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### Computer supported self-managing teams

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# Computer Supported Self-Managing Teams

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For several decades investigations in the behavioral sciences have focused on those conditions that promote team effectiveness. These conditions have been applied to the development of self-managing teams. This article defines requirements for computer support using the conditions that enhance the performance of self-managing teams. We discuss the fundamentals of team design defining what a self-managing team is, propose a self-managing team development model, and introduce three approaches to the design of self-managing teams: sociotechnical systems, a normative model, and social-learning theory. We then introduce a team information architecture (TIA) for the support of self-managing teams and describe computer support requirements for the design, formation, management, and mentoring of self-managing teams. We conclude by reviewing the conditions required for team effectiveness and compare the TIA against those conditions.

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computer-supported cooperative work, groupware, workgroup computing,  
self-managing teams, teams, nonhierarchical management,  
horizontal organizations, team information architecture

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## 1. INTRODUCTION

The deliberate design, direction, motivation, and commitment of teams produces high performance [1]. The establishment of the context and conditions leading to superior team performance has been thoroughly researched in the fields of social psychology, sociology, and organizational design since the 1950s. Underlying principles have been studied and recommended. Research in socio-technical systems and social learning theory and the comprehensive behavioral research behind the normative model of enhanced team performance delineate those conditions required for the effective design, formation, management, and mentoring of teams. This research has also concluded that team self-management is the basis for sustaining high performance in organizations [2,3]. Many in-depth and comprehensive empirical studies as well as proven field tests have contributed to the body of knowledge surrounding the design and support of high performance teams or self-managing teams. In addition, industry and

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major management consulting firms are embracing the use of self-managing teams because of the increase in worker productivity and quality [4–6].

In this article we articulate the factors enabling the self-management of teams, while defining the role of computer support for self-managing teams. Using proven research, we identify those conditions required for producing high performance in self-managing teams and determine how a team information architecture (TIA) and computer-supported cooperative work (CSCW) tools can assist in sustaining this performance.

We propose a team-development model that encompasses team design, formation, management, and mentoring, and a TIA based on this model. This information architecture widens the scope of current groupware research. Many groupware tools, as they exist today, would only be a functional piece of this much broader architecture required for sustaining team design, development, and performance.

This architecture establishes where most groupware fits into the “behavioral” approach to team development. This intersection occurs in the alleviation of “process loss.” Process loss occurs in such areas as team coordination, scheduling, brainstorming and decision making, and the execution of team meetings. The alleviation of process loss is useful; however, other important conditions are crucial to sustain the high performance of self-managing teams. We promote a more comprehensive view of computer support for teams by using a framework of conditions that lead to team effectiveness and high performance. Using these conditions we then determine what computer support is needed for enabling teamwork.

The TIA proposed in this article is designed to assist the creation and maintenance of teams comprising knowledge workers in environments with low levels of project predictability and routine work flow. Examples of these teams would include a cross-functional product development team, a task force responsible for the development of a long-range strategic plan, a software development team, a task force with the responsibility for determining the technology strategy of a company, and a team with the task of formulating the plans for a new division. Characteristics of these teams are that they may be geographically distributed, comprise cross-organizational/functional/disciplinary membership, be task focused, and have a mission that is time limited. In addition, the work is nonroutine and the members may be on multiple teams.

The focus of this article will be to: (1) outline the fundamentals of team design, including a model for the development of self-managing teams; (2) articulate a TIA that supports the self-managing team development model; and (3) discuss why this information architecture reinforces the conditions and strategies required for the design of highly effective teams.

## 2. FUNDAMENTALS OF TEAM DESIGN

Before describing the capabilities and functionality of the TIA we will give some background on the fundamentals of team design. In this section we will address

what a self-managing team is, articulate a model for the development of self-managing teams, and discuss three approaches to the design of self-managing teams.

## 2.1 What Is a Self-Managing Team?

According to J. Richard Hackman, a team can be characterized by the distribution of authority over four responsibilities: setting overall direction, designing the team and its context, monitoring and managing work processes, and executing the task [7]. The responsibilities having to do with “managing” can be the sole right of management and/or distributed to the team (see Figure 1).

We are all familiar with manager-led teams. Examples of self-managing teams exist in factories that have been redesigned for self-management, for example, at Procter and Gamble, Hewlett-Packard, etc. An example of a self-designing team is a team that has what Peters and Waterman call a “champion” as a member of it [8]. The champion conceptualizes, promotes, designs, inspires, and participates in the team. An example of a self-governing team is an organization’s board of directors. The type of teams the TIA is designed to support include self-managing, self-designing, and self-governing teams.

## 2.2 Self-Managing Team Development Model

The self-managing team development model proposed in this article and used in the design of the TIA is based on research in the fields of sociotechnical systems, Hackman’s normative approach to team development, and social-learning theory. This model of team development has five phases: team design, team formation, team self-management and leadership, team mentoring, and organization learning (see Figure 2). Details on each phase will be addressed.

An alternative model is the Drexler/Sibbet team performance model presented by Robert Johansen at the conference on organizational computing, coordination, and collaboration in 1991 [9] (see Figure 3).

Some of the differences between the self-managing team development model and the team performance model include:

- The self-managing team development model begins with the design of the team, whereas the team performance model begins with “team orientation” after the team has been selected.
- Mentoring is built into the self-managing team development model.
- The self-managing team development model can be used to understand information support requirements for self-managing teams.
- The self-managing team development model provides fundamental building blocks for sustained team effectiveness.
- The self-managing team development model can be used as the foundation for organization learning.

The relationship between these two models are represented in Figure 4.

Setting Overall Direction	Area of Management Responsibility		
Designing the Team and its Context			
Monitoring and Managing Work Processes			Area of Team Responsibility
Executing the Task			
	Manager-led Team	Self-managing Team	Self-designing Team

Figure 1. Four types of teams.

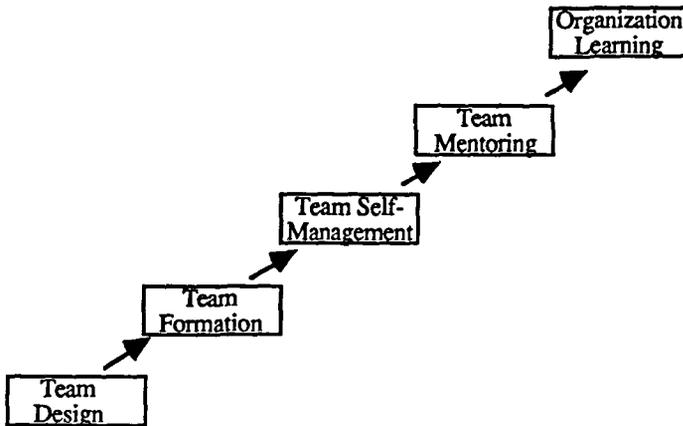


Figure 2. Self-managing team development model.

### 2.3 Approaches to the Design of Self-Managing Team

The design and support of self-managing teams has been investigated from the perspectives of sociotechnical systems, normative models, and social-learning theory. These approaches are based on behavioral research performed over three decades. We will explore these three approaches to the design of self-managing teams.

#### 2.3.1 Sociotechnical Systems Approach to Self-Managing Teams

The sociotechnical systems approach focuses on the integration of teams into the functioning of an organization. Teams are seen as basic components of an orga-

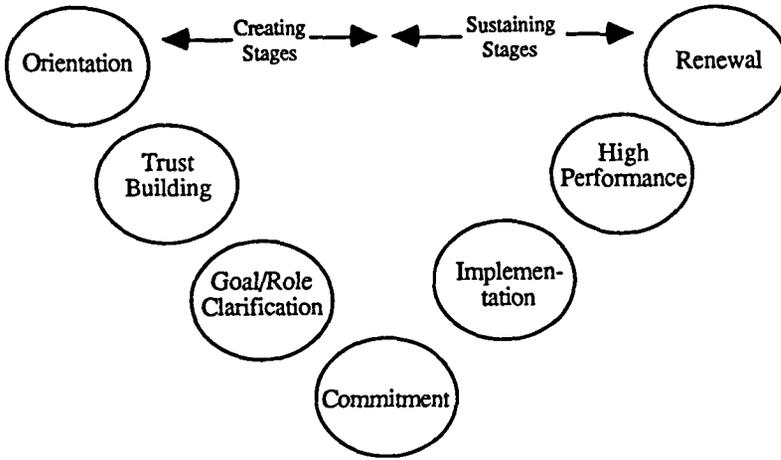


Figure 3. Drexler/Sibbet team performance model.

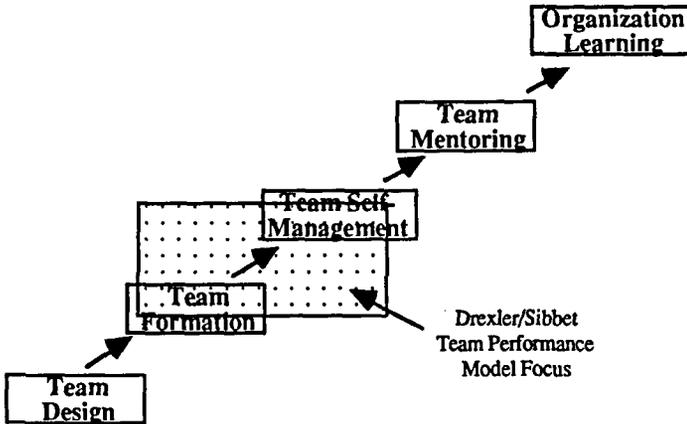


Figure 4. Relationship between two team design/process models.

nization, and teams are the contexts in which workers work. Teams affect and are affected by the organization's design. The sociotechnical system's emphasis is at a macro level—the design of the organization. However, this concern reach-

es into the design of the team. In particular the sociotechnical system approach analyzes the types of knowledge that are needed for the design of highly effective teams. According to Cummings there are at least three types of knowledge needed to optimize a team's design: knowledge about how to alter team outputs, knowledge of values that translate output into performance, and an understanding of the design process [10].

### 2.3.2 Normative Model Approach to the Design of Self-Managing Teams

Hackman's normative model identifies potentially manipulable aspects of teams and their contexts that behavioral science researchers have determined to be highly effective in promoting high performance in teams. The model proposes factors that can be used in diagnosing the strengths and weaknesses of teams and articulates "conditions" that are required to support self-managing teams [11].

### 2.3.3 Social-Learning Theory Approach to Self-Managing Teams

Social-learning theory as it is applied by Manz and Sims is focused on self-leadership and management. Their research indicates that a team's external manager's most important behaviors are those that facilitate the team's self-management. Their focus is in two areas: the first is in determining how managers can become "super-leaders" ("one who leads others to lead themselves"), and the other area is in determining those behaviors needed by team members to lead themselves [12].

All three approaches to the development and support of self-managing teams add unique perspectives and insights. Therefore, these three perspectives are incorporated in the self-managing team development model and the TIA. The scope of these three approaches to self-managing teams is shown in Figure 5.

## 3. A TEAM INFORMATION ARCHITECTURE

This section describes a TIA used to identify computer support for the development of self-managing teams. The architecture, the objectives of the architecture, and the potential users who would be supported by it are described. The TIA, conceptually represented in Figure 6, supports the development of self-managing teams through their five developmental phases.

TIA supports team development by utilizing advanced organization design principles in the design, formation, and self-management of team experience, acting as a repository for experience related to task execution and team performance, and supporting organization learning by capturing this experience and information for further analysis and synthesis after the team has ceased to exist.

### 3.1 Objectives of the Team Information Architecture

The objectives of the TIA are to: (1) provide a structured system for helping to consistently create and reinforce high performance conditions for teams; (2) continually monitor and assess the behaviors that inhibit team effectiveness; (3)

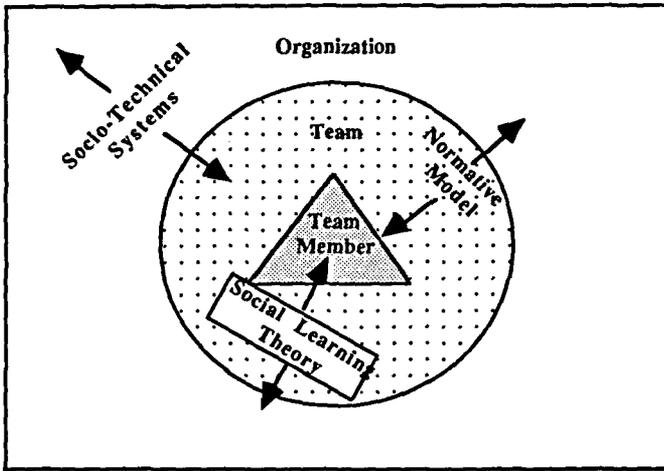


Figure 5. Scope of each approach to self-managing team.

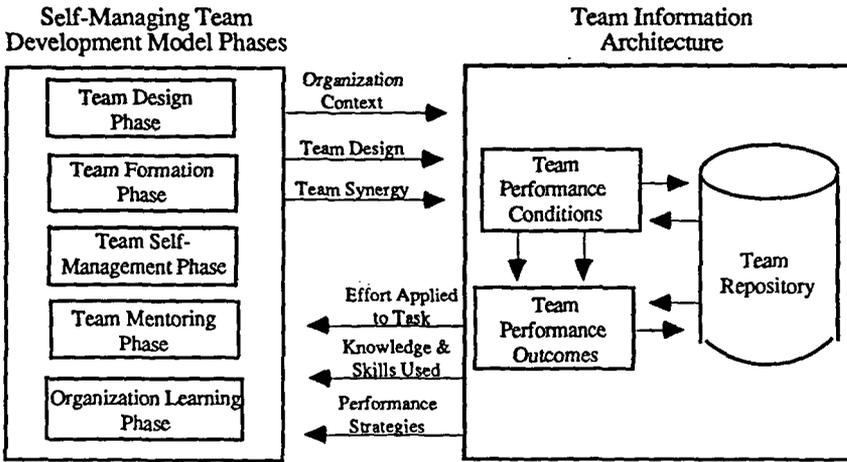


Figure 6. Team information architecture.

diagnose potential problem areas; and (4) develop within the team the skills of self-leadership.

### 3.2 Users of the Team Information Architecture

There are potentially five users of the TIA. These are (1) the designers of the team; (2) the person(s) who mentors the team (this could be the designers); (3) the team members; (4) the customer who will be receiving the end product of the team (the customer may be a person or team within the organization or outside the organization; and (5) management who approved the formation of the team.

The TIA is not to take the place of verbal interactions between people in the organization. Nor does it replace human leadership. Its primary purpose is to enable the design, implementation, and mentoring of high performance teams. In addition, the TIA supports organization effectiveness by facilitating team focus and communication, feedback to management and implementers, and mapping of organizational resources and direction, as well as providing a vehicle for organization memory.

The following sections outline computer support functionality for the (a) design of a team and the creation of performance conditions; (b) formation of a team; (c) support of team self-management and self-leadership; and (d) mentoring of the team.

The next four sections will describe each team development phase, the design principles that support the phase, the functions needing computer support, and the benefits obtained by the organization.

#### 4. COMPUTER SUPPORT FOR THE DESIGN OF TEAMS

The TIA fosters the design of self-managing teams by creating the conditions to support team effort. It optimizes team effort by the design and structure of the project task and increases team member utilization of knowledge and skill by insuring the composition of the team and the organizational resources are adequate for completion of the task. The functions described in this section are to be used by a team mentor or champion—that person responsible for the design of the team's performance conditions.

##### 4.1 Team Design Principles

Hackman and Oldham state that a well-designed team fosters high collective effort [13]. Norms that emerge in a team that encourage high or low effort are the reaction to how tasks are devised. The objective of the team design functions is to develop a consistent method for designing effective team task and performance conditions.

##### 4.2 Team Design Functions

Team design consists of four functions: team task development, team composition, organization support, and team design approval. These functions are represented in Figure 7.

###### 4.2.1 Team Task Development Function

The output of the team task development function is stored in the team repository for later use by the team. This function would assist in the development and documentation of the design of team tasks and critical task demands. The objective is to clearly define what the team needs to accomplish. The team design function will help the designer of the team meet the following design criteria as outlined by Hackman [11]:

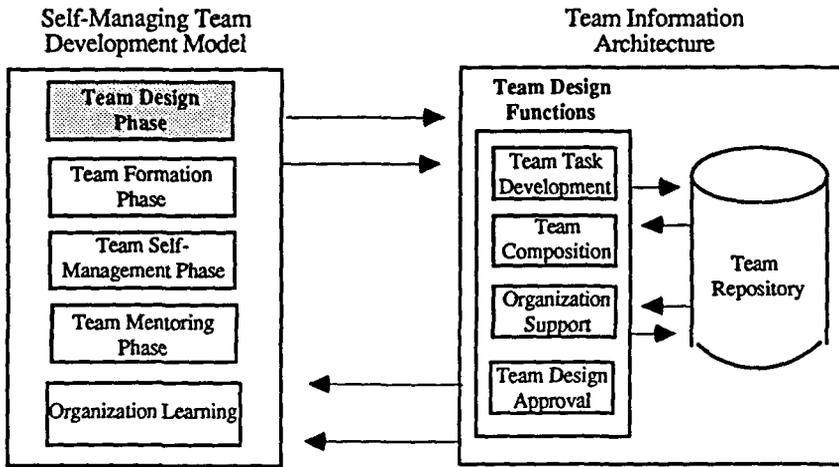


Figure 7. Team design functions.

1. The project task requires variety of high level skills.
2. The project is a meaningful piece of work with a visible outcome.
3. The outcome of the team's work has significant consequences for other people (e.g., other organization members or external clients).
4. The project task provides substantial autonomy for deciding how to do the work—the team "owns" the task and is responsible for the work outcomes.
5. Working on the task creates regular, trustworthy feedback on how well the team is doing.
6. It must be possible for the team to identify what it must do to accomplish its task well and on time and what approaches are to be used in completing this task.

**4.2.2 Team Composition Function**

The team composition function helps the designer of the team determine the team's composition by focusing on the following questions:

1. Should the task be assigned to a team or to an individual?
2. How small can the team be to perform the task effectively?
3. What level of responsibility and authority should the team have?
4. What personal perspectives and values could contribute to this task?  
How diverse should the team be?
5. Do team members have the requisite interpersonal skills?

In addition, this function assists the designer of the team to identify the skills and expertise required to fulfill the team task objectives and to locate team members with the requisite skills and knowledge who are currently or soon will be available for the assignment. To support this function a database of human resources would be needed. Human resource information such as a list of skills, interests, course work, expertise, and role in previous/current projects could be

updated by team members over time to reflect their changing needs, capabilities, and experience. This would allow them to announce new areas of interest and expertise that could be utilized on new projects. In addition, confidential information could be made available to team designers and mentors, following of course, company-mandated policies and protocols. This confidential information could include who is currently or soon to be available, with date of availability; a complete history of the projects participated on by the potential team member; performance evaluations on prior assignments; history of participation in self-managed teams; particular experiences that could add a needed perspective to a project; and level of interpersonal skills. This information would be available in both summary form and in more detail.

#### **4.2.3 Organization Support Function**

The organization support function helps in the identification of organizational support and resources required to fulfill the team task. It captures the answers to the questions: What resources are needed by this team for accomplishing its task? What types of information or educational support are required by the team? If information is required from corporate databases, then the responsibilities of this function lie in determining security access requirements to the data.

The level of information a team needs depends in part on the latitude it has in managing its own affairs. Teams who have the responsibility for developing their own performance strategies and managing their process will have the need for relatively complete data.

#### **4.2.4 Team Design Approval Function**

After the task is defined, the team composition issues are resolved, and the organization supports and resources identified, this team design information can be sent to the customer of the teams output as well as to management for feedback and approval. This step facilitates formal linkage between the team's task and the customer's objectives, as well as alignment with management's overall vision and goals for the organization. The feedback and subsequent changes can be captured in the team repository to be used later by the team.

### **4.3 Organizational Benefits**

The task development function enhances organizational memory by documenting the team design step, thereby capturing the necessary information to determine if the task was designed correctly and executed effectively. It also provides the organization with an experiential base of information for developing better task definitions as well as providing upper managers with the necessary information needed to determine if there is goal congruence in the implementation of the organization's mission and vision.

The team composition function has several benefits. It can help increase knowledge-worker utilization and provide knowledge-workers with more opportunities to work on different types of projects. It can support the structured planning of human resource career development, and it can provide

knowledge-workers with opportunities to work across organizational functional boundaries because this function could be used by more than one department or division.

The team design approval function provides a contract with the customer helping assure that the team's output is worth pursuing. It can be used by the team to focus on a specific end product and to judge if its task is completed. This function also allows for dynamic redefinition and feedback by management in the organization to align team task to changes in the environment.

## 5. COMPUTER SUPPORT OF TEAM FORMATION

The team information architecture's objectives in the formation of a team are to support the development of differentiable boundaries for the team, the team's ownership of its task, and the initiation of appropriate team norms.

### 5.1 Team Formation Principles

The use of the TIA can be important in the early stages of forming the team. The structured environment provided by the TIA can help support a team to get started on the right foot. Hackman states that events early in the life of a team have long-lasting effects on their performance and effectiveness. Certain steps must be taken to form a team that conducts its work successfully and develops the capacity for responsible autonomy, according to Manz and Sims [14].

Cummings [17] asserts that controlling the boundary of the team is very important in defining the team's work territory and its members' influence on the transactions with its environment. Boundary control correlates significantly with team members' job satisfaction and team satisfaction.

According to Hackman, forming a capable team requires helping members with three issues: (1) the development of differentiable boundaries for the team; (2) facilitation of the team's ownership of the task; and (3) the creation of appropriate behavioral norms required for effective team performance.

### 5.2 Team Formation Functions

Team formation consists of three functions: team boundary, task ownership, and team norm development. These functions are represented in Figure 8.

#### 5.2.1 Team Boundary Function

Hackman states that it must be clear who is a member of the team, and therefore shares the responsibility for the team's task, and who is not. The team boundary function supports the proper formation of the team's identity by the creation of a team mail address and team repository. When a member is assigned to a team she or he will be assigned to the team's mail address and have access to the team's repository.

Communication to the team, including customer and upper management

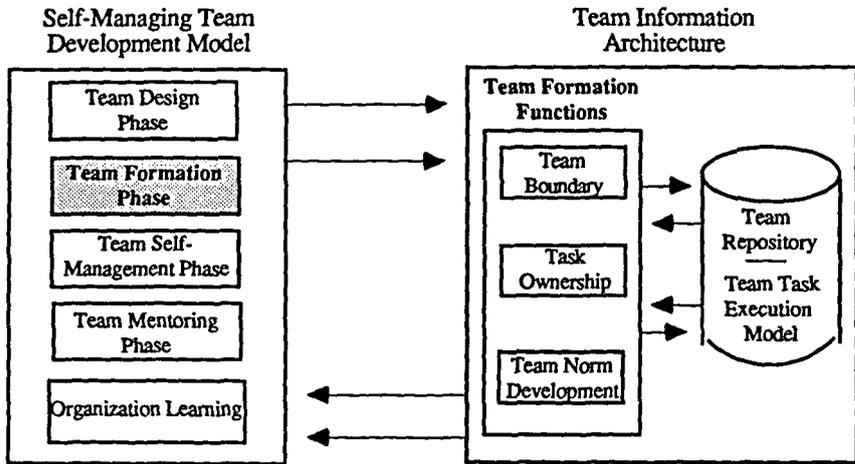


Figure 8. Team formation functions.

input, and performance feedback for the team would be funneled through the team's mail address. The assignment to a team and the subsequent creation of the mail address and team repository would provide concrete evidence that the member is now assigned to the team.

In addition, team identification can be reinforced by using the database of human resources to produce a summary biography for each team member giving his or her history of project involvement together with other useful information. This information could be distributed to new teams and be used to help team members become acquainted with one another's abilities and expertise. This function would further allow for identification with the team and also help facilitate the development of appropriate weighting of members' levels of knowledge and skill.

### 5.2.2 Task Ownership Function

Hackman states that confronting questions regarding a team's task definition early in the life of the team will minimize confusion and idiosyncratic interpretation of what is required of the team. The task ownership function would help facilitate the team's ownership of the task by providing the context for the team to systematically review, discuss, and revise the detailed task description developed by the designer/mentor and approved by the customer and management. By supporting the team's effort at clarifying, understanding, and possibly changing the task description, the task ownership function can facilitate communication about possible discrepancies between the team's understanding of the task and the task's initial detailed description. The clarification of initial assumptions made by the team regarding its task assignment will forestall potential problems, and help insure that the team's focus will be consistent with the view of the designer/mentor/customer/management thereby clarifying early on any confusion or differing interpretation.

The effort to redefine and accept the task early in the life of the team will

provide ownership of the project by the team and thereby reinforce the likelihood that the team's output will hit the mark and not end in wasted effort. In addition, the team would develop a shared team task execution model outlining its plan for the successful completion of the team's task, and the individuals' responsibilities and roles. This team task execution model would be used to support team communication and coordination by actively propagating information as needed to support the execution of the team's work. The team task execution model would be dynamic in that the team's execution plans could be easily changed to reflect new realities in the team's environment.

### 5.2.3 *Team Norms Development Function*

Hackman indicates that the process of identifying behavioral norms is rarely discussed explicitly in teams and that assumptions of appropriate behavior based on prior experience by each member contribute to the gradual development of the team's norm. Hackman further states that if explicit attention, early in the team's life, is given to the types of behaviors that will be valued and how the work of the team is to be managed, then the team is likely to function more effectively.

The team norms development function would assist the team deliberation on the kinds of behavior that will be effective in the work of the team by capturing its agreements. The execution of this function will help bring to the fore issues that are important to the proper performance of the team and encourage the ongoing process of open dialogue around the issues of evolving norms within the team.

## 6. COMPUTER SUPPORT FOR SELF-MANAGEMENT AND SELF-LEADERSHIP

The team information architecture functions promote self-management and self-leadership of the team. The objectives of these functions are to enhance the conditions that improve the team's effectiveness by providing team members with information regarding their performance, helping the team learn from its experience, obtaining needed resources for proper team functioning, and improving the team's process gains through the use of "groupware" tools.

### 6.1 *Self-Management and Self-Leadership Principles*

The process of assisting and providing leadership to a self-managing team has been studied by social-learning theorists. Manz and Sims indicate that it is important to help individual team members, and the team as a whole, develop self-regulatory behaviors. Team self-management is described as active control by team members over their immediate environment and themselves that results in productive goal-oriented behavior. What self-management behaviors need to be reinforced in highly effective teams? How does a team develop such behaviors?

The self-management behaviors, defined by Manz and Sims, needing to be reinforced in highly effective teams include:

1. Self-observation—a team needs to make constructive evaluation of its efforts and make needed adjustments based on the continued gathering of information and feedback regarding its own activities and performance.
2. Self-goal setting—a team that sets explicit, realistic, and challenging performance goals will be provided with targets to strive for.
3. Self-reinforcement—a team increases the likelihood of positive behavior by positive reinforcement.
4. Self-criticism—undesirable behaviors can be decreased by the team through negative reinforcement.

The team self-management and self-leadership functions can help a team develop these self-management behaviors by providing the team with an opportunity to continually *review and update* its performance, *systematically learn* from its experiences, obtain the *resources and information* for effective operation and feedback, control its *team boundaries*, and enable *team collaboration*.

## 6.2 Team Self-Management and Self-Leadership Functions

Team self-management/self-leadership consists of five functions: review and update, learning, resource and information access, boundary control, and team collaboration. These functions are represented in Figure 9.

### 6.2.1 Principles Underlying the Review and Update Function

Hackman refers to a great deal of evidence in stating that goal-directed effort is greater when a team receives feedback about the progress it has attained in its objectives [11]. He also states that the outcome of a team's performance influences a team's interaction. Feedback supports the team in making the appropriate adjustments to its performance and possibly changing its final output. The ability to help a team explicitly review and renegotiate its performance context is a very important process in the ongoing development of the team, because the initial design of a team and its context are sure to be flawed. Therefore, it is important to create a team environment in which these flaws are not accepted as a fact of organizational life but are rather to be openly identified, renegotiated, and changed.

### 6.2.2 Review and Update Function

As stated above, the team information architecture provides a context where the team task is defined by a champion/mentor and is modified, agreed to, and recorded by the team. In addition, the tactics and strategies for performing the team task will be agreed on, represented in a shared team task execution model, and captured in the team repository. Once these agreements are made, repre-

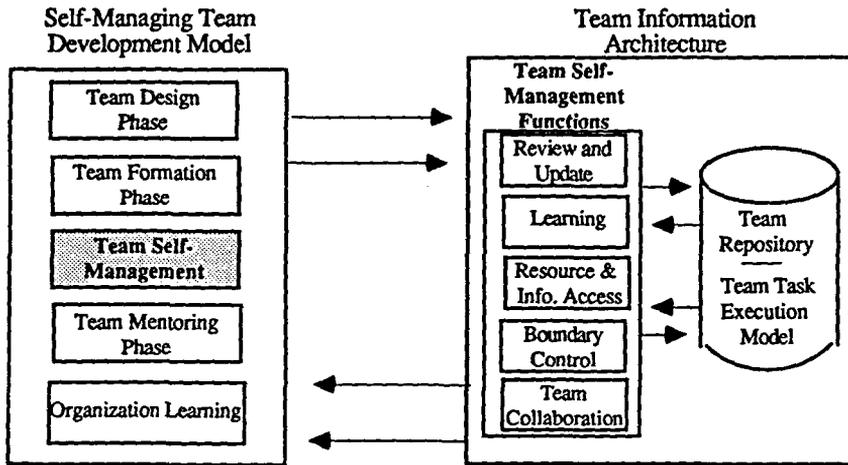


Figure 9. Team self-management and self-leadership functions.

mented, and recorded, then the review and update function will support the team in reviewing and updating its progress systematically, and help the team in its coordination and communication over the entire life of the team. If there are any changes that affect prenegotiated outcomes, timeframes, or milestones, then the needed changes are renegotiated with management and the customer, and the records of these changes are updated in the team task execution model to reflect current realities. Any changes reflecting environmental changes, for example, realities of competitive moves or changes in the market, can be propagated to and brought to the attention of management, providing them feedback about external forces affecting their business. If the changes are the result of team performance issues then they can be propagated to and brought to the attention of the team mentor for attention and possible assessment.

In addition, as milestones are reached and interim output is produced, they can be propagated to the customer for feedback to the team.

### 6.2.3 Principles Underlying the Learning Function

The learning that takes place by a team includes the identification of skills and knowledge needing further development by members, facilitation of skill sharing, ongoing team norm development, determination of members' contribution weighting, and developmental changes within the team.

Many opportunities arise where learning takes place in a well-structured and well-managed team. Finding ways to take advantage of these opportunities is important. However, the time pressure to complete team task work often precludes the conditions allowing the team to reflect together on their experience and seize the opportunity to learn from it. Hackman indicates that it is necessary to create the context for reflecting and learning most likely at a natural breakpoint in the team's work cycle.

#### 6.2.4 *Learning Function*

Because the team task execution model will be updated when certain tasks are accomplished, the team could indicate what point in its work cycle it would see as a natural breakpoint to reflect on what it learned. A set of queries could be established to assist the team in learning from its experiences. These interim learning experiences could be captured in the team information repository to be used in a "post mortem" at the end of the team's life. These "post mortem" learning discussions/experiences could be captured and organized for use by future teams to improve their functioning in the organization's database of team learning experiences.

#### 6.2.5 *Principles Underlying the Resource and Information Access Function*

The organizational context (reward systems, education and training systems, and information systems) that influence the team and the material resources that are placed at the team's disposal have a direct impact on team performance. At some point within the team's life there will be a need for additional talent, expertise, or information not available within the bounds of the team. Resources to fulfill these needs hopefully can be found through the organization's education and information systems, as well as through other employees within the organization who may have the requisite knowledge or expertise to assist the team. It is important that the team be able to identify and access assistance or information. Such assistance could be in the form of guidance from a fellow knowledge-worker on a particular issue, seeking a relationship with a consultant, or sometimes it may take the form of a formal training program.

#### 6.2.6 *Resource and Information Access Function*

Available educational resources and consulting assistance could be made available to the team in a number of modes including a database of educational resources. The database of educational resources could provide the team with the necessary database of colleagues within the organization who may have the expertise or knowledge to assist the team. Of course, the targeted individuals would have to determine whether they have the time available to devote to the exchange of information with the team; of course the organization reward system would need to reinforce collaborative behavior.

As the team determines a need for access to a corporate MIS database, the resource and information access function could provide this capability. Necessary security authorization could be anticipated and established during the team design phase when the champion/mentor of the team is determining the team's task and the required resources to accomplish the task. If the original security authorization parameters established during the team design phase are inadequate then the team members can renegotiate the necessary changes.

As more information becomes available through electronic means, the resource and information access function could be used by the team to request appropriate topics as needed that can be extracted from internal as well as external databases such as Dialogue Information Services.

### 6.2.7 *Principles Underlying the Boundary Control Function*

According to Cummings, "boundary control involves the extent to which [a team] can influence transactions with their . . . environment." Manz and Sims describes several leadership behaviors that focus on the team's boundaries, including communication from management and communication to management; communication between teams; training of inexperienced members; and facilitation of access to equipment and supplies. Manz and Sims assign these behaviors to the team's mentor. My position is that the team information architecture could facilitate boundary control, thus relieving the mentor of some of these functions.

### 6.2.8 *Boundary Control Function*

The boundary control function could allow the team to control transactions with their environment by providing a mechanism for easy identification of, access to, and communication with management, other teams, and resources required by the team.

### 6.2.9 *Principles Underlying the Team Collaboration Function*

A condition that Hackman describes as the promotion of group synergy fostered by the alleviation of "process loss" is primarily supported by the team collaboration function. Steiner hypothesized that interpersonal interactions of team members do not combine optimally the efforts of all members, resulting in the cost of some potential effort [15]. Hackman and Morris concluded that coordination difficulties increase with the size of a team [16]. Hackman surmises that "overhead costs" exist when groups perform tasks [11].

### 6.2.10 *Team Collaboration Functions*

The purpose of the team collaboration functions is to increase the effectiveness of collaboration within the team while minimizing process loss. Also, these functions provide the capabilities that allow team members to be geographically dispersed. With the use of telecommunications and team collaboration tools, team membership could literally be distributed in locations across the globe. Many tools are being developed to support team collaboration. They include coordination systems, team scheduling and calendaring systems, project management systems, team decision-making processors, brainstorming programs, computer conferencing, team authoring, and electronic mail. This list is not exhaustive by any means.

A preponderance of research and development in groupware technologies are focused on this one function—the team collaboration function. Behavioral research has shown that the alleviation of "process loss" is important, yet it has also shown that many of the other functions identified in the team information architecture are necessary for effective team performance. In addition, groupware technologies focus on point solutions at the expense of a comprehensive understanding of team performance. For example, teams perform work in meetings, yet these meetings are only one forum in which the team collaborates. If the information utilized and generated in a team meeting is not captured in a

team task execution model or at least in a team repository then the ongoing work of the team is not supported. The work of teams occur in many forums, including team meetings, e-mail, the writing of reports, telephone conversations, informal discussions, interviews. The design of an information architecture for teams needs to support the capture, propagation, and use of team task execution information. This team task execution information comprises content information that directly relates to the output of the team and behavioral information that directly relates to the performance of the team. The tools for supporting collaboration need to access and provide information to a team task execution model that enhances the overall performance of a team.

### 6.3 Organizational Benefits

The team information architecture provides the ability for organizations to effectively design, form, and support sustained team performance. The team self-management support and self-leadership functions enable the team to manage and improve its ongoing performance and to be geographically dispersed. These capabilities lay the foundation for the "virtual organization" where teams comprise individuals from different geographic locations, working together and improving their performance to accomplish task-focused goals.

## 7. COMPUTER SUPPORT FOR THE MENTORING OF TEAMS

The behavioral framework underlying the team information architecture provides mechanisms for the mentoring of teams. According to Hackman, the goal of team mentoring is to address the developmental issues faced by task-oriented teams over time by encouraging self-perpetuating spirals of increasing effectiveness (and to minimize spirals of decreasing effectiveness). In this section we will first explore those factors that determine whether a team is performing well or not. We will then focus on those factors used to diagnose the problem in order to lead to an appropriate intervention strategy. The mentoring role can be embedded in the self-managing team or could be the role of the team's mentor.

### 7.1 Principles Underlying the Team Mentoring Functions

The information generated in the design, formation, and self-management of teams can be utilized to diagnose those conditions helping or hampering the team's performance. Such information can be used to determine the level of effort the team is applying toward performing its task work, the amount of knowledge and skill members' are bringing to bear on the task, and the appropriateness of the tactics and strategies chosen by the team to carry out their work.

According to Hackman, this information is very useful in determining the strengths and weaknesses of the team as a performing entity, ascertaining what aspects of the team's design, context, and process are most developed, uncovering where improvement is most needed, and in guiding the selection of appro-

priate interventions intended to improve the performance of the team. In addition, these data should help in predicting with some confidence the team's eventual performance effectiveness.

**7.2 Team Mentoring Functions**

Team mentoring consists of two functions: performance diagnosis and performance intervention. These functions are represented in Figure 10.

The team mentoring functions involve the analysis of information regarding the team's efforts, utilization of members' skills and knowledge, and the appropriateness of their performance strategies in order to assess the teams functioning. This information can be structured, eventually through the use of an expert system, to help identify the key attitudes, behaviors, and issues that both support high performance and dampen effectiveness. With this information the team can then encourage those existing behaviors that enhance its effectiveness, and it can look further into the issues hampering its effort. The team mentoring functions would provide the analytical frameworks and diagnostic tools used to assess those conditions that impede team performance.

**7.2.1 Diagnostic Function**

Through the use of tailored questionnaires and other diagnostic instruments like in-depth interviews or structured observation, the diagnostic function could be utilized to capture information to determine more specifically the problematic or developmental issues facing the team.

**7.2.2 Intervention Function**

The team intervention function could incorporate a knowledge base of proven techniques and methods that could support appropriate action to bolster the team's development or help get the team "on track." These techniques and

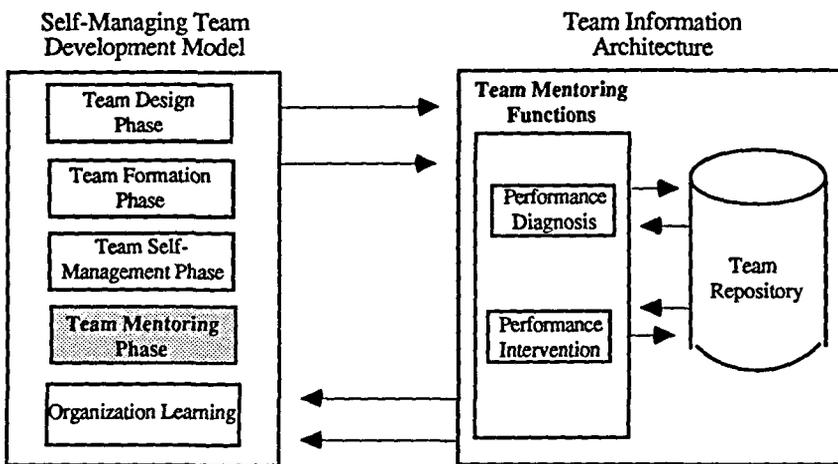


Figure 10. Team mentoring function.

methods could be developed within the organization through their experience designing, forming, and supporting self-management in teams. Examples of these techniques or methods could include designing of a structured review and reflection session for the team, or encouraging the team to focus on those specific task-oriented issues that are assessed to be crucial in improving the performance conditions of the team.

### 7.3 Organizational Benefits

This section lays the foundation for “diagnosing and intervening” when there are team problems. This last set of functions completes the loop in the creation, maintenance, and perpetuation of high performance self-managing teams. By providing the capability to mentor and diagnose team performance problems, as well as designing, forming, and supporting self-management in teams, the competencies are established within an organization for sustaining and controlling the work performance of a “learning organization.”

## 8. THE CONDITIONS REQUIRED FOR TEAM EFFECTIVENESS

The conditions and contexts that directly affect the performance of teams will be outlined in this section. What conditions foster effective team performance? What role do organizational conditions play in supporting effective or optimal team performance? What are the strategies and components of an effective team design?

The team information architecture will be reviewed in light of the conditions necessary for the development of team effectiveness as proposed by Richard Hackman [11]. He states three criteria that together reinforce the overall performance of teams: the *effort* team members put into the team task, the *knowledge and skill* members use in completing the task work, and the *performance strategies* developed by the team to accomplish its work. The degree to which the team utilizes and enhances these functions will determine the total effectiveness of the team.

Hackman proposes three classes of variables that can affect the level of team effort, the amount of skill and knowledge by the team, and the appropriateness of the performance strategies developed by the team. These are the team design, the organizational context in which the team performs, and the team synergy that results from the team working together. Increasing the overall effectiveness of the team will be enhanced by optimizing the conditions that affect the team’s performance: the team design, context, and synergy.

### 8.1 Conditions that Support Team Effort

The conditions needing to be optimized to support a high level of team effort are: (1) the design of the team task; (2) the organization’s reward system; and (3) the team synergy that is fostered by the alleviation of process loss, and the fostering of a shared commitment to the team and its work.

### 8.1.1 *Design of Team Task*

The team task development function would provide the team champion/mentor with a structured environment for creating an effective project task. This function would prompt the designer to consider the various task design criteria enhancing the conditions for higher team effort. In addition, the information generated by this procedure would supply the team with complete and detailed information about its assignment.

### 8.1.2 *Reward System*

The team information architecture can contribute to a limited extent to the reward system of the organization. By helping define more thoroughly challenging, moderately difficult performance objectives, through the use of the team task development function, the system is creating the conditions increasing the team's effort. Feedback on the progress the team is making toward these objectives would be incorporated into the team review and update function. Challenging objectives and feedback to the team would help facilitate greater goal-directed effort [17].

### 8.1.3 *Team Synergy*

A team information architecture can offer many tools to help facilitate effective task behavior in two areas described under team synergy: avoiding "process losses" and creating shared commitment to the team and work task [11].

The team collaboration function can be effectively used to maximize a team's collaborative effort. Coordination, brain storming, team scheduling, and other types of collaborative capabilities can contribute much to team effectiveness. The team collaboration function could provide the ability necessary to increase team process gains.

Interpersonal interactions will be enhanced to the degree to which the team collaboration function helps members perform their collaborative work more easily and efficiently while avoiding frustration, and the team task development function helps design a more rewarding and challenging task thereby contributing to an increase in the team's effort.

## 8.2 **Conditions Supporting Knowledge and Skill Utilization**

The conditions that maximize the amount of knowledge and skill team members are bringing to bear on the team task are the composition of the team, the organization's education resources, and the team synergy that minimizes the inappropriate "weighting" of member contributions, the cross-training among members, and the commitment to collective learning.

### 8.2.1 *Composition of the Team*

According to Hackman and Morris, the most potent controllable variable for teams designed to rely heavily on members' expertise and skills is the composition of the team [16]. Because this proposed information architecture is to be used for designing teams comprising knowledge-workers with highly evolved

repertoires of talents, the composition of teams with appropriate skills and knowledge is crucial.

The team composition function provides a structured environment in which much consideration is taken in the composition of the team. This function will help create the optimal conditions for maximizing the amount of knowledge and skills available on the team.

### 8.2.2 *Educational Resources*

The organization's education resources can be useful for helping team members' obtain added skills and knowledge. In turn, the educational resources can be influenced by feedback by the designer of the team through a team information architecture in two ways: first, the database of human resources and the team design function could capture relevant feedback on the evolving skills and knowledge of the organization thereby helping those individuals responsible for planning future educational resource investment. Second, through access to the database of educational resources the team could provide feedback on their changing skill and knowledge needs as they execute their work.

During the team composition stage the designer could identify educational resources to be used to support the skill and knowledge development of the team. If in composing the team the designer finds that the individuals with some of the skills and knowledge required to perform a task are not available, then the designer can use this part of the system to develop contingencies in staffing the team with less skilled or knowledgeable individuals, supporting them with predetermined resources. In addition, the team designer's feedback would be captured and provided to the human resource organization regarding new staff requirements.

During the ongoing performance of the teams, team members can use the educational resources to augment their skills and knowledge base when they are confronted with problems and issues where they lack expertise.

### 8.2.3 *Team Synergy*

Hackman raises two aspects of team synergy that affect the amount of skill and knowledge exhibited by the teams toward its task: fostering collective learning and minimizing the inappropriate weighting of member contributions. The team review and update, and the team learning functions could be used on a regular basis to stimulate reflection and feedback on these issues.

### 8.2.4 *Collective Learning*

The learning function could be used to query individual team members regarding the type of cross-training they will be needing. In addition, it could display a list of skills and knowledge of other team members, using information from the database of human resources. This would allow team members to identify the specific member within their team who has the requisite skills or knowledge to help them. This function could also help orient the team toward collective learning and help foster the development of the team's internal talents. However, this function is not a panacea. Development of trust and interpersonal sup-

port is required to facilitate the team's ability to recognize individual differences, to learn, and to share learning. Various methods can be used to develop such trust and support, including long-term process consultation. Cummings states that when trust and support develop this can lead to more team innovation and experimentation and help members better tolerate the stresses associated with learning.

Cummings also points out query-based methods for helping teams learn to learn, such as Bateson's theory of deutero-learning. These queries can also be incorporated into questionnaires captured in these functions [17].

### 8.2.5 Member Weighting

The team learning function could also provide the opportunity for assessment of individual performance of team members' contribution. This function could serve several purposes. First, and most importantly, this application can provide feedback to individual team members about how their contribution of skill and knowledge as well as their level of performance are being perceived by their teammates. This would either give the member positive reinforcement for their contribution and/or give them needed information so that they can make the appropriate adjustments in their behavior in order to be more effective. Second, it could provide a mentoring function to the team by determining whether inappropriate weighting of member contributions is occurring within the team. In addition, this information could be used by a team mentor, who designed the team and selected its membership, to help determine whether inappropriate weighting of member contribution is taking place since they assessed the skill and knowledge level of each team member before selecting them on the team. This diagnostic feature would support the team mentoring role by helping to determine if an intervention is needed.

Finally, if the feedback about an individual's abilities, interpersonal skills, or value perspective is not reflected accurately in the database of human resources, then an update could be made to an individual's records. This allows for continued reflection about team member's skills and expertise as well as providing a quality control mechanism for the database of human resources.

## 8.3 Conditions that Support Performance Strategies

Performance strategies are defined by Cummings as the methods an individual or a team uses in accomplishing their work. The behavioral research used in the design of the team information architecture specifies that the ends (or task) is defined for the team (in the team design function); the means by which the team will accomplish the task are left unspecified so that team members can develop their own performance strategies (within the team task ownership and the review and update functions). It is assumed that the knowledge and expertise necessary for the team to construct an appropriate performance strategy resides in the combined skills of the team members. This requirement would have been met by the use of the team composition function.

According to Hackman, the likelihood of a team using a task-appropriate

performance strategy will increase when three factors are supported. First, the team norms support a continued and active assessment of performance strategies and actively considers alternatives. Second, the organization's information systems provide the team with data facilitating the assessment of performance strategies and evaluate alternatives. Finally, the team synergy, developed through the execution of performance plans, and the resulting team interaction, causes little "slippage" or "process loss," and instead fosters innovative ideas about ways of proceeding with the work.

### 8.3.1 Team Norms

Cummings states, "Assigning responsibility for performance strategies to a team promotes the emergence of a team norm legitimizing the examination of performance strategies. A flexible role structure where multiskilled members can interchange task assignments and deploy themselves in diverse ways reinforces this strategy-development norm by minimizing members' allegiances to specific tasks and idiosyncratic ways of performing. The need to synthesize new responses to emerging task and environment demands also legitimizes learning and skill improvement" [10].

The team information architecture supports team norms by providing a context where the team decides on the performance strategies, records them, and then periodically reviews and updates them.

Capabilities for the support of decision-making embedded in the team collaboration function can be used to facilitate team decision processes and the recording of team agreements. These capabilities could be used in helping members reach agreement early in their time together regarding how they will approach and execute their team task using the team task ownership function. The review and update function can assist the team in reviewing their agreed upon strategies and updating each other as to what has been accomplished by each person in meeting their assigned work. The review and update function could be limited to capturing items to be placed on the agenda for the next team meeting or it could be as comprehensive as a team task execution model that facilitates the exchange of behavioral and performance information within the team, thereby reducing the number of regularly scheduled meetings. Flexibility to support a wide variety of teams with different operating procedures is required.

Cummings cautions that performance strategies are codified in team norms. Because of this, strategy changes usually require changes in norms, and "discovery of team norms may be a prelude to strategy changes." Therefore, the team information architecture needs to provide the conditions for examining and reviewing the behavioral norms that lead to changes in strategies.

### 8.3.2 Information Systems

The functionality provided by the team information architecture to assist in the design, formation, support, and mentoring of high team performance as well as the increasing availability of information in electronic form will provide teams

with capabilities and access to information needed for meeting their information/performance requirements.

### 8.3.3 Team Synergy

A team information architecture could be very beneficial in helping teams implement their performance strategies. It could be used to gain agreement from members on the formulation of their performance strategy (through the team task execution model), assist the team in reviewing and updating each other on their agreed upon commitments (through the team review and update function), and provide tools for developing innovative strategy plans.

## 9. CONCLUSION

The team information architecture provides the foundation for a learning-based organization. The information, learning, and performance conditions supported by and captured in the team information architecture can become a crucial asset to organizations interested in improving their people, processes, and products. The ability of an organization to create and support the conditions for effective team performance on a sustained basis will lead to its overall competitiveness. Ignoring this fundamental building block; that is, the development of teams and teamwork, an organization is limited to its ability to learn in an ad hoc manner.

Michael Porter discusses strategic discontinuities in industries that force businesses to adapt to new competitive strategies/technologies—or to lose influence in their industry [18]. An example in the electronics industry is the transition from mechanical devices to electromechanical devices in the late 1960s and early 1970s. A few companies like NCR Corporation had to either adopt new technology or die a slow death.

The development of sustained and improved team performance in a company could lead to this type of strategic discontinuity in an industry. One competitor in an industry could create a strategic discontinuity by building its organization on the design, formulation, support, and mentoring of team performance. The first companies to do so will have a strategic competitive advantage that cannot be easily copied by their competitors.

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