual Projects

Although there may be many ways to classify key issues for the management of virtual projects, we propose that three major issues capture the essence of the different views, namely communication, coordination, and control. We use these three concepts both because they are intuitive and have been consistently used in previous research as well as practice (e.g., Goodbody, 2005). At the same time, we recognize the difficulty inherent in using these constructs since they are closely tied to each other. For example, it is well understood that, control is a mechanism for mitigating coordination and communication challenges in virtual project teams. We are aware, as were previous researchers, that communication in all its forms is essential to achieving effective control and coordination. Thus, the apparent interaction suggests a level of confounding. However, this does not in any way take away from the fundamental differences between these concepts and their relevance, separately and together, to the management of either virtual or traditional projects.

In the following paragraphs, we briefly discuss each of these concepts in turn, along with a justification for their importance and a summary of what is known from prior research. Due to space limitations and the focus of this study, we summarize this research rather than provide extensive detail.

For the purpose of this research, we define communication as the process by which people convey meaning to one another via some medium through which they exchange messages and information in order to carry out project activities. Communication is fundamental to virtual projects, and a large body of research has accumulated from the study of virtual teams in a variety of contexts. Virtual team members can find it difficult to deal with different interaction styles and preferences (Sarker & Sahay, 2001), and they sometimes make rapid and negative attributions based on infrequent communications and perceptions of unresponsiveness (Cramton, 2001). Periodic face-to-face meetings help to overcome communication problems by serving as reinforcement points for the confidence and trust that are required to work remotely (Maznevski & Chudoba, 2000; Shani, Sena, & Stebbins, 2000). Cultural differences can exacerbate communication problems due to differences in such things as preferences for interaction and debate (Massey, Hung, Montoya-Weiss, & Ramesh, 2001), expectations of compatibility (Rutkowski, Vogel, Bemelmans, & van Genuchten, 2002), and frames of reference (Van Ryssen & Godar, 2000). Appropriate communication is also needed to develop and sustain trust (Jarvenpaa & Leidner, 1999) and to set and reinforce norms that support attention and commitment from team members (Cramton, 2001; Watson-Manheim & Belanger, 2002). Overall, the existing research reinforces the importance of communication and the continuing attention that must be paid explicitly to communication issues throughout the life of the virtual team (Schubert, Leimstoll, & Romano, 2003).

Coordination is the second major issue for management of virtual projects. We define coordination as the mechanisms through which people and technological resources are combined to carry out specified activities in order to accomplish stated goals (Crowston, 1991; Grant, 1996). Coordination is a broad-ranging concept that requires action related to the task, team member role, member relations, time, norms or values, language and culture, and even media (Zigurs, Evaristo, & Katzy, 2001). Zalesny, Salas, and Prince (1995) suggest that there are four components of coordination: identifying goals (i.e., what are the objectives of joint activities), mapping goals to activities (i.e., what specific activities are needed), mapping activities to actors (i.e., who does what), and managing interdependencies (i.e., sequencing and synchronizing activities). Contextual and organizational factors such as training, trust, and team cohesion can affect coordination (Chinowsky & Rojas, 2003). Dependencies within teams need to be managed (Malone & Crowston, 1994) and appropriate structures put into place (Gassman & Von Zedtwitz, 2003). Finally, reward systems can affect coordination (Burke, Aytes, & Chidambaram, 2001). Achieving and sustaining coordination occurs over time and is not a single event (Turvey, 1990); as such, it requires the expertise and experience of team members (Zalesny et al., 1995). In sum, coordination presents significant challenges to virtual teams, not the least of which is that it occurs through communication, and thus includes interaction effects.

The third and final issue is control. We define *control* as the process of monitoring and measuring project activities so as to anticipate and manage variances from project plans and organizational goals (Hendersen & Lee, 1992; Kirsch, 1996; Project Management Institute, 2004). In virtual projects, specific challenges with

respect to control might entail establishing standards, communicating progress, structuring team interaction, and monitoring performance. These challenges are closely tied to coordination and communication problems, whether directly or indirectly (Carmel & Agarwal, 2001). Other control-related issues in virtual projects include reinforcing project objectives (Chinowsky & Rojas, 2003), monitoring and measuring, providing appropriate collaborative infrastructures (Evaristo & Munkvold, 2002), and leadership (Homsky, 2003).

This necessarily brief review highlights the many factors that can have an impact in virtual project environments, showing the complexity involved in seeking generalizations. Our approach in dealing with this complexity was to start with the typology and identify the three key dimensions for management. We recognize that our choice of communication, coordination, and control as the key dimensions of our typology represents a choice—a choice that could be argued or made differently. However, the prevalence of these three dimensions in the literature of project management—including the PMBOK™—supports their importance. The next step is to use pattern theory to look for significant practices that could make a difference.

Pattern Theory

Pattern theory is a key starting point for the research reported in this paper, and a natural perspective for understanding, at a somewhat abstract level, effective practices for virtual project management. The concept of patterns is a useful way of making sense of complex behavior by looking for the regularities in such behavior. To quote Alexander (1965), "When we build something good, when we build a system that works well, we must ask what is it about this that makes it good? Why is it good? What are its essential qualities that will allow us to build something completely different but which is good in the same way." Patterns are analogous to recurring themes, familiar processes, rules of thumb, or standard procedures. Patterns are a means of providing holistic, "abstractions of experiences" that are profound in some way, and can be implemented to solve problems in a specific context. To some extent, patterns are a means of communicating insights about a problem domain to others. Patterns do not have to be distinct from each other; in fact if they are linked in some way, that allows us to develop a pattern language. Pattern theory arose in architecture and the work of Alexander (Alexander, 1965; Alexander et al., 1977), who developed patterns for common architectural problems, for example, "bathing room" or "bed cluster." Formally, a pattern is defined as a three-part rule that expresses a relationship among a specific context, a problem, and a solution (Alexander et al., 1977). Alexander's work was carried over into software engineering and popularized in object-oriented design by the "Gang of Four" (Gamma et al., 1994). There are many ways to document specific patterns, but common practice is to include the key elements of the context, problem, and solution. An example of a pattern from object-oriented development is shown (adapted from Gamma et al., 1994) in the same format that we later use to describe our derived virtual project patterns. Please see Figure 1.

Some work has been done on patterns in the context of collaborative work. Schuemmer (2003) proposed a structure for sociotechnical patterns that could be used to support collaboration. Fernandez,

Figure 1.

Singleton
Context There are certain actions that need to be coordinated by a single object across the entire application, for example, print spooler and file manager.
Problem How do you provide a single instance of a class that is easily accessible?
Solution Ensure that only one instance of a class is created, and provide a global point of access to it. (Note: At this point, the actual code for implementing the Singleton pattern could also be provided.)

Holmer, Rupart, and Schuemmer (2002) specified patterns for designing groupware tools, with the goal of developing a common vocabulary. Völter (2002) presented patterns specifically for project management, naming them "antipatterns" because they represented the antithesis of common knowledge for basic project management techniques. To our knowledge, no one has applied pattern theory in a systematic way to the management of virtual projects.

Essentially, we are arguing that the major components of the framework—project type, technology, and virtuality—all affect managerial dimensions of communication, coordination, and control, which in turn affect project outcomes. Considerable existing research addresses these major components, but it is not our intent to reargue that research here. Instead, we view pattern theory as providing a new way to bring these components together. Thus, and as stated earlier, our research question asks what patterns of communication, coordination, and control can be identified for the successful management of virtual projects.

RESEARCH METHOD

We devised a study that represents a first step in examining our research question. We used a grounded theory approach because such an approach is particularly useful to explore complex and dynamic phenomena in organizational settings (Glaser & Strauss, 1971). Participants in the study were business people who had experience with being members of a virtual team. They interacted asynchronously in a series of virtual focus groups, brainstorming their ideas on the factors that contributed to the success or failure of virtual projects. A presession questionnaire and the brainstorming ideas from the focus groups served as the data from which we inductively derived our patterns.[1]

Twenty-nine individuals from 5 different firms committed to participate in the virtual focus groups, with 14 people completing all phases of the study. Each focus group was an asynchronous brainstorming session conducted via Web-based groupware, with a separate session conducted

for each company. All five firms were global companies: two were software and service providers, one was a technology manufacturer, one a services company, and one a research and engineering firm. Each participant was asked to respond about a project in which he/she had participated within the last 12 months, thus each participant was responding about a different project. The project descriptions ranged from Web site development, to systems integration, to development of customer support applications.

The virtual focus groups were conducted using WebIQ™ (http://www.webiq.net), a Web-based meeting support application that includes capabilities for building an agenda, conducting electronic brainstorming, and administering questionnaires. Each participant was given an individual login and password. After logging in, each participant filled out a questionnaire that asked about a specific virtual project in which they had participated within the last year. Responses to brainstorming questions were instructed to be about that same project. Participants then had a 72-hour window in which to brainstorm their ideas about the following two questions:

1. What specific management and team member practices contributed to the effectiveness of your project?
2. What specific management and team member practices contributed to the ineffectiveness of your project?

The instructions asked participants to think broadly to include individual behaviors, processes, technologies, and tools, as they applied to both of the questions.

The questionnaire data provided the basis for classifying each project with respect to the typology. The following characteristics of the project were derived

- Project complexity (average of eight questions related to complexity)
- Project scope (average of three questions related to scope)
- Project risk (average of six questions related to risk)

Project type was calculated based on the mean of project complexity, scope, and risk. There was a natural breakpoint between the top four projects (highest complexity, scope, and risk) and the bottom three projects (lowest complexity, scope, and risk). The four projects with the highest scores were identified as extreme projects; those with the lowest scores were identified as lean projects; the remaining ones were identified as hybrid projects. The overall mean for extreme projects ranged from 3.94 to 4.08, while the overall mean for lean projects ranged from 2.00 to 2.68 (on a 5-point scale). Hybrid project means ranged from 3.21 to 3.75, thus each breakpoint between the three different project types was half a point between lean and hybrid, and nearly a quarter point between hybrid and extreme. A total of 14 unique projects were reported: a different project by each participant who completed all the phases of the study. Two examples from each type of project show the diversity: (1) lean projects—development of a Web site; installing and testing a new version of an application; (2) hybrid projects—customer support; enhancement of an application; and (3) extreme projects—large dual shore-development project; adding a new product line.

Project success and virtuality were also calculated from questionnaire items. Based on prior research, overall virtuality

Table 2. Coding scheme with examples

Text of brainstorming idea	Theme	Subcategory (if applicable)	Technology (if applicable)	+/-
Utilized the phone for discussion and error diagnosis/resolution	Communication	Meaning	Telephone	+
Good error-logging capabilities of tools	Coordination		Distributed PM tools	+
Daily check-point meetings amongst the developers and the architecture folks were crucial and added a lot value	Control			

was assessed by asking participants to rate the number of organizations or firms represented by project team members and their temporal dispersion. Similarly, project success was measured by assessing the extent to which subjects perceived that the project was completed on schedule, within budget, met goals/specifications, and whether the project was, on the whole, successful. These variables were used to evaluate the impact of virtuality and success across the proposed virtual project typology.

We developed a coding scheme to analyze the brainstorming text (see Table 2). Each complete idea from the two brainstorming questions was coded for references to communication, coordination, or control. Each idea could have more than one reference to a theme, as well as a reference to multiple themes. Each complete idea was also coded for any reference to a technology, and a plus or minus sign was used to show whether the technology was being referred to as having a positive or negative impact. The authors worked together initially to identify the codes, resolving disagreements through discussion. Remaining data was coded independently then reviewed, and discrepancies resolved through discussion, with few disagreements.

ANALYSIS AND RESULTS

This section provides descriptive information from the questionnaire data, first with respect to the nature of the projects and use of technology. We then discuss key patterns that relate to coordination, control, and communication, as derived from the virtual focus-group data.

Nature of Projects

Each participant in the study was asked to describe a specific virtual project that would then be discussed in the brainstorming questions. The projects described ranged in scope, complexity, level of risk, and virtuality. Examples of projects that were coded as lean projects include designing a Web site for a construction company; and installing, configuring, and testing a new version of application software. Examples of hybrid projects include large deployment of a payment system, and installation of a remote customer support system. Examples of extreme projects include a business rules engine for automatic underwriting assignment, and a development project being executed in two countries, with customers, developers, and systems integrators involved at both sites.

Use of Technology

In the presession survey, participants were asked to rate the extent to which they used specific technologies to work with team members on the project. Our data confirm that e-mail is still the most often-used technology for communication among virtual team members, regardless of whether the project type is lean, hybrid or extreme (see Table 3). The next most-used technology was various forms of the telephone, including conference calling and voice mail. The frequency rankings of e-mail and telephone use were true across all project types. Next in importance were face-to-face meetings, including an especially interesting result. The data show that team members make the most use of face-to-face communication in extreme and hybrid projects, and very minimal use in lean projects. This is probably because lean projects are clear and have little complexity/scope, and could potentially be dealt with collaboratively via e-mail alone.

Interestingly, there is also a clear break in the frequency with which participants used the more traditional e-mail and voice tools, vs. the tools for group work that have been developed more recently. Such tools as simultaneous document editing and shared whiteboard were rarely used. It is also worth noting that distributed project management and electronic meeting systems were used very little across all project types. The means of usage are highest in hybrid projects for both of these tools, but even so, the means are still low. These two tools, in particular, support structure for group process, but they require a greater learning curve and continuing reinforcement.

PATTERNS FOR EFFECTIVE MANAGEMENT OF VIRTUAL PROJECTS

We argued that three theoretical elements should help to define patterns of project management, namely communication, coordination, and control. Furthermore, technology is expected to constrain and enable how each element is handled, and the balance or pattern among elements. Thus,

Table 3. Use of technologies during virtual projects

Technology	Mean for lean projects	Mean for hybrid projects	Mean for extreme projects	Overall mean	Overall std. dev.
E-mail	4.65	5.00	5.00	4.93	0.27
Telephone	3.00	4.71	4.50	4.29	0.91
Conference calling	2.67	4.57	4.50	4.14	0.95
Voice mail	2.33	4.00	4.00	3.64	0.84
Face-to-face meetings	1.33	3.14	3.25	2.79	1.12
Tools for groupwork, distributed PM tools, EMS, IM, shared whiteboard, and others	Ratings ranged from 1.00 to 2.00				

Scale: 1 = Never; 5 = Almost always

*Table 4. Patterns by project type**

Lean	Hybrid	Extreme
• CommTime	• FaceTime	• CoordinateHumanResource
• SharedResources	• MeetingDesign	• ManageVirtuality
• FlexWorkTime	• SharedResources	• ManageCommitment
• TeamProjectControl	• RoleCoordination	• Standardize
• ManagerialProjectControl	• HumanExpertise	• ManageKnowledge
• ChangeControlCoordination	• RelationshipCoordination	• SharedUnderstanding
• Gatekeeping	• ConflictResolution	• ManageTeamTraining
• TaskCoordination	• ProjectLeadership	
• VersionControl		

** Three patterns that are common across all project types are not shown in the Table: CommunicationCheck, FaceTimeCheck, and ScopeCreepCheck.*

a potential design pattern for virtual project management would include descriptions of processes, best practices, factors, tools, and/or techniques that impinge upon coordination, communication, and control.

In this section, we detail some of the patterns that we identified for lean, hybrid, and extreme projects, respectively. Each pattern is based on the brainstorming data from the virtual focus groups. That is, for each type of project (lean, hybrid, extreme), we examined all the comments that were coded for each dimension of management practice (communication, coordination, control), and developed a pattern based on that set of comments. Multiple patterns could be generated from one set of comments.

Each pattern is described in terms of (1) the pattern's **name**—a descriptive word or phrase that captures its essence; (2) the **context**—a description of the situation to which the pattern applies; (3) the **problem**—a question that captures the essence of the problem that the pattern addresses; and (4) the **solution**—a prescription for dealing with the problem. The patterns presented here are a subset of all the patterns discovered during this study, since space limitations preclude including the entire set. The goal here is to provide the most critical patterns for a virtual context: those that could potentially be used as a check or safeguard against ineffective project management practices. Appropriate attention and management of communication, control, and coordination via the application of these patterns may offer help in improving or assuring the effectiveness of virtual project management practices. A summary of the names of all 25 patterns identified in our research study is provided in Table 4. Only a small set of these patterns is illustrated in the subsequent sections of the paper.

Common Patterns

Communication is not only critical for all types of projects, but it impacts effective coordination and control as well. The importance of communication is reflected in the first two patterns presented, both of which are common to all three types of projects. The patterns relate to communica-

tion among team members, either generally via various media and/or by using face-to-face meetings. Participants working in lean projects were particularly concerned about communication. Since lean projects are neither complex nor large in scope, the study's participants handled them mostly via a virtual mode, and predominantly used e-mail and regularly scheduled telephone conferencing for communicating with stakeholders. However, it was evident from participant comments that these patterns were also applicable to hybrid and extreme projects. Please see Figures 2 and 3.

The third pattern that was common across all types of projects, "Scope Creep

Figure 2.

CommunicationCheck
Context Team members do not have a shared understanding of project issues and solutions.
Problem How do you ensure effective communication among team members?
Solution Schedule periodic conferences using technologies that emphasize communication, for example, telephone and telephone conferencing, e-mail, and video conferencing.

Figure 3.

FaceTimeCheck
Context Team members neither agree nor have a shared understanding of project issues, solutions, work processes, and documentations requirements.
Problem How do you ensure effective communication among team members?
Solution Schedule periodic face-to-face conferences by flying some team members, possibly by rotation, to different locations. Though costly, even occasional participation in FTF meetings over the lifetime of a project is very effective. FTF meetings can engender increased trust and engagement among team members, and also help clarify various facets of the project and resolve issues/conlicts.

Figure 4.

ScopeCreepCheck
Context The project has major scope creep because of an absence of clear definition of scope at the outset.
Problem How do you coordinate and control for project scope creep that could substantially delay or increase the cost of the project?
Solution Manage scope creep by rescoping the project with stakeholders and managing expectations. Conduct an impact analysis and attach a revised cost and schedule of the new requirements. Set clear project expectations. Document requirements and review them with stakeholders before sign-off. Develop a flexible project plan that allows users to participate in analysis and design. Establish a formal change management process that makes users who ask for more functionality accountable for their requests.

Check," emphasizes the importance of communication about project scope, and its critical influence on project schedule and cost. The issue of scope creep was raised more often by participants involved in extreme and hybrid projects than in lean projects. Please see Figure 4.

Patterns in Lean Projects

Patterns identified in lean projects related to resource sharing; work schedule flexibility; and task, managerial, and team control issues. Issues included sharing of information across virtual stakeholders, management of rework, change control and coordination, and management of scope creep. Participants in our study were particularly concerned about the negative impact of rework requests that cropped up without warning, primarily due to the absence of good communication and established coordination among stakeholders, project manager, and virtual team members. Two patterns for lean projects were particularly interesting, and may need specific attention from managers. Please see Figures 5 and 6.

Patterns in Hybrid Projects

Patterns in hybrid projects related to meeting design, shared resources and infrastructure capabilities, team member role and relationship coordination, human expertise, conflict resolution, and project leadership. The following three patterns were particularly critical. The "Meeting Design" pattern emerged from emphatic comments about overly long and detailed conference calls when all stakeholders participated. The "Human Expertise" pattern

Figure 5.

TeamProjectControl
Context A delay occurs in a project task that could impact dependant activities.
Problem How do you monitor project progress within a virtual team?
Solution Schedule periodic (weekly or daily as needed) project review meetings for all or some members of the virtual team. These meetings are used to review progress on project tasks, discuss timelines and dependent activities, and to resolve issues. The frequency of the meetings may vary depending on the total timeline for the project and the criticality of the issue to the success of the project.

Figure 6.

Gatekeeping
Context The project involves too much rework.
Problem How do you ensure that rework is minimized by effectively coordinating project milestones?
Solution Coordinate rework on the project by (a) establishing a client sign-off requirement at each major milestone on the project, (b) insisting on client sign-off at each milestone, (c) reviewing with clients the impact on scope, cost, and schedule, and (d) building contractual language to manage excessive rework requests.

addresses the issue of inadequate access to domain expertise within a virtual team, which can slow progress. The "Conflict Resolution" pattern related to comments by study participants about the challenges of resolving conflicts in a virtual team because of the differing personalities, cultural and language backgrounds, and personal goals. Please see Figures 7, 8, and 9.

Figure 7.

HumanExpertise
Context You are unable to fix something within the team and progress is stalled until this issue is resolved. This problem is difficult enough in a colocated office environment, but the virtual nature of your project substantially increases the magnitude of the problem/issue.
Problem How do you establish consensus and resolve conflicts effectively when team members have differing personalities, cultural and language backgrounds, and personal goals?
Solution Plan for and provide the project team with easy access to subject-matter experts, technical experts, and experienced software/system architects who can provide advice/help when needed to resolve problems/issues that crop up during the project. Use process technologies such as Web-based intranets and/or knowledge management portals to share experiences across the organization and dispersed team members.

Figure 8.

MeetingDesign
Context During meetings conducted via conference calls, the team gets bogged down in details that do not necessarily apply to many on the team. The problem is compounded with a large number of project stakeholders.
Problem How do you develop a meeting environment that stimulates effective communication among team members?
Solution Schedule periodic conferences using a variety of technologies that emphasize communication, for example, telephone and telephone conferencing, e-mail, and video conferencing. Design meetings based on the following guidelines: (a) Use the participation of all stakeholders when the goal is to inform and develop a shared understanding of broad project goals and issues; (b) Use selective participation of relevant stakeholders to deal with specific issues and challenges; (c) Keep meeting agendas short. Remember people have short attention spans, particularly when you cannot see them. Anything more than an hour is probably better suited to a focused small meeting; consider having more meetings rather than longer ones; and (d) Consider which format would work best for the meetings for the issues at hand.

Figure 9.

ConflictResolution
Context Your team is not able to manage conflicts and resolve them during discussions on a shared understanding of requirements, resolution of project-related issues, and challenges.
Problem How do you establish consensus and resolve conflicts effectively when team members have differing personalities, cultural and language backgrounds, and personal goals?
Solution Establish and communicate the project vision, goals, tasks, roles, and responsibilities clearly. When team members have shared goals and work towards them, projects are successful. At the outset, establish, in consultation with the team, a clear work process for evaluating recommendations on issues and handling conflicts. Consider using a team steering group to handle conflicts that do not reach a consensus solution. Have a mechanism to prioritize problems and issues for consideration by the whole team. Regular and open communications among team members, team and management, team and vendors, and team and customers will impact the team's ability to manage the conflict resolution process. All recommendations should be given due consideration, and if accepted, must be acted upon. In addition, building consensus on solutions and meaning of things like requirements and goals will depend on team cohesion and project leadership.

Patterns in Extreme Projects

Extreme projects are likely to need all of the patterns that we previously identified for hybrid projects. In addition, we identified patterns for extreme projects that related to coordination between remote and local sites, management of virtuality, management commitment, standardization of process and documentation, knowledge management, building a shared understanding of project requirements and processes, and appropriate and consistent training of all team members. We present three patterns for hybrid projects that were particularly interesting and need specific attention from managers.

First, the "Manage Virtuality" pattern is particularly significant for extreme projects, which by definition involve a combination of high complexity, scope, risk, and varying levels of virtuality. Overcoming geographic and time zone differences is not just critical for global teams. For example, one of the participants from the U.S. stated that project notifications from the Pacific time zone would reach the Central time zone later in the day, leaving less time for addressing issues and/or requiring team members to work outside of normal hours. See Figure 10.

The next pattern, "Manage Team Training," is based on comments about inconsistencies in training of virtual team members, which impacts effective coordination of project tasks. For example, one study participant conducted periodic virtual

Figure 10.

ManageVirtuality
Context Your team is having difficulty with time zone differences at both the national and global levels. This problem occurs especially during crunch time or crisis situations when communication is not prompt. As a result, problem resolution process is delayed.
Problem How do you overcome time zone and geographic differences and effectively engage all team members?
Solution Overcome distance barriers due to time zone and geography by eliminating them by providing activities that require intensive interaction and coordination such as project initiation, by temporarily collocating team members. Require periodic site visits and travel by team members to different sites. Designate team member liaisons as focal points of coordination who spend some time in the home office location, to become acculturated and informed about technical issues; liaisons can then transfer knowledge to local sites for day-to-day coordination. Assign team members in one geographic region (e.g., North and South America) to tasks requiring telephone or video-based interactions because they share time zones and thus, can more easily schedule conferences

Figure 11.

ManageTeamTraining
Context There are differences in training between team members. For example, the test lead does not recognize the connection between requirements and the test plan.
Problem How do you reduce the impact of differences in training and background?
Solution Require training for all new team members on standard work processes and project methodologies prior to starting new projects. Encourage initial communication between team members using video or telephone conferencing to discuss standards, roles/responsibilities, methodologies, team culture, and issue resolution processes. Assign individuals with the skills to successfully accomplish their tasks. Build on individual team members' strengths while allowing them to expand their skills and expertise through additional training and role rotation.

Figure 12.

ManageKnowledge
Context Team members are unable to share intelligence, best practices, and simultaneously edit master documents. In some instances, team members are not following established processes.
Problem How do you mobilize and share knowledge across the team and your organization?
Solution Start with input from project team members across the organization and build a repository of best practices, templates, learning tools, workflow standards, and examples of processes within standard methodologies. Make sure all members of the team have access to and can contribute to the knowledge portal.

team workshops to identify and address strengths and challenges for the virtual team. Another alluded to differences in training of team members as a cause for miscommunication between developers and testers. See Figure 11.

Finally, the "Manage Knowledge" pattern focuses attention on the importance of knowledge management and information sharing among stakeholders and the organization as a whole. One participant pointed to the effectiveness of a knowledge portal in the project as follows: "[W]e have a home grown tool—knowledge portal which has features for collaboration, e-learning and knowledge management which was found really useful. It was a challenge to implement it but once the team started using it everyone saw the power and usefulness of the same." See Figure 12.

IMPLICATIONS AND CONCLUSIONS

This study makes several contributions. First, we developed a project typology based on theoretically founded characteristics of projects. Second, we applied pattern theory to the practice of virtual project management in terms of coordination, control, and communication. Third, we collected data that identified a starting set of patterns for the effective management of lean, hybrid, and extreme virtual projects. And fourth, we developed a new approach that is usable by other researchers.

The contributions to theory come from the development of concepts, the typology, and the pattern approach. We have elaborated the concepts of virtuality, communication, control, and coordination as they relate to virtual project management, and developed a new typology and descriptions of extreme, lean and hybrid projects. In addition, if at its core, pattern theory is the basis for developing "a solution to a problem in a context," our study has identified an initial set of patterns in virtual project management across various types of projects. Indeed, there is still much to learn from the original concept

of patterns. For example, in his speeches and other writings, Alexander has argued that patterns should also have a "moral component," "create coherence, morphological coherence in the things which are made with it," and "be generative, i.e., allow people to create coherence, morally sound objects, and encourage and enable this process" (Alexander, 1996). We have not dealt with these aspects directly in our study, but they have the potential to contribute to the higher level of understanding discussed. Also, patterns might be viewed as providing a bridge between virtual and traditional contexts. Earlier, we argued that virtuality is a continuum. Viewed that way, patterns can expand one's capability to operate effectively along the entire continuum, that is, to connect to what we already know from traditional practices and bridge the gap to virtual environments.

The contributions to research methodology arise from the measures and coding scheme. We have developed and implemented measures for the various concepts that drive the typology of virtual projects. We have also developed a coding scheme to analyze brainstorming text from virtual focus group sessions. In fact, we believe that our study is a unique example of conducting research using asynchronous virtual focus groups with globally dispersed participants. This required the development of a complete set of protocols for managing, organizing, and conducting the data collection elements of the research.

Contributions to practice are in the patterns themselves. The patterns identified in the study can be utilized as critical checks and/or design principles for use in managing virtual projects. Managers of virtual projects can follow either a deductive or inductive process. A deductive approach would start with identifying the type of project (using the measures developed), then searching the patterns for that project type, and applying the prescribed solution for each relevant problem. An inductive approach would start with a search of the pattern library, looking for any patterns that apply. If the problems fall primarily into one project type, then a manager can reasonably infer that this is the type of project.

As with any study of this kind, several limitations apply. Firms and participants were selected from a convenience sample, based on contacts developed by the authors. We recognize the limitations inherent in such a sample, but given that the study is only a first step and that the firms represented a good cross-section of global industries, we believe that the data provides a good starting point. The patterns were derived from a limited data set. Even though we had participants from five different companies and a sufficient diversity of projects types for our categorization, still the generalizability of our conclusions is limited. In addition, even though the coding scheme was based on theory, there may be other relevant dimensions besides the ones we identified and used in the development of patterns. The next steps for research follow naturally from the limitations of the study. Additional settings need to be examined and the concepts tested with additional data. We are well aware that this first data set is a starting point for iterative evolution of the patterns. Some of our patterns are clearly related to each other in some way; this came about from the natural process of applying the grounded theory approach to our data. Inducing from the data that was provided during discussion in our virtual focus groups, we found that some patterns turn out to have similarities and apparent relationships. In fact, this is as it should be within the realm of pattern theory, since it

allows us to develop a pattern language as more patterns are discovered, and a coherent structure of patterns in virtual project management evolves. Our study resulted in the identification of patterns for managing virtual projects; we do not lay claim to the uniqueness of all of these patterns. In fact, we are quite sure that many elements of these patterns already exist in some form in traditional PM or in other fields of endeavor. Further exploration of these patterns may result in coalescing of some and/or expansion or redefinition of others.

One issue that was reinforced throughout these projects is the importance of communication. Regardless of the type of project, communication was mentioned time and time again as a fundamental necessity. Both prior research and our study reinforce the idea that communication is important in and of itself, as well as through its relationship to coordination and control. All of these teams relied heavily on e-mail and voice media, which emphasize communication. Thus, the communication dimension of technology had the greatest priority: more so than process structure or information processing.

Our study also reinforced the importance of periodic face-to-face communication for virtual teams, a finding that is consistent with prior research (Maznevski & Chudoba, 2000). Participants emphasized the advantages of regular face-to-face meetings for some or all team members, to help resolve issues and monitor progress. Periodic collocation of team members can help to establish ground rules and common understanding, which in turn facilitates communication and coordination when team members return to their home, distant locations. This practice allows team members to build a social network, as well as stimulating the development of team identity, cohesion, and commitment that help to sustain members during dispersed periods (Davidson & Tay, 2003). Another interesting result related to technologies was the relatively low use of distributed project management tools. Indeed, there was generally low use for all of the technologies that we would categorize as providing support for process structure or information processing. Clearly, there is much room for improvement in providing better tools and training for virtual teams in these areas.

We started with the goal of going beyond a cookbook approach to the management of virtual projects. The theoretical frame of patterns helps us make a large step toward that goal. One of the most intriguing aspects of the pattern approach is the idea that specific patterns themselves should fit together into a coherent pattern language that provides a higher level of understanding. A specific pattern is not a prescription, although a pattern could be used to create a prescription in a specific context. Patterns are generic and more akin to the idea of universal laws than to prescriptions. Consistent with Alexander's ideas, patterns should help to create new processes, and help organizations to continue to change and adapt. Patterns, as a set represent, an abstraction of something important; they provide a language for communication and action, and they embody a value set. It is these aspects of patterns that can provide that higher level of understanding.

The results from this study provide immediate and practical guidance for managers of virtual projects, as well as providing a strong foundation for the necessary next steps in research. Those steps entail studying how people use patterns in a systematic way, how they adapt them, and how their use reveals what really matters across a variety of contexts. The pattern perspective

provides an essential cross-level view: a view of specific practices for success as embodied in individual patterns, as well as the systemic view that comes from their combination in a pattern language.

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