WORK ORGANIZATION: PARADIGMS FOR PROJECT MANAGEMENT AND ORGANIZATION

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A family prepares and eats an evening meal, a road crew repaves a section of a street, a jazz ensemble jams in Harvard Square, and a group of programmers tests the modules for an on-line transaction processing application. Everyday life affords us countless examples of groups of people carrying out a joint activity or task in a coordinated manner. Indeed, the phenomenon of coordinated group effort is so ordinary, so ubiquitous, that normally it hardly commands our interest or invites inquiry. If we are interested in fully understanding the organization and management of programming projects, then it is reasonable to ask how it is possible for groups of people to carry out coordinated efforts and what are the various possibilities for doing so. This is no different than asking how a piece of software operates or inquiring about how many different control statements are provided by a programming language. The purpose of this article is to establish a conceptual framework for understanding the full range of variation in how software development projects, as examples of collective human activity, can be organized and managed.

Family dinner may initially seem to have little in common with a programming project, but both include a group of people jointly involved in carrying a common activity to completion. While relying on the same few basic mechanisms for control and coordination, families and project teams can take on many forms and variations. For example, they can be close-knit or relatively dispersed, they can be organized essentially as pyramids or as more or less flat networks, they can be managed by a fixed set of strict rules or by informal "walking around."

If we observe the same family or same programming department on different occasions, we will see differences in specific content and detail but also recognizably consistent patterns of interaction. The Blackstone family may be eating vegetarian lasagna one night and tuna steak the next evening, yet both times we may find the mother is the last to sit and the first to rise or that the conversation, centered around school activities, is orchestrated by the father. The WhizApp programmers may go from a design walkthrough of a new payroll system to planning the work assignments for a field sales application, yet Bill consistently tends to dominate the discussions and Jill can be counted on to come up with the bright idea that finally rallies the group. On the other hand, the family next door to the Blackstones may have a free-flowing style of dinner table behavior that contrasts sharply with the formal predictability of their neighbors, and the competing software house across town may organize its work through strict top-down decision making that would never be seen at WhizApp.

If we are to comprehend the full range of options for organizing and managing work projects we need to understand such similarities and differences. The first challenge for us is to account for the ability of groups to carry out coordinated efforts, including the consistent and the changing patterns of behavior in any given group along with differences and commonalities among different groups. The second challenge is to use this understanding to elucidate some of the practical issues in software project teams.

Process, Structure, and Paradigm

Project teams and other work groups differ not only in how they operate, but also in what underlies observable operation. They can be described and understood at three levels of analysis. One level, process, is what you see—the actual behavior taking place at a conference table or in someone's office, what a visiting social scientist or management consultant could observe. At another level are the operating mechanisms, the structures that account for patterns in observed behavior. For example, Jorge produces flowcharts for every routine he writes because that is how he has been told to work, and he will be reprimanded or even dismissed if he does not. Finally, we reach the level of paradigm, the model and its incorporated assumptions that guide or inform the organization and operation of a group. Jorge's company assumes employees will do as directed, that for the good of the corporation insubordination cannot be tolerated. These three levels of description are interrelated, since it is structure that regulates process and paradigm that informs structure.

The set of assumptions forming the basis for the structure and operation of an organization is referred to as an ***organization paradigm*** [7, 9]. Although paradigm is an overused and often misused term, here it is

employed in its strictest sense to mean a model that embodies a set of underlying and generally implicit assumptions through which the world is interpreted [5, 16]. An organizational paradigm is, thus, both a standard or model for an organization and a world view, a way to make sense of organizational reality.

The framework outlined briefly here is based in systems theory [23], especially human systems theory [24] and grounded in research. The structure of this framework can be specified quite rigorously (see the sidebar "Paradigmatic Framework"), but here it will suffice to be relatively informal. The framework applies results from research and theory building in family studies [1, 24] and family therapy [5] to work organizations. Although there are certainly important differences, families and project teams resemble each other in essential ways that allow modeling them both as human systems. Families are also a convenient, manageable context in which to study the diverse ways by which groups actually organize and coordinate daily activities. The paradigmatic framework derives originally from extensive research that includes laboratory studies of the behavior of enduring groups [19], field observations of intact families [14], and clinical experience [3–5, 18].

A Paradigmatic Framework

Organization paradigms can be understood as variations in how working groups set priorities and deal with certain fundamental, unavoidable issues in all human endeavors [15]. These include issues that are as salient to organizations as to families, for example, continuity and change, tradition and innovation, individual and group, unity and diversity [5, 9]. Organization paradigms can also be understood in terms of variation in the mechanisms by which groups control and coordinate their efforts on a common task. Projects or other tasks or activities can be coordinated by a traditional hierarchy of authority, by reliance on independent individual initiative, by collaborative discussion and negotiation, or by virtue of alignment with a common vision or direction.

A simplified context that bears some resemblance to programming can help clarify the various mechanisms by which groups can be coordinated. Imagine three reporters who work as a team on a breaking news story. All three have been to the scene of the story and taken part in interviews with witnesses.

Their work can be coordinated by a hierarchy of authority, with an editor who closely supervises, deciding how the story is to be covered and written, handing out the assignments of who will write which parts or cover which angles, then reviewing the results and specifying changes. On the other hand, the teams might rely on individual initiative as the basis of decisions. The reporters could work independently according to their own special interests and talents, reading some of their favorite lines to one another as they go along, carving out their own creative niches. As each expresses an individual slant, the combined story emerges as a varied patchwork with sidebars and teasers held together by a common headline.

Yet another approach might use discussion and negotiation to reach a working consensus on the content of the story. The main structure of the piece might be planned jointly on a whiteboard. Then, as the reporters write, they look over one another's shoulders, making suggestions and asking to borrow quotes. Some of the story might be worked out word-for-word by all three sitting around a table.

These three models rely on some form of ongoing communication or interaction among the participants to coordinate work on the common task. This communication comprises feedback loops that sustain and regulate the collective pattern of interaction. Early research on coordination within naturally occurring groups identified these patterns [14], but also raised questions about the possibility of other basic mechanisms of coordination, particularly, whether it is possible for a group of people to function in a coordinated, patterned way without communicating in some way [4].

Indeed, communication is theoretically unnecessary for coordinated effort. The reporters might have an established and conventional way of covering a story, worked out over years of practice or drilled into them by their common mentor. If they share a common understanding of the overall task and how it is to be carried out in detail, they can work in parallel with the confidence that the pieces of their story will fit smoothly together. One might be a master of lead paragraphs and headlines, another by habit always wraps up the story, and the third, who knows how the other two think, fills in the middle. Each knows exactly what has to be written and what part to play in writing it. They have, in a sense, already been "preprogrammed," sharing a well-articulated and specific common vision of what must be accomplished and how it will be carried out. This mode of coordination corresponds to what has been called 'channeless communication' in communication theory [2]. If the receiver has a full enough model (understanding) of the sender's behavior, the receiver can predict a message even when no channel connects the two.

Figure 1 can be thought of as representing a map of the range of possible paradigms for human systems. At the corners are four "reference paradigms" corresponding to stereotypical extremes distinguished by their reliance on differing assumptions about control and coordination. Table 1 summarizes defining characteristics for these reference paradigms. Of course, real project teams, families, and corporations do not necessarily conform neatly and cleanly to simple stereotypes. Often they reflect admixtures and amalgamations of the features and facets of more than one paradigm.

Traditional Hierarchy

Many people assume that, as in the first group of reporters previously mentioned, someone has to be in charge of others and that decisions must be made by whomever is in charge. This belief is a basic assumption of traditional hierarchy, technically known as the closed paradigm. Within this paradigm, standards and rules of operation promote continuity, and highly valued stability is

maintained through control that counteracts any deviation from established norms and patterns. Such organizations are structured as pyramids or hierarchies with distinct and well-defined roles specified for each position in the hierarchy. Information is carefully controlled and channeled along lines of authority, and decisions made by managers and supervisors are handed down to subordinates for implementation. When they succeed, such organizations provide security built on a solid foundation. Corporate or collective interests come first and foremost. Individuals are expected to demonstrate loyalty and defer to the group. Insubordination is not tolerated, and opposition or criticism may be seen as disloyal. The purest examples of the closed paradigm are probably military services and government bureaucracies, but the closed paradigm also underlies the organization of many of today's most visible and successful corporations.

Innovative Individualism

A traditional hierarchy of authority is not the only way to make decisions or run a project. The random paradigm, represented by the second group of reporters, is the antithesis of the closed paradigm, relying on the independent initiative of individuals for direction and decision making. Rather than stability and continuity, it is oriented toward innovation and change through creative autonomy. The freedom of the individual to create and act independently is considered more important than group interests. Not surprisingly, such groups are strongly egalitarian, operating with a freewheeling informality that eschews fixed roles. Common examples of this paradigm include breakthrough project teams developing new technology or a corporate R&D center within a larger, traditionally managed company.

Adaptive Collaboration

It may seem that these two paradigms represent the full spectrum of possibilities, from stable collectivism at one extreme to freewheeling individualism at the other, but these extremes are found synthesized in the open paradigm, which has characteristics distinct from either the closed or random paradigm. The open paradigm, illustrated by the third group of reporters, is based on adaptive collaboration, integrating innovation with stability and individual with collective interests through negotiation and discussion. This, too, is an egalitarian model in which roles and responsibilities are flexibly shared.

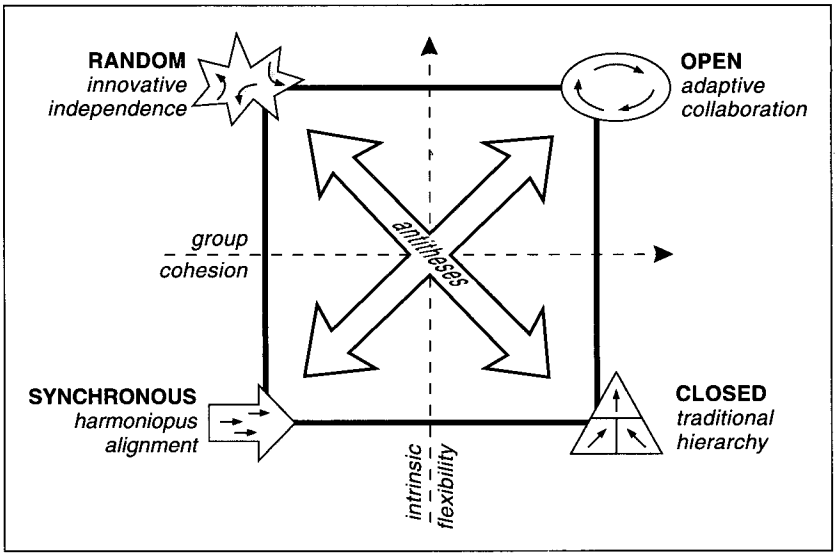

Figure 1. Map showing relationships among reference organizational paradigms

Harmonious Alignment

The open paradigm has its own opposite number in the synchronous paradigm, based on harmonious and effortless coordination through the alignment of members with a common vision that reflects the collective goals and methods of reaching those goals [4]. Like the last of the reporting groups discussed, such organizations sustain their unified, parallel action through tacit agreement and shared knowledge. In such groups, smooth, efficient operation with quiet unanimity is all important. An Amish community engaged in a barn raising is a good illustration of the synchronous paradigm in action: working with quiet efficiency without orders being given, without negotiation, and without individuals taking off on divergent courses.

Strengths and Weaknesses

It is essential to recognize that a particular organization paradigm is neither good nor bad. Viable organizations can be based on any of the reference paradigms, and no one paradigm is a guarantee of success. Teams can flourish or fail with any model.

Each paradigm, however, has its own particular strong suit as well as intrinsic areas of weakness (see Table 2). Larson and LaFasto [17] for example, found that different kinds of organization were needed for best performance on clearly defined 'tactical' tasks than for achieving breakthrough innovations or for solving complex, more loosely defined problems. Traditional hierarchies have the advantage in stability and predictable performance, but they are relatively weak on genuine innovation. Random paradigm organizations excel at creative invention, but are not inherently either highly stable or efficient, often depending on a larger including organization for stability and resources. Because groups based on the open paradigm share information so freely and combine diverse approaches, they excel at solving complex problems. However, open paradigm groups can waste too much time spinning their wheels in fruitless debate. Synchronous groups can be remarkably efficient in smoothly performing established procedures, yet they tend not to be highly responsive or adaptive to changing requirements.

Each paradigm is also vulnerable to particular modes of failure. Under great stress or challenges that strain

available resources, closed organizations too easily succumb to tightly controlled rigidity, while random ones are prone to degenerating into anarchy and dispersing in chaos. Open organizations can become enmeshed in endless exploration, while synchronous organizations can become a group of silent robots. These tendencies are fatal flaws that are intrinsic to the premises on which each paradigm is based, the flip side of the very strengths that make them work.

Applications of the Framework

The framework described can be used to deepen understanding of a variety of issues in project management and organization. Three areas of application will be considered here. A brief exploration of how effective project teams are established and how project leadership and management styles fit with team organization will be followed by a more detailed look at a specialized teamwork model designed for software projects.

Team Building

Successful project teamwork begins with selecting the people (see the sidebar "Choosing the Team Members") and building them into a working team. Team building refers to activities aimed at enabling a group to become a cohesive working unit capable of functioning at the highest performance levels. Effective team building helps a team establish an appropriate organization and work culture and accelerates the accumulation of experience in functioning as a team. Teams going through a well-executed team-building process that meets their needs as a group outperform comparable teams that simply plunge into the work at hand.

Team-building activities, ranging from a brief meeting to a week-long retreat, can take many forms: anything from a pep talk given by a newly appointed manager to a white-water rafting excursion, from a group design task for a team tee-shirt to formal planning and assignment of work responsibilities. The team-building needs of a project team depend on how it will be organized and managed, and team-building activities are more likely to be effective when they are compatible with the corresponding organizational culture of the team. For example, establishing clear lines of authority, unambiguous objectives, and well-defined partitioning of tasks are especially important for teams based on a traditional hierarchy. Such tactically focused teams are the most likely to respond to simple directives or to activities that are formal and orchestrated in a top-down manner.

Members of teams built for breakthrough projects need to get creative juices flowing and to develop trust and respect for one another as talented contributors. They need guidelines rather than rules or standards and can become resistant if team building is too formal or controlled. For them, team building should be informal and nondirective, emphasizing individual action and contribution over group activity. Artistic and recreational activities that generate a joint product while allowing participants to shine as individuals fit this model well. Examples include painting a team mural for the group's "war room" or brainstorming approaches to key project problems.

For open paradigm teams, the critical success factor is likely to be interpersonal skills. The style of team building that best fits with open paradigm teams fosters full participation and involvement, often with real work training relevant to the project. Although all teams may benefit from practice with actual or case study applications, open paradigm teams

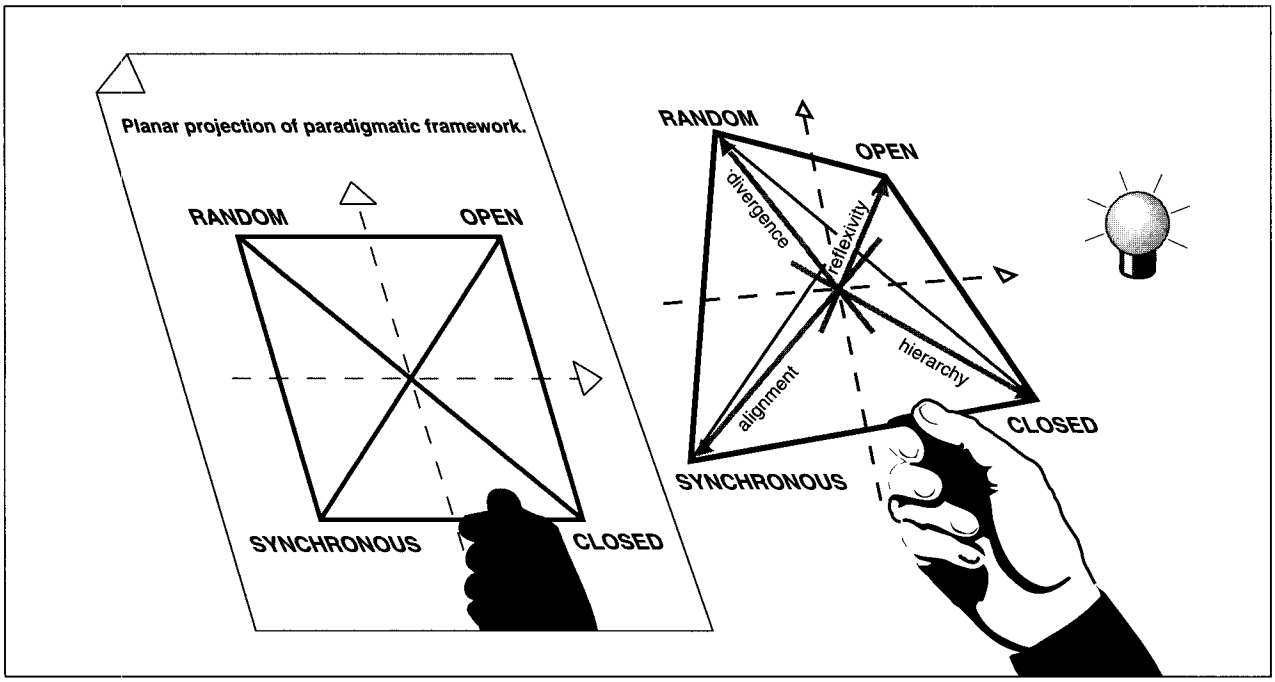

Figure 2. Paradigm map as planar projection of 3D geometry

Table 1. Defining characteristics of four organizational reference paradigms

Paradigm	Coordination	System regulation	Priorities	Decision making
closed	traditional authority **hierarchy**	negative feedback, deviation attenuating	stability, group; secure continuity	formal, top-down by position
random	innovative independent **initiative**	positive feedback, deviation amplifying	variety, individual; creative innovation	informal, bottom-up, by individual
open	adaptive collaborative **process**	combined feedback, flexible responsiveness	stability and change, group and individual; adaptive effectiveness	negotiated, consensual, by group process
synchronous	efficient harmonious **alignment**	shared programming, efficient uniformity	harmony, mutual identification; effortlessness coordination	unnegotiated, predefined, implied by vision

Table 2. Strengths and weaknesses of four organizational reference paradigms

Paradigm	Strong suit	Weak areas	Best application	Failure mode
closed	stable security, preserves resources	genuine innovation, full use of individuals	routine tactical projects	rigid enmeshment, mindless over-control
random	creative invention, promotes personal best	dependable stability, efficient resource use	creative breakthrough	chaotic disconnectedness, destructive competition
open	practical adaptation, information sharing	efficient process, smooth, simple operation	complex problem solving	chaotic enmeshment, endless processing
synchronous	quiet efficiency, smooth operation	response to change, open communication	repetitive critical performance(?)	rigid disconnection, drifting deadness

Table 3. Team building to fit project organization

Paradigm	Objectives	Form and style	Typical methods
closed	clarify goals; set up rules, roles and responsibilities, authority structure	directive, formalized; group-oriented; challenging and "cheerleading"	policy statements and directives; kick-off meetings; pilot projects and test runs; challenges and competitions
random	outline guidelines; build trust, mutual respect; release creativity	nondirective, freewheeling; individualized; fun and creative	arts and crafts, recreation and games, brainstorming, idea building
open	planning, strategy, agenda setting; skill building; clarify roles	cooperative, explorative; strategic, flexible; learning and practice	joint training, simulations and practice sessions, cooperative games, problem solving
synchronous	build vision; promote bonding, mutual identification; precise coordination	symbolic, indirect; visionary, reflective; charismatic	image building, 'visioning'; guided fantasies, meditation; drills, ritualized task practice

are especially responsive to this kind of activity, as well as to cooperative games and group puzzles or problems to solve.

In contrast, synchronous teams depend on developing a high degree of personal commitment and alignment with a shared vision for their best performance. They also need to learn how to coordinate activity based more on implicit understanding than overt communication. Symbolic activities that help the group generate and identify with a rich and well-articulated vision are appropriate, as is practice in silent synchronization, such as quickly rearranging a room without talking.

Table 3 outlines the style, focus, and method of team building that best fits with each team paradigm. The needs of the many groups guided by a combination of reference paradigms can also be under-

Paradigmatic Framework

The paradigmatic framework can be modeled with some rigor [6, 12]. The framework is a taxonomy of systems in which reference paradigms—the taxons—are distinct but logically interrelated. The "map of the territory" in Figure 1 is a convenient simplification, but does not fully model the structure of this taxonomy. Among other limitations, it does not represent all meaningful combinations of any two or three of the reference paradigms.

In an ideal taxonomy, taxons are maximally distinct from one another. From Tables 1 and 2 it can be seen that reference paradigms are logically related by a dialectical sequence. The random paradigm is the antithesis of the closed paradigm, the open paradigm is the synthesis of closed and random, and synchronous is the antithesis of open. Each reference paradigm can be distinguished from the others by an essential or defining factor that is absent in the other three.

Modeling these features of the taxonomy requires a particular three-dimensional (3D) geometry which turns out to be a tetrahedron [12]. The map of Figure 1 can be regarded as one planar projection of this underlying geometry, as shown in Figure 2. In this multidimensional space the paradigmatic basis of any actual human system is represented by a point corresponding to a particular linear combination of the defining characteristics of the four reference paradigms.

This geometric metaphor is rich with implications for understanding human systems. Among other things, it (correctly) predicts that defining measures, such as hierarchy or alignment, are not independent, but are correlated. A full discussion of the underlying theory is beyond the scope of this article. (For more detail see [12]).

Choosing the Team Members

Just as in sandlot baseball, an essential part of building a project team is picking the players. All too often in the computer field, members are selected simply on the basis of who happens to be available, with little if any consideration of the actual needs of the team. A more rational basis might take into account how different kinds of people fit with the needs of different kinds of teamwork.

Larson and LaFasto [17] interviewed team members to learn how the people who performed best within different kinds of teams were described. Their conclusions on problem solving, tactical, and creative teams have been extended and refined by observations of programming teams. People who do best in closed paradigm (tactical) teams have been described as loyal, committed, and action-oriented. They seem to have a strong sense of urgency and respond well to leadership. People who work best within the creative environment of a random (or breakthrough) team are independent thinkers, often artistic or intellectual. They are persevering self-starters who do not need orders to get going or close supervision to keep going. People who thrive in the collaborative consensus-building of open (problem-solving) teams, are practical-minded but sensitive to "people issues." They have integrity and are seen as trustworthy by peers, exhibiting intelligence coupled with good interpersonal skills. It appears that those who fit well in strongly synchronous teams are intuitive, somewhat introverted, yet people-sensitive. They are good at linking the larger picture to specific action and work with quiet efficiency.

Each paradigm reinforces and is reinforced by a different type of individual behavior [5]. Closed paradigm organizations favor the dependence, conformity, and obedience that sustain stable uniformity, while random ones encourage and depend on counter-dependent behavior, nonconformity, and individuality. Interdependent but assertive individuals who demonstrate committed involvement fit best with open organizations. Bystanders who maintain separateness with strong mutual identification are most likely to promote synchronous operation.

stood within this framework. For example, a random-synchronous team that emphasizes creative individual initiative informed by a strong collective vision might employ a specialized brainstorming process, such as 'notestorming' or affinity clustering [11] to generate elements of a team vision for a project.

Project Leadership

Many established notions of leadership and project management fail to take into account differences in organization paradigms. Decisiveness and clear communication of authority may be virtues for a leader in a traditional hierarchy, but are not likely to be particularly valued or practical within a random organization. In fact, strong assertion of closed-style leadership is likely to trigger dissent or rebellion among the independent-minded innovators of a good random paradigm team.

Successful leadership must fit, in style and form, the needs of the paradigm. In general, managers whose own worldview and leadership style are the same as the team paradigm are likely to fit more comfortably, but this is not the whole story. The best managers supply items that may be lacking in the team paradigm, but do so in a style familiar and comfortable to the team. For example, a purely random, *laissez faire* style of management is less than optimal for random teams. The best manager in such a team is one of the bunch, a respected programmer or software engineer, but also a charismatic technological fashion leader who sets the tone and style for the team without giving orders. The best managers also run interference for the team, shielding them from bureaucratic intrusions or unappreciative upper management. Often they take on clerical or support functions for the team, freeing others for creative software development.

Good managers of open teams resemble the best in random ones, but also supply structure that helps keep the team focused and efficient. They are team players who are also good facilitators and mediators, helping the team deal with the outside world and build consensus and sustain trust internally.

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but do so in a style familiar and comfortable to the team.

The best managers in closed teams are strong leaders who can give clear directions, but they temper their top-down discipline with a willingness to listen to input and to grant autonomy in meeting project objectives. They manage more by results or criteria than by detailed direction. They build enthusiasm and foster commitment to established objectives.

Synchronous teams need visionary leadership from inspirational gurus, especially ones who foster mutual identification. They also need leaders who can build bridges and keep team members from becoming too disconnected. The best may themselves serve as message-bearing intermediaries between team members and provide critically important feedback. They observe and monitor performance and watch for changing conditions and requirements, then incorporate this into a new visionary message for the team.

Structured Open Teams

Project teams can be based on any organization paradigm, but an examination of Table 2 makes clear that none of the reference paradigms is ideal for software development projects. Software projects typically involve a combination of complex problem solving with the need for a certain amount of innovation, yet much of software development is also routine and calls for dependable, predictable tactical performance.

Collaborative teamwork and consensus engineering [11] have many characteristics that make them appealing as the basis for software development. Open paradigm teams are in the best position to freely share and fully utilize complex information, drawing on and integrating the contributions of all team members into a single, practical, high-quality solution. In drawing on everyone's contributions to build consensus, decision-making and problem-solving processes in open teams increase the sense of ownership each participant has in the team's results. On the other hand, many organizations have difficulty with assigning accountability to a truly collaborative team. Consensus-based teamwork is also prone to getting bogged down in protracted debate and discussion. Once entangled in these circular processes, collaborative teams may be tempted to use the expedient of voting to decide issues. Majority rule means mediocre results, because the product seldom incorporates valuable minority contributions and because the outvoted minority loses sense of ownership in the final solution. Without pride of ownership, individual investment diminishes and quality declines.

By understanding the fundamentals of organization paradigms, a carefully conceived combination of models can be constructed. A promising example of such a hybrid is the 'structured open' teamwork model [6, 8], a model that combines closed (formal, fixed, or hierarchical) elements and open (shared, flexible, egalitarian) ones, with a sprinkling of random teamwork. It uses formal structures to promote flexibility along with more efficient group problem solving. The model has been used successfully for various software projects [20, 22].

Structured open teams do much of their actual work in face-to-face problem-solving sessions. For high performance in this setting, certain key group roles are identified. Instead of making them into job descriptions assigned permanently to specific team members, these are considered the collective responsibility of the entire team, to be rotated flexibly among team members. In this way the model promotes technical consensus building with high levels of participation and the diffusion of teamwork skills among members.

Special features of the structured open teamwork model include:

- catalog of essential team roles
- formal specification of and institutionalization of functional roles
- default assignment of roles to assure essential functions are performed
- rotation of roles to promote flexibility and skill acquisition
- a structured, externalized group memory for information management
- clear, simple external accountability
- technical consensus building, not majority decision making
- promotion of personal ownership of work products

A technical leader in a structured open team is "first among equals" internally, but has full external responsibility, preserving simple lines of reporting and accountability. The technical leader is also a court of last resort to decide unresolvable issues, thus providing an escape valve for debates that become prolonged and unproductive.

It is widely recognized that efficient and effective meetings are based on facilitation and recording with scrupulous neutrality [13]. This means that the facilitator and recorder cannot be parties to technical discussions or debates. Some older teamwork models, such as Joint Application Design (JAD) [25], employ trained outside facilitators and recorders or team members permanently assigned to these roles. Where the facilitator and recorder must be both technically knowledgeable and continuously available this approach is expensive and wasteful of resources. By rotating these roles, the structured open model achieves an efficient compromise.

A structured open team is coordinated not just by facilitated discussions but also through a structured,

externalized group memory (see [7, 11], as well as the article "Design by Walking Around" in this issue). This organized continuous record of what the group does and how is key to making the consensus-based group process more efficient and reliable. Belonging to the group collectively, the shared memory is external rather than carried in members' heads. Physically it may be expressed in a variety of media: newsprint-decorated walls, on-line text and graphic files, or entries in a CASE tool repository. Conceptually, it is structured as a number of distinct components, some of which solve specific problems in group process. In addition to a ***product record,*** consisting of intermediate and final deliverables, and a ***process record,*** which tracks how deliverables were developed, a set of specialized 'bins' provide convenient repositories for problematic issues and information. For example, a ***deferred decisions*** record provides for tabling development problems on which the team seems unable to reach a technical consensus or for which more information is needed, thus making group decision making and problem solving more efficient. A ***parts bin*** for those bits and pieces of technical ideas that inevitably come up at the wrong time keeps potential gems from being lost without distracting from the main discussion. A ***reject bin*** records approaches the group decides against, along with the rationale for rejection, thus facilitating group learning and simplifying future revisions and extensions to the system.

The structured group memory illustrates how formalized mechanisms can be devised to enhance the efficiency of informal group analysis and design processes. Because this record is an institutionalized part of the organization it promotes what one management guru [21] calls organizational learning.

Conclusions

Although project management and organization are not usually approached through theory, theoretical insights can have practical implications for software developers and their managers. This article has introduced a concise theoretical framework for making sense of the diverse possibilities in the organization of collective human effort, including the work of software project teams. The framework defines four reference paradigms—closed, random, open, and synchronous—based, respectively, on traditional hierarchy of authority, on creative independent initiative, on adaptive collaboration and communication, and on alignment with a shared vision. These models provide a powerful tool for understanding and shaping working groups within software development organizations.

Any of these models, alone or in combination, can form the basis for effective teamwork. Project teams can be organized based on varied project needs and objectives, whether for new product research and development or for rapid deployment of mission-critical enhancements to existing systems. Knowing the paradigmatic foundations for a project group, managers can identify potential strengths and probable weaknesses, anticipating specific management needs as the project progresses. Matching the team model and team members can lead to higher performance, while fitting team building to team culture can help groups achieve peak performance more quickly. Using insights from this framework, team organization can be tailored to the special problems of software development through carefully conceived combinations of different paradigms.

Because it models coordinated human effort in general, the paradigmatic framework can be applied to human systems of many kinds and on widely varying scales. Perhaps the greatest promise lies beyond software.

Organization paradigms offer a unifying perspective for not only software teams but the divisions and companies in which they work as well as the myriad groups and organizations with which they must deal in the larger world. ◻

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CR Categories and Subject Descriptors: D.2.9 [**Software Engineering**]: Programming Teams; K.6.1 [**Management of Computer and Information Systems**]: Project and People Management; K.7.2 [**The Computing Profession**]: Organizations

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