A Systems Approach to Team Performance Measurement

by

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Submitted to the System Design and Management Program in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Engineering and Management
at the

Massachusetts Institute of Technology

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A SYSTEMS APPROACH TO
TEAM PERFORMANCE MEASUREMENT

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Abstract

Teams are rapidly becoming the primary work unit across business and industry. Much
has been written about the advantages of teams in problem solving, decision-making,
quality improvement and performing complex tasks. Likewise, the body of knowledge
surrounding team development, teamwork and team dynamics has grown rapidly over
the last 15 to 20 years. Many theories of team performance have been developed.
However, few unified approaches to measuring team performance have been proposed.
Team performance measurement (TPM) is important for several reasons: 1) team
measures have a motivating and focusing influence on team processes; 2) measurement
provides necessary feedback for decision-making, problem diagnosis and intervention;
and 3) measurement is fundamental to team learning and continuous improvement. The
premise of this thesis is that the design and deployment of effective team performance
measurement strategies can best be accomplished through a systems approach. A
systems approach to TPM considers the following: 1) The object of the measurement, the
team is a system. 2) Team performance measurement strategies must consider the
elements of the system (members, sub-teams, tasks, processes and interfaces) in addition
to system outputs. 3) The team operates within an organizational super-system, which
imposes contextual and environmental influences on team performance. 4) Team
performance measurement is itself a system, with an associated function, interrelated
elements, interfaces, influences and context. This thesis suggests an architectural
framework for analyzing the critical factors influencing team performance and a holistic
TPM framework for developing and deploying a balanced set of team measures.

Thesis Supervisor: John R. Williams
Associate Professor, Civil and Environmental Engineering
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This work is dedicated to the ones whose sacrifices made it possible, my devoted wife and family.
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1. Introduction

Teams are rapidly becoming the primary work unit across business and industry. Much has been written about the advantages of teams in problem solving, decision making, quality improvement and performance. Likewise, the body of knowledge surrounding team development, team dynamics and teamwork has grown rapidly over the last 15 to 20 years. While many theories have been proposed and supported by “laboratory” and empirical study, there is still no consensus on the critical factors of, much less reliable models of work group and team performance. There are several likely reasons for this. 1) Teams are inherently complex socio-technical systems. As such, the inter-relatedness of influencing factors makes them difficult to study. 2) Teams evolve and adapt in complex ways over time. Hence, models must also capture the dynamic effects of team development on performance variables. 3) Teams exist within dynamic organizational contexts, which influence their behavior. This limits the validity of team experiments conducted in controlled, isolated environments, such as team training. 4) Lastly, teams are open systems with respect to information, ideas and influence. This is particularly true of cross-functional teams (e.g. product development), which interface to varying degrees with customers, suppliers, regulatory agencies and multiple functional areas in the process of meeting their objectives. The very boundaries of these teams are dynamic.

Despite our inability to model or predict their performance, team approaches are increasingly being applied to a wide range of business problems and functions. A 1994 survey of Fortune 1000 companies revealed that almost all use project teams, 91 percent use problem-solving teams (an increase of 33% from 1987) and about two-thirds use permanent work teams.\(^1\) While several theories of team effectiveness have been proposed, unified measures of team performance do not exist.\(^2\) Yet, the importance of

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measurement to team performance has been widely recognized. Team performance measurement (TPM) is important for several reasons, including: 1) Team measures have a motivating and focusing influence on team processes. 2) Measurement provides necessary feedback for decision-making, problem diagnosis and intervention. 3) Measurement is fundamental to team learning and continuous improvement. Section 3 will elaborate on these and other roles of TPM.

Traditional performance measurement systems can create conflicts when applied to teams. Measures that are focused on individual and unit performance can be especially troublesome in cross-functional teams. Today's team-based organizations require performance measurement systems that are designed with an understanding of the underlying structures (chains and cycles of cause and effect) that drive behaviors. This is the essence of systems thinking.

The premise of this thesis is that the design, construction and implementation of effective team performance measures can best be accomplished through a systems approach. A systems approach to team performance measurement considers the following:

1. The object of the measurement, the team is a system. It is composed of a set of interrelated elements, which work in such a way that the output of the system is greater than the sum of the capabilities of the individual elements.

2. Team performance measurement strategies must consider the elements of the system (members, sub-teams, tasks, processes and interfaces) in addition to system outputs.

3. The team operates within an organizational super-system, which imposes contextual and environmental influences on team performance.

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4. Team performance measurement is itself a system with an associated function, interrelated elements, interfaces, influences and context.

The systems perspective ensures that the team's measurement process fits and supports the team purpose, meets the needs of team members and stakeholders, and aligns the efforts of the team with the goals of the overall organization.
2. Teams: A Systems Perspective

2.1 What is a Team?

A basic assumption of this thesis is that the entity subjected to performance measurement is indeed a real team. But what distinguishes a team from other groupings of individuals? The word "team" and variants such as "teamwork" and "team player" have become so popular in organizations that their meanings have become diluted and confused. The problems that many organizations have experienced with teams have been attributed to this diffusion of meaning. The team ideology itself has also been blamed for the widespread inappropriate use of the team approach. In the popular book, *The Wisdom of Teams*, Katzenbach and Smith used an empirical study of fifty teams to derive the following working definition of a team:

"A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable."

The authors draw strong distinctions between teams and working groups based on criteria such as shared leadership, cohesiveness, degree of interdependence of processes and work products, organizational orientation and performance measurement. Other definitions cast teams as specialized forms of working groups. For example, Schein defines a working group as a "small set of individuals who are aware of each other, interact with one another and who have a sense of themselves together as a unit." Still others have used the terms interchangeably. Hackman defines work groups and work teams as having the following three characteristics:

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1. They are intact social systems complete with boundaries, interdependence among members and differentiated member roles.

2. They have one or more tasks to perform. The group produces some form of outcome for which its members have collective responsibility.

3. They operate in an organizational context. The group, as a collective, manages relations with other individuals or groups in the larger social system in which the group operates.

A second assumption of the thesis is that the team task or purpose is appropriate to a team approach. Donnellon suggests that a reason for a growing dissatisfaction among managers with team performance is that "...they are being used when they are not needed; that is, teams are being used inappropriately to do work that individuals can manage more efficiently." In general, the team approach is needed when the task cannot be completed by individual efforts alone and when a high degree of coordination and communication is required among group members to achieve acceptable levels of performance. The following is a partial list of other situations where a team approach might be appropriate:

- The task is complex
- Creativity is needed
- The path forward is unclear
- More efficient use of resources is required
- Fast learning is necessary
- High commitment is desirable
- The implementation of a plan requires the cooperation of others
- The task or purpose is cross-functional
- There's a need to do more with current staff levels

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2.2 Teams as Systems

As Hackman's definition suggests, teams are indeed systems. W. Edwards Deming defines a system in terms of its processes:

"It is a series of functions or activities (sub-processes or stages) within an organization that work together for the aim of the organization."

In their book, The Art of Systems Architecting, Rechtin and Maier define a system as "a collection of different things which together produce results unachievable by themselves alone. The value added by systems is in the relationships of their elements." Both definitions capture important elements of teams. Teams are a collection of individuals with complementary skills interrelated through a common approach and process to produce outcomes, which have value to the organization and its customers. Implicit to the nature of teams and teamwork is the expectation that the output of the group will exceed the capabilities of the individual members working alone.

The value in thinking of teams as systems goes far beyond analogy. Hackman points out the inherent difficulty in assessing group effectiveness due to the inter-relatedness of contributing factors:

"the performance effectiveness of groups in organizations usually is over-determined -- that is, it is the product of multiple, non-independent factors whose influence depends in part on the fact that they are redundant."

Hence, focusing on too few or the wrong factors often fails to produce desired results. Hackman is essentially reflecting on the dynamic nature of teams as complex systems.

Others have recognized the importance of a systems perspective of teams and team processes. A systems perspective recognizes the fact that the teams' net value must exceed the sum of its individual member's contributions, that the team receives inputs in the form of information, resources and skills, and produces output. In addition, teams

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operate in and are part of a larger system context. As such, the team has a function within an interacting network of other teams and systems. Recognition of this last point is the key to linking team efforts to the organization's goals, strategies and mission.

**Complexity**

In his book, *The Fifth Discipline*, Peter Senge differentiates between two types of complexity: detail complexity (many variables) and dynamic complexity. With teams, we are primarily concerned with the latter. Systems having dynamic complexity are characterized by the existence of many dependencies, where cause and effect relationships are not obvious and may be unstable over time. This is consistent with Hackman's view of team performance assessment above. Senge points out that today's management tools are suited primarily for dealing with detail complexity. Yet the key to solving most difficult problems in teams and organizations today lies in understanding dynamic complexity.17

**Systems Thinking and Teams**

Jay Forrester's observation of the complex inter-relationship between system structure and dynamic behavior in social systems is particularly relevant to teams:

"The idea of a social system implies sources of behavior beyond that of the individual people within the system. Something about the structure of a system determines what happens beyond just the sum of individual objectives and actions. In other words, the concept of a system implies that people are not entirely free agents but are substantively responsive to their surroundings."18

The implication for teams is that factors that influence aggregate performance go beyond those that motivate and drive individual performance. The tools of systems thinking can provide ways to examine and understand the dynamic influences and structures underlying team processes, behaviors and performance. The development of these

“shared mental models” promotes and enables team learning, one Senge’s five disciplines of learning organizations.¹⁹

2.3 Team Taxonomies

The identification of a comprehensive categorization of team types is as difficult (and unlikely) as gaining consensus on the definition of the word “team.” Classification schemas range from the abstract²⁰ to the detailed and specific. Of the many authors who have described team taxonomies, I have chosen three whom offer useful and distinctly different approaches. These are summarized in Table 1 and described in more detail in the following sections.

<table>
<thead>
<tr>
<th>Organizational</th>
<th>Performance</th>
<th>Multidimensional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Teams</td>
<td>Work Groups</td>
<td>Permanent Work Teams</td>
</tr>
<tr>
<td>Lightweight Teams</td>
<td>Pseudo Teams</td>
<td>Project &amp; Development Teams</td>
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<tr>
<td>Heavyweight Teams</td>
<td>Potential Teams</td>
<td>Parallel Teams</td>
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<tr>
<td>Autonomous Teams</td>
<td>Real Teams</td>
<td>Management Teams</td>
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<tr>
<td></td>
<td>High Performance</td>
<td>Ad Hoc Teams</td>
</tr>
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</table>

Table 1: Team Taxonomies

Wheelwright and Clark differentiate between different approaches to product development teams from an organizational perspective. Katzenbach and Smith present a taxonomy based on team performance and team effectiveness. Several other authors have taken hybrid approaches such as Mankin, Cohen and Bikson who characterize teams along multiple dimensions of permanence, design, focus and influence.

²⁰ For example, Katzenbach and Smith’s: “teams that run things”; “teams that recommend things” and; “teams that make or do things.”
2.3.1 **ORGANIZATIONAL TAXONOMY**

Wheelwright and Clark identified four basic organizational forms used in product development projects: functional, lightweight, heavyweight and autonomous teams.\(^1\) The characteristics, advantages and disadvantages of each approach are described below.

**Functional Teams**

Functional teams are permanent organizational structures with specialized skills and well-defined outputs. Their common purpose is usually to provide service or expertise focused on a narrow set of disciplines, technologies or skills. In product development, a functional team approach implies that the development work is done within the functional organization and overseen by a functional manager. The development project work and responsibility flows sequentially from function to function (e.g. marketing, mechanical/electrical/software design, process engineering, and manufacturing). One advantage of functional teams is the depth of disciplinary knowledge and problem-solving ability that can be developed and maintained in difficult or complex technical domains. There are also efficiency advantages for mature and relatively stable product domains. Disadvantages of this approach lie in reduced cross-functional communication and problem-solving ability, coordination and integration difficulty and the potential for error propagation resulting in costly rework and delays. The performance of the functional team is primarily based on the quality, cycle time and cost-efficiency of the function it performs.

**Lightweight Teams**

In a lightweight team structure, the task work is also performed within the functional organization. The team unit however is a cross-functional group of representatives or liaisons from each of the functional areas involved in the development process and a project manager with coordination responsibilities for the entire process. The degree to which these types of team structures operate and behave like “real” teams varies widely.

Each member maintains primary reporting responsibility to his or her functional organization. For this reason, lightweight teams can share the same advantages and disadvantages as functional teams. However, conflicts between team and functional goals can create a "no-win" situation for team members. Although, the team's responsibility spans the entire development process, their influence over resources and work execution in the functional units is limited. Their main advantages over functional teams are in the coordination of activities and the potential for improved cross-functional communications and problem solving. The performance of lightweight teams is related to their ability to influence and gain cooperation from functional organizations, balance the interests of individual team members, and coordinate workflow to meet the project timeline.

**Heavyweight Teams**

Heavyweight teams are structurally similar to lightweight teams. The major distinction concerns the degree of influence that the project manager has over resources in the functional areas. The core team members, while organizationally distributed are dedicated to the project and may be co-located. The heavyweight project manager is usually a senior staff member with much more experience and organizational clout than their lightweight counterparts. Because of this influence, these teams generally have fewer problems concerning member commitment, cooperation and goal conflict. It also facilitates greater coordination and integration of functions. The result is the potential for a much larger impact on the overall development process and it's outcome. Members develop a deep sense of team orientation and identify themselves more strongly with the product than with their functional roots. Heavyweight teams have advantages in level of commitment, focus, teamwork and performance. However, the degree of influence that these teams command can also create problems. The disadvantages of heavyweight teams relate to the inevitable conflict with functional management and potential estrangement of team members from their home organizations. The performance measures of heavyweight teams should reflect their scope of influence. Hence, product performance, time-to-market, product and process quality and customer satisfaction measures might be appropriate.
**Autonomous Teams**

Autonomous teams are organizationally distinct from the other three approaches. Unlike functional, lightweight and heavyweight teams, the actual development work is executed outside the functional organizations and within the boundary of the project team. All required resources are transferred from their functional organizations to the team and co-located with one another for the life of the project. Autonomous teams, commonly known as “tiger teams”, have nearly complete control over organizational processes, policies, work practices and even rewards and incentives. They have the same advantages as heavyweight teams with an additional level of focus and enhanced cross-functional coordination and integration due to the captive resources. Their freedom from the traditional organizational hierarchy promotes innovation and rapid creation and deployment of streamlined processes, resulting in shorter development cycles. The major disadvantage of autonomous teams also stems from their degree of freedom. Management has less control and fewer opportunities for intervention, compared to traditional projects. Team learnings embedded in methods, procedures, process innovations and development principles can be difficult to translate back into the company’s traditional organizational structure and process. Lastly, the formal transfer of team members out of their functional organizations combined with the temporary nature of the team creates an element of individual risk and uncertainty that may be a barrier in staffing autonomous teams. Performance criteria for autonomous teams are at least as broad ranging as for heavyweight teams. They are usually more ambitious, reflecting the business and market conditions and urgency which led to the adoption of this riskier, more radical approach.

**2.3.2 PERFORMANCE-BASED TAXONOMY**

Katzenbach and Smith identified five distinct team types based on their levels of performance and effectiveness: working groups, pseudo-teams, potential teams, real
teams and high-performance teams. Collectively, they form the basis for the Team Performance Curve (Figure 1).²²

![Team Performance Curve Diagram]

**Figure 1: Katzenbach & Smith's Team Performance Curve**

The shape of the curve indicates that increasing team effectiveness (i.e., improving the elements of teamwork) does not improve performance in all group situations. In fact, under conditions that exhibit neither task nor outcome interdependence, nor call for significant levels of coordination among group members, embarking on a team approach will degrade overall performance. The five group/team types are described below.

*Working groups* are the appropriate forms for tasks or functions that do not require the “overhead” of a team approach. They are composed of individuals brought together with a common interest but often lacking common goals. As long as individual goals are not in direct conflict, group members benefit from sharing information, processes, decisions and best practices. There is very little coordination or inherent interdependence of activities among members. Group effectiveness (and usually membership) is maintained as long as a symbiotic relationship exists between the individual and the group. Working group performance is additive with respect to its members' efforts.

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²² Katzenbach and Smith, 1993, pp. 84-92.
**Pseudo-teams** are under-performing groups who may or may not have a need for improved team effectiveness. They are characterized by "wheel-spinning", lack of focus, non-productive meetings, incessant debate, difficulty reaching consensus, low morale and general inertia. Pseudo-teams can result from a working group miscast as a team, a task force given an ill-defined or unachievable task, an under-staffed or under-trained team or a team that has lost its focus due to major internal or external changes. The first question that must be asked is whether the group’s task is amenable to a team approach (see Section 2.1). If not, the team approach should be abandoned. Group consensus on the definition of its task and the appropriateness of a team approach is the first step up the performance curve toward a potential team. The group may also need to address the questions of group size and skills appropriate to the task before progress can be made. The performance of pseudo-teams is less than the sum of its individual member’s efforts.

**Potential teams** have the compelling need for and "makings" of a real team but lack certain critical conditions for improvement. A potential team may have a meaningful mission but lack a clear purpose and goals. They are often made up of capable, committed and motivated team members, who are working hard but collectively making little progress. In these cases, more up-front effort is needed in clarifying the team’s purpose, developing specific measurable performance goals and a common approach. This process builds commitment and mutual accountability. Like working groups, the performance of potential teams can be characterized as approximately equal to the sum of its member’s performance levels.

The **Real Team** fits Katzenbach and Smith’s definition. It is a "small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable." The transition from a potential team to a real team occurs when individual members begin to assume the personal risks that are associated with interdependence, conflict and collective accountability for team performance. The performance of real teams exceeds the sum of its member’s efforts. Hence, real teams also qualify as systems.

The **High Performance Team** is a rare extension of a real team in which members are "deeply committed to each other’s personal growth and success", according to the
authors. The result is a degree of commitment that drives the team to unexpectedly high levels of performance and unprecedented achievements. These teams are "over-achievers" whose performance exceeds expectations. The performance is rarely sustainable but the relationships among team members usually outlast the team's function.

2.3.3 Multidimensional Taxonomy

Mankin et al. propose a multidimensional classification of teams. Their description of five distinct team types covers a broad range of tasks and functions. Examination of team type characteristics reveals four general criteria by which they base their taxonomy. These are: the continuity of the team effort over time; the team design or organizational structure; the primary focus or team purpose; and the scope and scale of team influence with respect to its boundary. The five team types, working teams, project and development teams, parallel teams, management teams, and ad hoc teams are described along these four dimensions in Table 2. Two other specialized forms of teams are worth mentioning due to their increasing occurrence. These are joint venture/strategic alliance teams and virtual teams. Neither fits neatly into the previously described taxonomies. Both types have unique attributes and challenges. Their summary characteristics are also included in Table 2.

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<table>
<thead>
<tr>
<th><strong>Work Teams</strong></th>
<th><strong>Continuity</strong></th>
<th><strong>Design</strong></th>
<th><strong>Focus</strong></th>
<th><strong>Influence</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>permanent, stable work structures, full time</td>
<td>dedicated, structure mirrors process, co-located</td>
<td>continuous output of products &amp; services</td>
<td>primarily internal to function, externally via product quality</td>
</tr>
<tr>
<td><strong>Project &amp; Development</strong></td>
<td>temporary, duration of project, full or part time</td>
<td>cross-functional, lightweight, heavyweight and autonomous</td>
<td>produce well-defined one-time outputs</td>
<td>can have large impact on external functions</td>
</tr>
<tr>
<td><strong>Parallel Teams</strong></td>
<td>part time, usually temporary</td>
<td>task force, working group, quality circle</td>
<td>process improvement, decisions &amp; recommendations</td>
<td>clear roles &amp; boundaries, limited external influence</td>
</tr>
<tr>
<td><strong>Management Teams</strong></td>
<td>permanent, stable membership</td>
<td>mirrors organization chart</td>
<td>coordination of sub-unit policy, direction &amp; control</td>
<td>hierarchical authority, high external influence</td>
</tr>
<tr>
<td><strong>Ad Hoc Teams</strong></td>
<td>temporary, part time, fluid membership</td>
<td>informal, loosely bound network, interest groups</td>
<td>diverse, shared interest, collaboration</td>
<td>short-term, localized impact</td>
</tr>
<tr>
<td><strong>Virtual Teams</strong></td>
<td>short or long term, full or part time</td>
<td>distributed over space, time, organizations</td>
<td>all of the above</td>
<td>all of the above</td>
</tr>
<tr>
<td><strong>Joint Venture /Strategic Alliance Teams</strong></td>
<td>temporary, full or part time</td>
<td>virtual or co-located, complementary skills and/or capabilities</td>
<td>contractual, collaborative effort, integration of capabilities</td>
<td>can have large impact on external functions</td>
</tr>
</tbody>
</table>

Table 2: Multidimensional Taxonomy

Virtual Teams share the characteristics and requirements of conventional teams but have the added challenge of coordinating tasks, processes and communications across temporal, geographic and organizational boundaries.\(^2\) Their emergence has been spurred by advancements in computer-supported collaborative work (CSCW) and communications technologies including: the internet, group-ware, electronic mail & scheduling tools, video- audio- and data-conferencing and the availability of inexpensive

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network bandwidth.

*Joint Venture/Strategic Alliance teams (JV/SA)* are specialized types of project teams that are formed across company boundaries. They differ from conventional projects in that a contractual agreement usually defines the scope and objectives of the team. Members are mutually accountable and committed to the team to the extent that the objectives and approach remain in the best interests of their companies. They can exist at multiple organizational levels depending on the phase and nature of the relationship. At the top (management) level they are rarely team-like. However, at the planning and work execution levels, they resemble cross-functional project teams. It is common for JV/SA teams to be virtual teams.

Taxonomies are interesting and sometimes useful from the perspective of understanding teams at a high level of abstraction. They can also contribute to a common language for dialogue to the extent that they find formalization within an organization’s processes and systems. As described in section 2.3.2 above, some taxonomies can be useful in high-level benchmarking and team development. Unfortunately, as is the case for "team" definition, there is no clear consensus on team classification, much less reliable classification criteria. This limits their utility for external benchmarking, correlation of empirical research results and establishment of standardized (team-level) performance expectations.

### 2.4 Team Development & Effectiveness

The vast majority of literature references to team assessment and evaluation involve multiple dimensions of performance. Hackman suggests that teams must be assessed along three dimensions: 1) the degree to which the group’s output satisfies the needs and expectations of its customers (quality, quantity, timeliness, etc.); 2) the degree to which the team’s process enhances their ability to work together in the future; and 3) the degree to which the team experience contributes to personal growth and fulfillment of individual
members goals. Sundstrom and McIntyre espouse four components of team effectiveness: performance (same as Hackman's dimension #1 above), member satisfaction, team learning and outsider satisfaction. The latter dimension includes stakeholders such as suppliers and management in addition to customers. Several other sources use a simple two-faceted approach to assessment, drawing a distinction between team performance (results & outcomes) and team effectiveness (task and team processes). Lipnack and Stamps suggest that teams have a two part "bottom-line" that includes task success and social success. They refer to the latter as "social capital: the structure of relations between and among actors, individual or organizational."

Teams are not steady-state machines. Their capability and effectiveness evolves and varies over time. Hence, just as is the case with individuals, team performance is related to their developmental stage.

2.4.1 TEAM DEVELOPMENT

Several models of team development have been proposed. This is an area where there is some amount of agreement. Empirical research suggests that all working groups go through a sequence of similar stages of development to varying degrees and duration. The five stages of small group development suggested by Tuckman & Jensen is one of the more familiar models: forming, storming, norming, performing and adjourning. Management consultant Ken Blanchard offers a four-phase model that closely parallels Tuckman and Jensen's first four stages: orientation, dissatisfaction, resolution and production. Interestingly, these two frameworks correlate well with Katzenbach and Smith's Team Performance Curve as shown in Table 3 (see Section 2.3.2, Performance-

Based Taxonomy, Figure 1).30

<table>
<thead>
<tr>
<th>Source</th>
<th>Forming</th>
<th>Storming</th>
<th>Norming</th>
<th>Performing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuckman &amp; Jensen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blanchard, et al.</td>
<td>Orientation</td>
<td>Dissatisfaction</td>
<td>Resolution</td>
<td>Production</td>
</tr>
<tr>
<td>Katzenbach &amp; Smith</td>
<td>Work Group</td>
<td>Pseudo Team</td>
<td>Potential Team</td>
<td>Real Team</td>
</tr>
</tbody>
</table>

Table 3: Models of Team Development

The team performance curve was not proposed by its authors as a team development model. However, the curve and corresponding descriptions of group characteristics, offer a useful roadmap for navigating through the development stages to team effectiveness through a performance focus (i.e., clarifying purpose, developing specific, measurable goals and common approach). Similarly, the development models present a complementary perspective of the performance curve for new teams. The objective for most teams is to compress the duration of the first three stages. However, taking shortcuts can lead to dysfunctional team processes and future performance problems.

2.4.2 TEAM EFFECTIVENESS

Katzenbach and Smith incorporated their team effectiveness model into their definition of a high performance team. "A small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable."31 The authors partition this definition into three major components of team effectiveness: commitment, accountability and skills. Figure 2 shows the graphical representation of this model of "team basics" from The Wisdom of Teams. A survey instrument for assessing team effectiveness based on this model can be found in Appendix A. The model's component definitions are listed below.

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31 Katzenbach & Smith, 1993, p. 84.

26
Figure 2: Katzenbach & Smith's Team Basics

Commitment – Team members share a common purpose. They are committed to a jointly developed, common approach and the achievement of specific performance goals.

Accountability – The team is made up of a small number of members who are mutually accountable for team work products and individually accountable for independent task work. Mutual and individual accountability tends to decrease as team size increases.

Skills – The right skills are present in the right amounts in effective teams. In addition to task specific functional and technical skills, teams must have sufficient quantities of team and interpersonal skills. This includes communication, problem-solving, negotiation, conflict-resolution, mentoring and leadership skills.

Similarly, Lumsden & Lumsden describe a set of team effectiveness characteristics based on their “superteam” model. They describe six team attributes: team culture, shared image, syntality, shared vision, synergy and cohesiveness.

Team Culture – Teams develop shared values, beliefs, assumptions, roles and norms that influence individual team member and collective behaviors within the team environment.

---

**Shared Image** – Just as individuals develop a “self-image”, team members develop a positive shared image of the team. This gives the team and its members a strong sense of identity, which may be visible outside as well as within the team boundary.

**Shared Vision** – Commitment builds as team members develop a clear picture of where they are headed and what it will look like when they get there. Shared mental models of the team’s purpose, success, and influence build collective efficacy, the belief in the team’s ability to achieve its goals.

**Syntality** – The authors define syntality as the team’s “personality.” It is the aggregation of individual behavioral traits as seen by outsiders. Teams can be introverted or extroverted, open or closed with respect to communications and influence. Traits that lead to team syntality include a constancy of purpose and a consistency of interactions and communication styles.

**Synergy** – The authors describe synergy as the “energy that moves the team.” It happens as a result of the coalescence of individual goals, needs and motives into a common purpose and drive. Synergy enables the team to perform at a level beyond the sum of individual contributions.

**Cohesiveness** – The degree to which individual team members identify with one another and the group as a whole. High levels of individual commitment to the team and each other, back-up behaviors, and a collective “single-mindedness” characterize cohesiveness. Too much cohesiveness can be problematic: groupthink, defocusing of team purpose, team-first mentality and isolationism are possible negative side effects.

These approaches focus primarily on internal team dynamics. Others have proposed more holistic models of effectiveness, which consider external influences and interactions. For example, Toquam et al., have suggested a conceptual model of team

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33 Groupthink is characterized by the absence of critical thinking and deliberation in group decision-making due to conflict avoidance and an overriding concern for maintaining group cohesion.
performance to illustrate the causal relationships leading to variability in nuclear power plant crew performance (Figure 3).  

![Diagram: Conceptual Model of Team Performance (Toquam, et al., 1997)](image)

**Figure 3: Conceptual Model of Team Performance (Toquam, et al., 1997)**

The model includes six basic components. External demands (policies, procedures and cultural factors, i.e., organizational context) influence task characteristics, team member characteristics and team characteristics. Task characteristics include complexity, interdependencies, coordination, and environmental uncertainties. Team member characteristics relate to task-specific and teamwork skills, cognitive abilities and job experience. Team level characteristics include group homogeneity, cohesiveness and communication patterns. Task, team member and team characteristics are hypothesized to dynamically influence team process effectiveness which in turn influences team performance.

Similarly, Ancona, et.al. propose a holistic model, based on Sundstrom & McIntyre’s definition of team effectiveness, which recognizes the dual cause-and-effect or feedback relationship between team process and team effectiveness (Figure 4).  

---


Figure 4: Model of Team Effectiveness (Ancona, et al.)

This model illustrates the important influence that team context has on team operations, which in turn determines (and is influenced by) its effectiveness over time. Other important aspects of this model include the explicit references to boundary management processes and team learning. Boundary management relates to how the team defines, interacts with and maintains its important external relationships. Team Learning refers to the acquisition of new skills, capabilities and behaviors in response to changing circumstances or new demands. Wheelwright and Clark identified five areas of focus for learning from development teams: procedures, tools and methods, process, structure and principles.36

2.4.3 TEAM TROUBLE-SHOOTING AND DIAGNOSIS

Diagnostic frameworks also abound (Katzenbach & Smith, 1993; Hackman, 1990; Huszczko, 1996). A 1993 workshop on product development at Wake Forest University, attended by fifty managers and academics, focused on the problem of “ineffective teaming.” Eight commonly found characteristics revealed by their diagnosis are shown in Table 4.37

Sources of Ineffective Teaming in Product Development

1. Start/stop too early or too late (poor coordination)
2. Unclear goals
3. Poor decision-making and accountability
4. Not enough communication or trust
5. Roadblocks
6. Difficult to motivate performance consistently
7. Insufficient skill development
8. Unsupportive environment

Table 4: Teaming Problems in Product Development

Snee et al. identified nine barriers to team progress along with potential contributing factors. These are summarized in Table 5 below."

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Contributing Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No or little management support</td>
<td>Organization lacks commitment, skills and/or methods for supporting teams</td>
</tr>
<tr>
<td>2. Project scope too large</td>
<td>The team and organization aren't clear on what is reasonable or management is</td>
</tr>
<tr>
<td></td>
<td>abdicating its responsibility to guide the team</td>
</tr>
<tr>
<td>3. Project objectives not significant</td>
<td>Management has not defined what role teams will play in the organization</td>
</tr>
<tr>
<td>4. No clear measures of success</td>
<td>Team is not clear about its charter and/or has not agreed to specific, measurable goals</td>
</tr>
<tr>
<td>5. Team is too large</td>
<td>Organization lacks methods for involving people in ways other than team membership</td>
</tr>
<tr>
<td>6. No time to do improvement work</td>
<td>Values and beliefs of the organization are incompatible with the team's work</td>
</tr>
<tr>
<td>7. Insufficient training</td>
<td>Organization and team are not aware of skills needed for team effectiveness, have not made training a priority, or have not allocated time</td>
</tr>
<tr>
<td>8. Lack of team alignment with the organization</td>
<td>Organization is not clear about its priorities for the team and how the team's charter supports its business goals and objectives</td>
</tr>
<tr>
<td>9. Unavailability of data</td>
<td>Management information systems are not adequate</td>
</tr>
</tbody>
</table>

Table 5: 9 Common Barriers to Team Progress

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*Snee et al., 1998.*
2.5 A System Model of Team Performance

2.5.1 Team System Model

Many, if not all of the concepts and components of team effectiveness from the previous section can be captured in an integrated systems framework. Figure 5 shows the team as a system with inputs, outputs, and operational context.

![Diagram of a System Model of Team Performance]

Figure 5: System Model of Team Performance

Team inputs include its mission and purpose\(^9\), the people that constitute its membership and various systems which support team processes (e.g. information, HR, financial, purchasing). In this model, *effectiveness* is a function of the team’s architecture as defined by its people (members), processes and interfaces. This will be described in more detail in the next section. *Team performance*, the degree to which the team meets its primary objectives in terms of specific criteria, is one of the process outputs. Team performance may include qualitative assessments beyond that of immediate customers.

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\(^9\) This can range from a management specified, formally documented team charter to a loosely bounded problem definition or identified need.
(e.g. peer teams, suppliers, management, etc.). Hence, the broader term "stakeholder satisfaction" is used. This reflects the influence (positive and negative) that team processes can have on its organizational context.

The system model of team performance proposes growth as a second output or outcome of the team process. The growth component is an outcome of team learning that goes beyond the enhancement of individual and team capabilities to effect organizational learning. Team learning translates to organizational growth through the creation of persistent knowledge artifacts. Knowledge artifacts can include documented learnings, transferable skills, process innovations and new tools and methods.

Finally, the model illustrates a fundamental principle of systems theory, that teams are components of larger systems, i.e. their organizational context. Furthermore, teams are open systems with respect to information, ideas and influence. The dotted lines represent the semi-permeable nature of the team’s boundary. Team processes, behaviors and outputs are influenced by and contribute to its organizational context.

2.5.2 Architectural Framework

In this section, an architectural framework is described which goes beyond a taxonomy or model of effectiveness to provide a tool for analysis and identification of the critical levers or "pulse-points" of team performance. Wilson and Pearson define pulse-points as "those particular places where operation of the system is most easily measured.... alternatively, they are where most problems are likely to occur." An understanding of the underlying "system architecture" is the key to locating a team's pulse-points. The architectural perspective compels one to view the team as an interconnected set of functional elements (people), processes, and interfaces. The arrangement of these three entities along multiple dimensions (e.g. space, time), i.e. the organization and coordination of capabilities, work processes and information flows, both internally and across the team boundary defines the architecture of the team as a system. The

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architectural framework is summarized in Table 6 and described in detail in the following sections.

<table>
<thead>
<tr>
<th>People</th>
<th>Processes</th>
<th>Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge, Skills &amp; Attitudes</td>
<td>• Shared Leadership</td>
<td>• Influence</td>
</tr>
<tr>
<td>• Roles &amp; Responsibilities</td>
<td>• Collaboration</td>
<td>• Information</td>
</tr>
<tr>
<td>• Physical &amp; Organizational Distribution</td>
<td>• Coordination</td>
<td>• Task/Process</td>
</tr>
<tr>
<td></td>
<td>• Capability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Communication</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Team Learning</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Team Architectural Framework

2.5.2.1 People

People are the fundamental functional elements of the team. Nothing is accomplished without the application of individual skill and effort. As previously mentioned, the team construct presupposes several things about the organization of the group, e.g. flat structure, cooperation-oriented, decentralized control, functional interdependence. However, the number of options for partitioning complex tasks and processes and roles among the members of a team are many. A few approaches are described in Section 2.3: Team Taxonomies. These descriptions are much too abstract to be of any assistance in analyzing and identifying a team's pulse-points. A much more detailed, team-specific view is needed that identifies important team member interactions, interdependencies and physical and organizational barriers. This can be accomplished by analyzing the team structure along three dimensions: 1) the partitioning of knowledge, skills and capabilities, 2) the allocation of roles and responsibilities and 3) the physical and organizational distribution of team members.

Knowledge, Skills & Attitudes

Teams must have the right combination of skills in adequate amounts to achieve their objectives. Cannon-Bowers and Salas have identified an extensive set of team competencies that they classified as knowledge, skills and attitudinal competencies or KSAs (Table 7). Surprisingly, task-specific skills were not among their list of
competencies. This has been added to the table. Unfortunately, the types and quantities of skills needed may not be apparent at team inception. This can be due to an unclear team purpose, a vague problem statement or the need for additional requirements analysis. Once the team clarifies its purpose and translates it into a set of objectives they can begin to identify specific skills and capabilities needed. This is best accomplished through a process of decomposition of objectives into goals and work products, processes, work breakdown structures and eventually sequences of individual tasks. In this way, task-specific skill requirements can be identified and quantified in terms of numbers of people or person-hours per task. This provides the baseline against which the team can assess its composition.

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Skills</th>
<th>Attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cue/strategy associations</td>
<td>• Adaptability, flexibility</td>
<td>• Team orientation</td>
</tr>
<tr>
<td>• Task-specific knowledge</td>
<td>• Compensatory behavior</td>
<td>• Confictive efficacy</td>
</tr>
<tr>
<td>• Shared task models</td>
<td>• Shared situational awareness</td>
<td>• Shared vision</td>
</tr>
<tr>
<td>• Knowledge of team norms, mission &amp; objectives</td>
<td>• Mutual performance monitoring and feedback</td>
<td>• Team cohesion</td>
</tr>
<tr>
<td>• Task sequencing</td>
<td>• Leadership, team management</td>
<td>• Interpersonal relations</td>
</tr>
<tr>
<td>• Accurate task models</td>
<td>• Conflict resolution, assertiveness</td>
<td>• Mutual trust</td>
</tr>
<tr>
<td>• Accurate problem models</td>
<td>• Coordination, task integration</td>
<td>• Task-specific teamwork attitudes</td>
</tr>
<tr>
<td>• Team role interactions</td>
<td>• Communication</td>
<td>• Collective orientation</td>
</tr>
<tr>
<td>• Teamwork understanding</td>
<td>• Decision making &amp; problem solving</td>
<td>• Importance of teamwork</td>
</tr>
<tr>
<td>• Knowledge of boundary spanning role</td>
<td>• Task-specific skills</td>
<td></td>
</tr>
<tr>
<td>• Teammate characteristics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7: Team Competencies (adapted from Cannon-Bowers, et al.4)

Knowledge, skill or capability gaps may be filled by the addition of new members, training existing members, or resourcing tasks externally. Mapping specific tasks to individual capabilities begins the process of defining the team’s roles and responsibilities.
Roles & Responsibilities

The assignment of team, sub-team and individual task responsibilities, along with a shared model of task sequencing (e.g. project plan, process map, Gantt chart) identifies important interactions and interdependencies between individual team members and external resources. These task responsibilities must be clearly defined, visible and understood by all team members. Implied roles may be embedded in task assignments when information or assistance is required from more than one team member. For example, a programmer seeks another team member to perform a peer code review before submitting a module for formal testing. A junior engineer needs to know the procedure for requesting a material stress analysis. In both cases, team members without direct task responsibility may be called upon to play the roles of reviewer and mentor, respectively. Implied roles are often based on experience, deep task knowledge or functional expertise. Group members having these qualities may be expected to mentor, consult, critique or participate in spontaneous problem solving as needed. Wherever possible, implied task roles should be made explicit up front.

Task roles and responsibilities ensure that work gets done. Other task-independent roles and responsibilities that are critical to team effectiveness have been identified. Huszczko proposes a framework for team role analysis based on 34 “team dynamic” roles which either facilitate task processes or build team relationships, and 20 “dysfunctional” roles which are disruptive to team effectiveness. Lumsden & Lumsden offer a similar framework for observing and assessing role behaviors in teams (Table 8). They identify three classes of team roles: 1) task processes facilitator – roles which focus on “doing the job”; 2) transactional processes facilitator – team building and maintenance roles and; 3)

---

43 Lumsden & Lumsden, 1993, pp. 49-50.
process blocker – dysfunctional behaviors which create obstacles to team effectiveness or disrupt team cohesiveness.

<table>
<thead>
<tr>
<th>Task Processes Facilitator</th>
<th>Transactional Processes Facilitator</th>
<th>Process Blocker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiator/contributor</td>
<td>Encourager</td>
<td>Aggressor/blocker</td>
</tr>
<tr>
<td>Information/opinion seeker</td>
<td>Harmonizer/compromiser</td>
<td>Recognition seeker</td>
</tr>
<tr>
<td>Information/opinion giver</td>
<td>Gatekeeper</td>
<td>Self-confessor/help-seeker</td>
</tr>
<tr>
<td>Elaborator</td>
<td>Standard setter</td>
<td>Player/fun-seeker</td>
</tr>
<tr>
<td>Coordinator</td>
<td>Observer</td>
<td>Dominator</td>
</tr>
<tr>
<td>Orienteer</td>
<td>Follower</td>
<td>Special interest pleader</td>
</tr>
<tr>
<td>Evaluator/critic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energizer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recorder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Framework for Team Member Role Observation

Permanent work teams, cross-functional teams and teams that work under prolonged periods of intensive effort or high stress may find key pulse-points in the area of roles and responsibilities.

Physical & Organizational Distribution

The organizational and geographic distribution of team members can offer both advantages and challenges to teams. Characteristics, advantages and disadvantages of various organizational arrangements were discussed at length in Section 2.3.1: Organizational Taxonomy. Geographic (and temporal) distribution of teams is becoming increasingly common. Virtual teams are able to draw from a wider base of expertise. Members are often dispersed across organizational, corporate and even international boundaries and cultures. Technology can play an important role in facilitating basic team processes such as communication and coordination of efforts. However, the absence or infrequency of face-to-face interaction creates special challenges to virtual teams in the areas of team building, development and maintenance. Moreover, critical elements of effectiveness, including commitment to a common purpose, shared performance goals and mutual accountability can require significantly more time and/or effort, compared to conventional teams despite the latest technological advances. These basic prerequisites to
team performance can represent important pulse-points for geographically and organizationally distributed teams.

2.5.2.2 Processes

Most team process theories differentiate between processes that focus on accomplishment of task work (task processes) and those that relate to the creation and maintenance of the team environment (teamwork processes). Ancona, et. al. describe seven task and four maintenance processes required for effective group functioning:

- Task Functions – Initiating, information and opinion seeking, information and opinion providing, clarifying, elaborating, summarizing, and consensus testing.

- Maintenance Functions – Harmonizing, compromising, gatekeeping and encouraging.

These are quite similar to the task and transactional process roles described in the previous section and listed in Table 8. Many other team processes can be identified and one could argue whether or not they fall within one of the definitions above. However, the salient point of concern here is the degree to which the model provides a useful framework for analyzing and improving team process effectiveness. To this end, a slightly more detailed classification schema and conceptual framework of team processes is suggested. The Team Process Model shown in Figure 6 is composed of four basic team processes (Shared Leadership, Collaboration, Coordination, and Capability) and two integrating processes (Communication and Learning).

---

Shared Leadership

In a traditional hierarchical organization, leadership processes tend to be associated with individuals and positions. In successful teams, leadership is shared, situational and distributed across many, if not all members of the team. This is of particular importance to virtual teams. The processes of shared leadership include clarifying, goal orientation, recognizing & rewarding, encouraging, supporting, motivating, promoting, and involving. Clarifying activities ensure that the team purpose, customer requirements, goals, roles and responsibilities are unambiguous and understood and that important information is disseminated accurately and effectively. Goal orienting processes extend beyond goal development. Team members continually monitor external influences for events or conditions that might necessitate realignment of the team’s purpose or goals. Other shared leadership processes are important to maintaining a cohesive, positive and productive team climate. These include providing support, encouragement, and motivation as well as recognizing and rewarding individual and team achievement. Promoting and involving processes apply both within and external to the team boundary. Shared leadership involves promoting one another’s and the team’s reputation and purpose, making sure that everyone is involved in the team process and involving stakeholder and external resources as required to meet the team’s goals. Some of these external activities are referred to as boundary management processes (see section 2.5.2.3).

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The pulse-points of shared leadership in teams can be found in the existence of a common purpose and goals and assessments of commitment, attitudes and team climate.

Collaboration

In the book *No More Teams*, Michael Schrage defines collaboration as "the process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own." In this sense, collaboration is the essence of teamwork. The processes and activities of collaboration include negotiating, compromising, consensus building, group decision-making, idea generation, brainstorming, cooperative analysis, problem-solving, designing, implementing, and managing conflict. Ancona, et. al. describe two types of conflict in teams, substantive and affective. Substantive or "good" conflict consists of the open, constructive exchange of differing opinions on task or team related issues. It can improve creativity and decision making by surfacing alternative points of view and courses of action for group discussion. The absence of substantive conflict in teams is a warning signal that "group-think" may be present. Affective conflict is non-constructive and problematic in teams, resulting from differences in values, personality or communication styles, lack of trust or respect and/or poor interpersonal skills. Processes for managing substantive conflict are those that facilitate open dialog and manage group discussion toward a decision or course of action. Affective conflict management processes are common to those shared leadership processes that promote team cohesion, mutual trust and respect for individual differences.

Collaboration processes can also involve external teams, organizations or individuals. In these cases, coordination and boundary management processes become important enablers. The nature of cooperative efforts is often determined by the perceived value of

---

the collaboration by each member involved. Lipnack and Stamps present a simple framework for analyzing the cooperative structure of collaborations (Figure 7).47

<table>
<thead>
<tr>
<th>Group Interdependence</th>
<th>Individual Independence</th>
<th>Group Codependence</th>
<th>Goals</th>
<th>Rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>0</td>
<td>-</td>
<td>Cooperative</td>
<td>Big Win / Win</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Win / Win</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Independent</td>
<td>Individual Win or Lose</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Competitive</td>
<td>Win / Lose</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Big Lose / Lose</td>
</tr>
</tbody>
</table>

Figure 7: Goal Interdependence Gauge

At the upper end of the scale, groups with a high level of goal interdependence are the most likely to cooperate and collaborate. These are win/win situations. On the other hand, group codependence implies that the team cannot succeed (win) unless there is a competitor who loses. This may be due to a scarcity of available resources or a limited or shrinking market for the team’s output. In the worst cases of codependence, beating the competition becomes the overriding goal, resulting in a zero-sum game where everyone loses.

Coordination

Teams frequently need to perform functions that involve high levels of dynamic complexity, i.e., functions that have a high degree of task and outcome interdependence. Aircraft cockpit crews, symphony orchestras, surgical teams, automobile assembly teams and cross-functional teams taking a product from concept to market all require effective coordination to manage dynamic complexity. Coordination processes include planning, organizing, scheduling, facilitating, monitoring and gatekeeping.48

Analysis of a team’s coordination requirements can reveal critical pulse-points of performance. These are often found in the timing and quality dimensions of task

48 Note that “gatekeeping” is used here in a different sense than as referenced by Ancona and Lumsden. Here the role ensures that predefined conditions are met before passing a milestone or stage gate.
interdependence. Tesluk, et al. describe a taxonomy of team work processes to illustrate differences in task interdependence within various types of teams found in the health care industry. Figure 8 depicts four distinct workflow scenarios that were identified.\(^9\)

![Diagram of workflow scenarios]

**Figure 8: Taxonomy of Team Work Flows**

The study found the existence of group-level effects on performance even when task work was primarily independent, as in the pooled/additive model. However, as task interdependence increases there is a corresponding increase in the importance of teamwork processes, including coordination, communication and collaboration. Large teams will have aspects of multiple workflow models operating simultaneously. Teams may also adopt different models at various stages of development and project phases. However, most teams can identify a predominant workflow, which maps best to one of the four models for a given task or process. A recent study of task and outcome interdependence in work teams utilized an assessment instrument, which can be useful in evaluating existing teams (Appendix B).\(^{10}\)

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Eppinger, et. al describe a technique, the design structure matrix (DSM), for partitioning activities in product development based on task interdependence. An example DSM matrix is shown in Figure 9.

![DSM Matrix Diagram]

**Figure 9: Analysis of Task Interdependence using DSM**

The sequence of process tasks or activities is represented on both axes by the letters A through N. The presence of an "x" in an individual cell of the matrix indicates a precedence relationship between its corresponding tasks. Expressed another way, the tasks (columns) on which an individual activity (row) depends are indicated by annotating the corresponding cell. Annotations above the diagonal indicate that the activity requires information or input from a "downstream" task. This is the case for the Design production cartridge (G) and Design mold (H) tasks in the example matrix. DSM identifies tasks as being parallel (independent), sequential (ordered dependence) or coupled (interdependent). Coupled tasks require iteration or collaboration. The utility of DSM is not limited to product development projects. It can be extended to other types of teams and applied to the analysis or design of processes and team structure. As a process design tool, task sequencing can be modified to minimize coupling (i.e., forward

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dependencies). For large or complex projects, a de-coupled solution may not exist. In these cases, groupings of coupled tasks can represent a logical partitioning for team design.

One of the most useful tools for team process planning and coordination to be developed in recent years is the process map. Process Mapping was pioneered by Deming and adopted by Toyota in the 1960’s as a simple method for visualizing the flow and interaction of process elements.\(^{53}\) Sometimes referred to as “four-fields mapping”, this technique captures multiple process components in a single, easily understood model.\(^{54}\)

![Figure 10: Example Process Map for a Product Development Team\(^{55}\)](image-url)

\(^{53}\) Lipnack and Stamps, 1997, p. 205.
\(^{54}\) Dimancescu and Dwenger, 1996, pp. 80-86.
\(^{55}\) This process map is a screen shot from the Team Flow™ software program for Windows 95/NT. Team Flow is available from CFM Inc., Bedford, MA, http://www.teamflow.com.
These include: 1) the list of team members and stakeholders, 2) the process flow diagram, including milestones, phases and decision points, 3) individual roles and responsibilities and 4) team and process outputs. An example process map is shown in Figure 10 for a portion of a cross-functional product development effort.

Time is represented in the vertical dimension. The crosshatched left border indicates the current timeline status. The process flow (②) is represented by the interconnected boxes (process elements) and arrows from top to bottom. Responsibilities of individual resources (①) listed across the top of the page are indicated by the presence of process elements in their corresponding column (③). Team outputs are shown as document icons (④).

Complete process maps can typically be developed in a team effort in no more than two to four hours. Because the process mapping involves the cooperative identification and sequencing of tasks and the assignment of responsibilities, it provides an excellent tool for locating process pulse-points.

Capability

The capability component of the Team Process Model encompasses the processes and activities that ensure that the team has the necessary skill and knowledge to achieve its goals. This includes the broad categories of capability assessment, feedback and improvement. Lumsden & Lumsden refer to "cybernetic processes" within teams as measurement, feedback, assessment/observation and discussion, "methods that help open-systems with their own development and improvement."56 Specific assessment and feedback activities include monitoring, observing, measuring, evaluating, reviewing, critiquing and reinforcing. Mentoring involves many of these same activities. The results of assessment and feedback activities may be a validation or certification of team capabilities or the identification of capability gaps and/or improvement opportunities. Options for closing capability gaps include training, process improvement, expanding

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team membership and "outsourcing" tasks or functions through external contracting or collaborations. Capability improvement can occur when assessment is followed by reflective inquiry into the root causes of the performance gaps, i.e., team learning.

Learning

Team Learning is an integrating process in the sense that it is influenced by and influences all other team processes. A systems thinking approach to team learning ensures that improvements are designed with an integrated process perspective. According to Senge, team learning is the process of "aligning and developing the capacity of a team to create the results its members truly desire." Team learning processes begin with assessment and feedback but are more ubiquitous in terms of scope and influence than those mentioned in the previous section. In general, learning processes include reflective inquiry, feedback (giving, receiving and seeking), dialog and discussion. Learning teams need to be able to differentiate and purposefully move between the processes of dialog and discussion. Dialog is the process of temporarily suspending assumptions and allowing for the free flow of ideas. Dialog broadens the scope of communication to expand possibilities or enhance collective understanding. It does not, however result in any conclusion or closure. This is the function of discussion. Knowing when to shift from one to the other is critical to balancing creativity with productivity.

Team learning is a special form of organizational learning. Schön and Argyris define organizational learning as both the product (knowledge, understanding, expertise, techniques or practices) and the process of learning (acquiring, processing and storing information). As such, organizational learning is neither inherently good nor bad. They make the point that some types of learning can actually inhibit productive learning. Productive learning or instrumental learning refers to a team's deliberate improvement of its task performance over time. It requires a task of identifiable type (and objective), a

57 Senge, 1990, p. 236.
58 Ibid., pp. 249-250.
59 Peter Argyris, and Donald A. Schön, Organizational Learning II: Theory, Method and Practice, Addison-Wesley, 1996, p. 3.
measure of effectiveness, and an agent who seeks to improve performance through deliberate thought and action. This is the process of reflective inquiry. For organizational learning to occur, reflective inquiry must be accompanied by the codification of resulting knowledge into organizational memory (strategies, routines, practices & information systems). Such organizational task knowledge is what Schön and Argyris refer to as *theories of action.* There are two forms of theories of action: espoused *theory* is the publicly communicated theory which is given to explain or justify a given pattern of activity whereas *theory-in-use* is theory derived from the actual observation of behavior. An organization’s theories-in-use are often tacit rather than explicit. Furthermore, they may be different from the organization’s espoused theory. They may be tacit because practitioners are not capable of describing them or because open discussion in the presence of conflicting espoused theories would be threatening or embarrassing. This latter point gives rise to a major barrier to organizational and team learning, namely defensive reasoning and defensive routines.

Schön and Argyris also differentiate between types of learning based on the depth of team or organizational inquiry. *Single loop learning* involves the acquisition of knowledge applicable to first order problem solving (e.g. problem detection and correction). In contrast, *double loop learning* (DLL) goes beyond the immediate problem to ask basic questions about second order effects, problem/solution generalization and barriers to earlier detection. Single loop learning may actually inhibit DLL by masking the underlying causes through rapid short-term returns. DLL may challenge existing values, strategies and/or performance measures and is therefore often accompanied by conflict and defensive routines.

**Communication**

Communication is the second of the integrating processes. It is a basic requirement of all of the other team processes as both an enabler and a determinant of performance. Poor communication has been cited as one of the leading causes of problems in product

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development (Table 4: Teaming Problems in Product Development). Communication has been defined as "the process of using verbal and nonverbal cues to negotiate a mutually acceptable meaning between two or more people within a particular context and environment." This definition holds several important implications. Communication involves verbal and non-verbal information transfer processes. It is never an exact transfer; i.e., meaning is "negotiated" and dependent on the context and environment of both sender and receiver. Lastly, it may involve one-to-one or one-to-many relationships. In team contexts, both internal and external communications can be critical pulse-points. External communications will be discussed in the next section (Interfaces).

Internal team communications influence coordination effectiveness through the accuracy and timeliness of information flow. It effects the team climate and culture through the shared leadership processes of clarifying, encouraging, recognizing, promoting and involving. Communication processes are also critical to capability assessment and learning through feedback, dialog and discussion. Collaboration processes are highly influenced by the amount and effectiveness of communications. The negotiation of "mutually acceptable meaning" involves individual risk-taking; risk that is compounded in group situations due to the number of possible interpretations and consequences that can occur. When team members are unwilling to take on this risk, the team processes of dialog and discussion break down, reducing overall group effectiveness. Influence in decision-making, problem solving and idea generation shifts to the more assertive team members, rather than the most knowledgeable or creative.

Sociograms can be useful tools for assessing internal team communication patterns. The technique involves observation and encoding of individual and group interactions using a simple graphic notation which can subsequently be analyzed. Because it requires observation, it is best performed by an objective, non-participant during a meeting or group discussion. A sample sociogram for a group of five individuals is shown in Figure

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61 Lumsden and Lumsden, 1993, p.16.
62 Ibid., p. 16.
11. Each participant is represented by a circle with his or her initials. When an individual communicates to the group as a whole, a mark is made on an arrow from that person's symbol to the center of the graph. Marking an arrow from the sender to the receiver of the message indicates communications between two individuals. Instances of encouragement and interruption can also be noted by placing an "e" or "i" next to the originating member.

![Diagram of team interactions]

**Figure 11: Example Sociogram of Team Interactions**

The sample sociogram shows that MB was the most active communicator in the group, followed by DH. The group member who distributed the most encouragement was DD.

In addition to communication patterns, language has been cited as both a determinant and an indicator of team behaviors. The Team Talk Audit is a team effectiveness assessment tool developed by Anne Donnellon and based on her book, *Team Talk: The Power of Language in Team Dynamics.* The premise of the book and the assessment survey is that team behaviors, culture and mental models have identifiable manifestations in the team's language. The survey queries these "linguistic indicators" across six areas of team dynamics: identification (affiliation), interdependence, power differentiation, social closeness, conflict management and negotiation processes. The Team Talk Audit may be a useful tool for measuring and tracking team development and for problem diagnosis in

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permanent or long-lived teams. It would not be well suited from a cost of measurement or relevance perspective for ad-hoc teams or temporary teams of short duration.

Many team communication processes are non-verbal, asynchronous and increasingly based in information systems, Internet and group-ware technologies. Advancements in these areas have enabled and facilitated the growth of virtual teams. Electronic communications can have challenges involving latency, information overload\(^5\), inefficiencies in "negotiated meaning" (i.e., misunderstanding), and incompatibilities of format. But there are also many advantages. Electronic communications generally leave an auditable trail and can be self-documenting. Collaboration can take place across time and distance. Computer-aided graphical tools promote enhanced communication through modeling, visualization and simulation (e.g. CAD, CAM, project scheduling). Information and data can be shared rapidly with large numbers of people. The number of tools available for group communications is large and growing.

2.5.2.3 Interfaces

"The greatest leverage in system architecting is at the interfaces."\(^6\)

- E. Rechtin

Eberhardt Rechtin cites the critical role that interfaces play in system performance in this excerpt from his "principles of systems architecting." The principle often holds true for teams as well. Three types of team interfaces have been identified by Ancona et al.: influence, information and task coordination.\(^7\) The latter category has been covered above under the discussion of processes (section 2.5.2.1). Here we will focus on interfaces that control the flow of information (external communications) and influence (boundary management) between the team and the outside world.

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\(^5\) This phenomenon is relates to the difficulty in filtering or discerning relevancy and importance in new information due to its volume or rate of arrival.


Successful teams are open systems with respect to information, ideas and influence. This characteristic of teams creates interdependencies with external groups and individuals, which are commonly referred to as stakeholder relationships. Team stakeholders are those external individuals or groups: 1) who are most effected by the team’s process or performance, 2) whose knowledge, skills or services are necessary to the team process or 3) whose commitment to or satisfaction with the teams performance will determine team success.

It may be beneficial for a team to isolate itself from external distractions for short periods of intensive, focused task work. However, prolonged periods of isolation can be the downfall of teams that operate in rapidly or dynamically changing organizational and business contexts. Even in relatively stable contexts, maintaining frequent communications with important team stakeholders can have a significant influence on the team’s ability to gain cooperation, secure needed resources and even obtain proper credit and recognition for its accomplishments. It has been shown that a high degree of external interaction is positively correlated with performance for some types of teams. In a study of thirty-eight product development teams from high technology companies, Ancona and Caldwell observed twenty-four boundary activities or ways of interacting with external individuals and groups. From these activities, they identified four distinct boundary management categories: ambassador activities, coordinator activities, scout activities and guard activities.

Ambassador activities are primarily concerned with the management of “vertical” relationships (influence). They include reporting progress, securing needed resources, maintaining clear communication channels to key external suppliers and identifying and defusing external conflicts which pose potential threat to the team’s well-being. Coordinator activities are focused on ensuring that external resource and task dependencies are coordinated so that task work proceeds according to plan and

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milestones and objectives are met. These can be interfaces for the flow of both information and influence.

*Scout* activities are primarily information interfaces and can be critical to team success. Few teams encompass all of the information and knowledge needed to perform complex tasks within boundaries. Scout activities include general information gathering, locating resources and expertise, refining customer needs, external benchmarking and collecting competitive intelligence.

*Guard* activities refer to the control of information (and influence) outflow from the team. They maintain the mutual trust and cohesiveness of the team environment, promoting constructive conflict and openness. Guard activities also protect against the potentially damaging outflow of confidential or proprietary information from the team. Establishing information security standards and developing group norms for external communications are a few specific examples of guard activities.

A useful tool for capturing and visualizing the team's stakeholder relationships is the Team Influence Diagram. This technique was adapted from Zigon's Customer Diagram, which models the team's flow of products and services to its various customers.

![Figure 12: Example Team Influence Diagram](image)

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An example team influence diagram is shown in Figure 12 for a team chartered with the task of creating a web site and online catalog for direct sales of selected products. A more detailed analysis of boundary management activities can be achieved through the development of a stakeholder matrix. There are six general motivations for interacting with external individuals and groups. Is the objective to influence, inform, involve, get information, coordinate or get permission? The team stakeholder matrix (Table 9) captures the major stakeholders of the team along with the nature of the required interactions.

<table>
<thead>
<tr>
<th></th>
<th>Inform</th>
<th>Influence</th>
<th>Involve</th>
<th>Get Info</th>
<th>Coordinate</th>
<th>Get OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate IS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>VP Marketing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Existing Retailers</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Distributors</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 9: Team Stakeholder Matrix

Each instance of these boundary activities represents an interface between the team and the external environment. The relative importance of these interfaces will vary depending on the nature of the task, the team and the organizational context. For many teams, they may represent vital pulse-points.

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3. Team Performance Measurement (TPM)

Measurement is intrinsically related to the achievement of team goals and ultimately the team’s purpose. According to Katzenbach and Smith, "transforming broad directives into specific and measurable performance goals is the surest first step for a team trying to shape a common purpose meaningful to its members." Measurable performance goals, and by association, performance measures play several important roles which are outlined in the following section.

3.1 Role of Measurement in Team Performance

Design, deployment and execution of a performance measurement system can impose significant overhead on a team. Therefore, it is important to gain an understanding of the purpose and role of measurement in the context of the team’s overall objectives. This understanding is also necessary to ensure that the amount of effort expended does not exceed the expected benefits of the team’s measurement system.

3.1.1 Research and Advancement of Team Theory

Many models of team behaviors, processes and effectiveness have been developed but our ability to predict performance in practice has yet to be realized. Measurement is an essential step in validating and improving these models and in ultimately enhancing our understanding of teams to the point where we can confidently design-in the level of performance required for the task at hand. Baker and Salas cite the importance of teamwork measurement to the evaluation and elaboration of team theory noting that “unified theories of teamwork have been proposed but unified measures of teamwork have not.”

71 Katzenbach and Smith, 1993, p. 53.
3.1.2 Organizational Learning

Team learning is an essential component or discipline of organizational learning and performance measurement plays an important role. Dibella, Nevis and Gould (1996) cite ten facilitating factors for organizations as learning systems, including the following two directly related to performance measurement:\footnote{74}

1. Performance gap – The team has a shared perception of a gap between the actual and desired states of performance. Performance shortfalls are seen as opportunities for learning.

2. Concern for measurement – Effort is spent in defining and measuring key factors when taking on new work. The group strives for specific quantifiable measures; discourse over metrics is seen as opportunities for learning.

A key component of Schön and Argyris’ model of organizational learning is the process by which individuals or groups transform an observed “mismatch” between the expected and actual outcomes of the organization’s theories-of-action into reflective inquiry into the underlying causal relationships.\footnote{75} Measures can play an important role in making those mismatches visible to the whole team. The ability to recognize gaps in outcome related performance is a necessary but not sufficient prerequisite to team learning. As described by Schön and Argyris and elaborated in the team context by Senge, defensive routines may be present. Defensive routines are systemic, learned behaviors that surface to avoid individual embarrassment or exposure when mistakes are made or problems arise. They block the open communication required for reflective inquiry and constructive learning. This would suggest that measures designed to monitor the behavioral factors that influence defensive reasoning among team members would provide valuable feedback for organizational and team learning.

\footnote{73} Senge, 1990, pp. 233-269.
Finally, teams whose work processes represent a core competency of strategic importance (e.g. product development) often have expectations regarding organizational learning as an outcome but few take the time to establish related goals and measures.

### 3.1.3 Certification

Certification of entire teams is increasingly being done in situations where safety and/or consistently high, sustained performance is critical. Two areas where team certification is a common practice are the nuclear power and airline industries. Another perspective on certification comes from the Carnegie Mellon University Software Engineering Institute Capability Maturity Models (SEI-CMM). The CMM models present a method for assessment and certification of organization-wide process capability levels in several areas including software engineering, systems engineering and human resource management. The latter category, captured in their People Capability Maturity Model (P-CMM), includes a set of baselines for teamwork and team-based practices. P-CMM certification at level four requires the following measurement-related activities, among other criteria:

- Objective performance criteria are established and revised for each team.
- Teams define appropriate measures of their work products and processes.
- Team performance is evaluated on a periodic and event-driven basis.
- Continuous team development is based on analysis of the team’s performance.

### 3.1.4 Work Product Quality

Whether stated or implied, managers and customers have expectations for the acceptable quality of any product or service. Taking the time to translate the team’s mission and purpose into a set of outcome measures (specifications), which can then be validated by

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the customer, ensures that the team is headed in the right direction from the outset. As a system, the quality of the team’s work products is a function of the quality of its internal processes. Deming’s third principle on quality for management, “Cease dependence on inspection to achieve quality”, also applies to teams.  

Outcome measures are analogous to “inspection.” Process measures are necessary to ensure that quality is “built in” to the team’s products and services. If the team produces output in the form of products or services on an ongoing basis (e.g. automotive assembly line team, customer service team) then stakeholders will be interested in measures of both process and outcome quality and their trends over time.

3.1.5 Recognition and Rewards

Companies are increasingly using a combination of individual and team-based incentives and rewards. However, a recent survey of 300 large companies found that less than ten-percent were satisfied with their team-based compensation. The difficulty in designing and deploying objective measures of team performance and of individual contributions to team work, is surely a contributing factor. Linking the organization’s performance management system (i.e., performance evaluation and compensation) to TPM through individual performance expectations for teamwork behaviors is a simple first step. Results of a survey by the Association for Manufacturing Excellence (AME) of fifty manufacturing firms the U.S. and Canada reinforced the need for new approaches to team-based compensation. The most successful team reward programs identified included:

- Programs that closely tie individual’s base pay increases to their level of team contribution;
- Group incentive programs with measures that can be influenced by employees;

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80 Anonymous, Non-Financial Rewards Motivate and Drive Team Performance, IIE Solutions, March 1996.
• Individual and group recognition programs that recognize teamwork and team results.

The success of programs such as these rely heavily on the existence of valid, reliable and objective team performance measures.

3.1.6 TEAM SELECTION

Team membership changes are a common reality. People leave teams as a result of retirement, illness, job changes, promotions and sometimes intervention. Even in temporary teams, key individuals are pulled off to other projects and must be replaced. Periodic assessments of team and task performance at both the group and individual levels create a collective self-awareness of strengths and capability gaps. Whether the situation calls for addition or replacement, this knowledge of both team process and task specific needs is invaluable in selection and training of new members. The existence of specific performance goals and measures can also refine and extend the criteria for new member selection.

3.1.7 COMMON LANGUAGE

There is evidence that cross-functional teams benefit from the process of creating their own performance measurement system. The discussion, negotiation, prioritization and selection of meaningful measures creates a “common language” which is a necessary component of effective teamwork.⁸¹ The concept of a common language is also closely related to the presence of shared mental models within the team. Shared mental models have been recognized as a characteristic of successful teams,⁸² a criterion for effective teamwork⁸³, and a key component of team learning.⁸⁴

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3.1.8 TEAM DEVELOPMENT

Individual and team level feedback is essential to improving teamwork skills and overall team effectiveness. A team can assess and track its development through the use of team process measures enabling it to identify weaknesses and strengths, plan corrective actions and monitor results. Team assessment surveys and Multi-rater instruments are useful feedback tools for development purposes. Correlation of the survey responses with the characteristics of the various team phases described in section 2.4.1 can provide additional insights to help guide both team and individual development.

3.1.9 MOTIVATION

As previously mentioned, motivation is an important element of team effectiveness (Section 2.4.3, Table 4). Katzenbach and Smith address the issue of motivation in high performance teams, citing the importance of specific measurable performance goals in providing the team with opportunities for small wins “invaluable to building members’ commitment.” A useful framework for thinking about motivational factors in a team context is offered by McClellan motivation theory. The theory proposes three motivational drivers of individual behavior: affiliation, power and achievement. All of these drivers can be positively influenced by the right performance measures and by the process itself. According to McClellan:

"Achievers" have a need for measurable and impactful personal accomplishment; they seek out challenges and competitive situations. They want to out-perform others, and often set their own standards and measures. They love unique accomplishments, and are not above bending the rules in order to succeed. Achievers will usually set specific and observable life-goals, and have a plan to achieve these goals over several years.

Thus, to the degree that individual team members are concerned with achievement,

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45 Katzenbach and Smith, 1993, p. 54.
choosing the right measures can enhance the motivational content of the team’s purpose and task work. Furthermore, the absence of team and process measures may promote individual behaviors that undermine team performance.

The collaborative process of creating team performance measures has a positive influence on affiliation as a motivational driver. As mentioned previously, common language and shared mental models of performance are developed during this process. This in turn results in enhanced cohesiveness and affiliation.

Power-seekers are often cited as disruptive influences in team settings. They may hold personal goals above those of the group when team success is not easily correlated to individual recognition or influence. Too often the lack of commitment and non-supportive behavior does not surface until late in the team process. However, power-seeking members can be valuable assets once they are committed to the team’s purpose. Defining specific performance goals and measures early in the teaming process helps to clarify the purpose and potential impact of the team’s success. This should reinforce and/or surface individual levels of commitment at a time when constructive dialogue is less likely to be impeded by defensive routines.

3.1.10 FEEDBACK

Team performance measures can provide feedback on product and process quality as well as overall progress toward goals. Feedback is essential for situational awareness, capability assessment, problem diagnosis, intervention and remediation. From a systems perspective, TPM can be thought of as the team’s feedback and control mechanism. Figure 13 shows a simplified feedback model for a single process output.

![Figure 13: Simple Feedback System](image-url)
An effective feedback system provides the operator with timely, relevant information on the critical parameters and indicators of the overall health of the process it supports. Similarly, an effective TPM system provides timely feedback on the effectiveness of team processes and tasks. Team processes that are recurring or continuous in nature can benefit from feedback. Useful feedback measures might include meeting effectiveness, customer response time or team “climate” assessments. It should be noted that TPM as a control mechanism, can suffer from the same types of problems (e.g. latencies, under and over-damped responses) as production control systems in achieving steady-state performance. Understanding process dynamics and variability is critical to the development of effective interventions and may be an initial objective of the measurement in itself.

The above roles and objectives of team performance measurement can be divided into two categories based on the recipient or end-user of the (Table 10).

*Externally Focused* roles provide some incremental benefit beyond the team’s primary objective and should be counted as secondary work products of the team. *Internally Focused* roles provide the team itself with information that helps the team to reach its goals.

<table>
<thead>
<tr>
<th>End-User of Measurement</th>
<th>Purpose of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>External to Team</td>
<td>Team Research &amp; Theory</td>
</tr>
<tr>
<td></td>
<td>Organizational Learning</td>
</tr>
<tr>
<td></td>
<td>Team Certification</td>
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<tr>
<td></td>
<td>Product Quality</td>
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<td></td>
<td>Recognition &amp; Rewards</td>
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<tr>
<td>Internal to Team</td>
<td>Team Selection</td>
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<td></td>
<td>Team Development</td>
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<td></td>
<td>Common Language</td>
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<tr>
<td></td>
<td>Motivation</td>
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<tr>
<td></td>
<td>Feedback</td>
</tr>
</tbody>
</table>

Table 10: Classification of Measurement Objectives

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3.2 TPM Frameworks

3.2.1 Types of Performance Measures

There are as many ways to classify team metrics as there are teams. Three perspectives are described below, 1) static, motivational and dynamic; 2) individual and team; and 3) outcome and process measures.

3.2.1.1 Static, Motivational and Dynamic Measures

Dimancescu and Dwenger suggest a framework for product development team metrics based on the role of the measurement. Static measures deal with attributes of the team’s output or products. They are static in the sense that they are collected “after the fact” and offer information only on what the team produced. They do not provide insight into how the results were achieved. Static measures are of primary interest to external stakeholders such as management and customers. Dynamic or predictive measures are indicators of direction or progress toward the team’s goals. They are process-oriented measures of primary interest to the team itself. However, they may have secondary interest to external stakeholders when boundary conditions signal the need for intervention. The ideal predictive metric should provide quick feedback and have low complexity. Motivational metrics support a continuous improvement philosophy. They may be process or product oriented but reflect goals that are based on a planned series of performance improvements from a baseline condition. Examples of motivational metrics include: 10X cycle time reduction at Eastman Kodak; six-sigma defect levels at Motorola; and Analog Devices’ improvement “half-life” metrics.

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69 John Carter, in a presentation at the International Association for Product Development (IAPD) workshop on metrics, September, 1991.
3.2.1.2 Individual and Team Measures

It is well understood in systems theory that optimum system performance is not attained by the sum of local optima. Likewise, team performance must be assessed systematically (holistically) rather than as an aggregate of individual measures. For the most part, a team’s output can be measured objectively and independently of individual considerations. However, some team level performance criteria can only be measured through the aggregation of individual level measurements. Measures of team cohesiveness and collective team member satisfaction fall into this category. When aggregating individual responses into a team level assessment, measurement reliability and construct validity issues must be considered (see section 3.3.3). Team measures build mutual accountability, provide system-level feedback and promote a holistic perspective of team performance. Individual performance measures reinforce team member accountability and provide feedback needed for learning and personal growth. In general, it is recommended that teams use a combination of team and individual measures.

3.2.1.3 Outcome and Process Measures

The statement of systems theory in the previous section applies equally well to the relative importance of outcome and process measures. Their definitions correspond closely to Dimancescu and Dwenger’s static and dynamic/predictive measures respectively. Outcome measures reflect the terminal objectives (results) of the team, whereas process measures are designed to assess the team’s instrumental objectives (intermediate goals). Both outcome and process feedback have been cited as critical to team performance improvement. Feedback associated with outcome measures, sometimes referred to as “knowledge of results”, can be directive and motivational but is not necessarily informative. Outcome measures are not “diagnostic”; i.e., they do not

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90 For more on this topic, see various works of E. M. Goldratt, e.g. The Goal, (2nd ed., 1992), Critical Chain (1997), It's Not Luck (1994), North River Press, Great Barrington, MA.
indicate the underlying causes of performance variability. In contrast, the purpose of process measures is to be predictive, diagnostic and informative. Process measures should only exist while they are useful and should be linked through team control mechanisms to effect changes to the appropriate strategies, plans, processes and behaviors.

3.2.2 TEAMWORK MODEL

Dickinson and McIntyre propose a framework for teamwork measurement based on seven behavioral characteristics of effective teams (Figure 14): Team Orientation, Team Leadership, Monitoring, Feedback, Backup, Coordination and Communication.

![Diagram of Dickinson & McIntyre's Teamwork Model]

**Figure 14: Dickinson & McIntyre's Teamwork Model**

*Team orientation* refers to individual team member attitudes toward each other and the team task. This includes: collective efficacy, the belief in the team’s ability to perform the task; group cohesiveness and affiliation; mutual accountability for group goals; and commitment to the team’s purpose and process.

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93 Cannon-Bowers and Salas, 1997, p. 54.
Team leadership goes beyond the existence of a designated “team leader” role. It includes such “leadership” behaviors as mentoring, guiding, coordinating, motivating and supporting, whether they reside in one or multiple members of the team.

Monitoring behaviors result in a mutual awareness of individual team members’ competence and performance enabling one-to-one feedback and intervention as needed.

Feedback is the process by which information concerning group and team performance is disseminated within the team. It involves the willingness of individual members to offer, request and accept performance feedback.

Backup behaviors refer to individual team members’ willingness and ability to assist one another as the need arises. It is closely related to the mentoring role.

Coordination relates to the interdependence of individuals, resources and tasks. Measures include the efficiency, timeliness and quality of intermediate work products, data and information.

Communication involves the reliability, accuracy and comprehensibility of information exchange between two or more team members.

Dickinson and McIntyre’s implementation of the Teamwork Model involves the use of expanded standard definitions of the above criteria together with observational scales and independent, objective raters.

3.2.3 Team Performance Matrix

Cannon-Bowers and Salas recognized the need for measures that reflect multiple levels of analysis (team and individual) and consider outcome as well as process characteristics in team training assessment.∗ The framework was intended for developing TPMs in training but can easily be extended to cover a broad range of team contexts (Table 11).

∗ Cannon-Bowers and Salas, 1997, p. 56.
<table>
<thead>
<tr>
<th>TEAM</th>
<th>INDIVIDUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Shared Task Models</td>
<td>• Assertiveness</td>
</tr>
<tr>
<td>• Strategy Association</td>
<td>• Information Exchange</td>
</tr>
<tr>
<td>• Task Organization</td>
<td>• Roles &amp; Responsibilities</td>
</tr>
<tr>
<td>• Compensatory Behavior</td>
<td>• Procedures for Task Accomplishment</td>
</tr>
<tr>
<td>• Collective Efficacy</td>
<td>• Strategy Association</td>
</tr>
<tr>
<td>• Dynamic Function Reallocation</td>
<td>• Mutual Performance Monitoring</td>
</tr>
<tr>
<td>• Task Interaction</td>
<td>• Flexibility</td>
</tr>
<tr>
<td>OUTCOME</td>
<td></td>
</tr>
<tr>
<td>• Goal Accomplishment</td>
<td>• Accuracy</td>
</tr>
<tr>
<td>• Aggregate Latency</td>
<td>• Latency</td>
</tr>
<tr>
<td>• Error Propagation</td>
<td>• Errors</td>
</tr>
<tr>
<td>• Aggregate Accuracy</td>
<td>• Safety</td>
</tr>
<tr>
<td></td>
<td>• Timeliness</td>
</tr>
<tr>
<td></td>
<td>• Decision Biases</td>
</tr>
</tbody>
</table>

Table 11: Cannon-Bowers and Salas' TPM Development Matrix

The framework facilitates the selection of appropriate attributes for measurement from a set of knowledge, skill and attitudinal competencies (KSAs).

3.2.4 Holistic TPM Framework

In this section a holistic framework for team performance measurement is presented (Figure 15). The holistic framework is based on a balanced view of team outcomes and processes from both internal and external perspectives. In this respect it is similar to Kaplan and Norton’s Balanced Scorecard approach to business and organizational measurement. The Balanced Scorecard incorporates traditional financial results along with measures from customer, internal business process and learning & growth perspectives into a framework for evaluating both short and long-term strategies. Similarly, the TPM framework incorporates measures of performance, process effectiveness and growth.

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Figure 15: Holistic TPM Framework

Team success is defined by performance against goals and measures in each of the three dimensions:

**Performance** – attributes of the team’s results or products, e.g., quality, quantity, timeliness, accuracy, cost and stakeholder satisfaction.

**Growth** – organizational learning as codified by the team in knowledge artifacts, e.g., innovation, transferable skills, documented learnings, best practices, tools, procedures, methods, process improvements and principles.

**Effectiveness** – characteristics of task and teamwork processes, e.g., behaviors, skills, attitudes, leadership, collaboration, coordination, and communication.

The outer regions of the conceptual model represent three team perspectives and their relationships to each other and to the three dimensions of team success:

**External Perspective** – This is perspective of team’s stakeholders and its organizational context. The external perspective is primarily concerned with and influenced by the teams outputs, growth and performance. In addition, the external perspective influences team process and team learning via feedback and organizational culture.
Team Process Perspective – The internal process perspective is concerned with both performance and effectiveness. Team process influences and is influenced by the external perspective through team performance and external performance feedback respectively. Team process effects team learning through norms, behaviors, roles and team culture, e.g. openness, communication patterns, reflective inquiry, defensive reasoning.

Team Learning Perspective – It has been said that teams naturally integrate performance and learning. This is true to the degree that the team process and its organizational context support a learning orientation. Team learning has a direct influence on team process through new skills, tools and practices that improve effectiveness. It has external influence to the extent that internal learning is translated into persistent organizational learning, i.e., growth. In some cases this can be a natural consequence of the team process but more often, meaningful organizational learning requires a proactive and concerted effort by the team.

The TPM Framework can also be viewed as a cyclical process of goal development, measurement and refinement (Figure 16):

1) The TPM Cycle is initiated from the External Perspective where the team purpose is clarified and translated into performance goals and measures.

2) Performance Goals drive and focus the internal perspective on the development of the team’s common approach, its processes, tasks, norms, roles & responsibilities.

3) The Team Process determines the pulse-points that must be monitored to ensure that the team is on track and in good health. This takes the form of Effectiveness measures and goals.

4) Effectiveness shortfalls or gaps drive the Team Learning Perspective where they are translated into opportunities for process improvement or learning.

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97 Katzenbach and Smith, 1993, p. 5.
5) The Learning Perspective selectively sets Growth goals in measurable terms that require the translation and formalization of team learning into organizational learning.

6) Growth and organizational learning has a cumulative effect on the External Perspective over time. Organization, customer and the team’s own expectations and confidence in their capabilities are elevated resulting in more ambitious missions, objectives and performance goals.

![Figure 16: The TPM Cycle](image)

The TPM Cycle is a framework for continuous improvement and organizational renewal. The continuous improvement phenomenon was recognized by Art Schneiderman, while VP of quality at Analog Devices in 1987. He noticed a persistent trend in the company's quality improvement data that showed a 50 percent reduction in defect rates every three months over a ten-year period for the dip soldering process. Schneiderman referred to this three-month interval as the improvement "half-life" of the process. More importantly, he found that a similar half-life period could be identified for a widely diverse sampling of manufacturing and business processes. Once identified, the half-life metric could be used for performance prediction and goal setting. High level

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determinants of process half-lives were found to be: 1) organizational complexity and 2) technical complexity. Table 12 illustrates this relationship.

<table>
<thead>
<tr>
<th>Organizational Complexity</th>
<th>Half-Life (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>14</td>
</tr>
<tr>
<td>Medium</td>
<td>7</td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 12: Prediction of Learning Half-life by Complexity

3.3 Systems Approach to Team Performance Measurement

The following sections present a systems approach to the design of team performance measurement systems based on the Holistic TPM Framework and an architectural perspective of team performance. The sections are organized into three main topic areas: 1) organizational context, 2) measurement system and 3) measures and metrics. Throughout the discussion, a set of twenty-five principles or heuristics, referred to as TPM Principles are presented. The list of individual principles can also be found in Appendix C.

3.3.1 ORGANIZATIONAL CONTEXT

Organizational context can have a significant influence on the success or failure of a team’s efforts to develop and implement effective performance measures. The components of organizational context that relate most strongly to team performance

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100 Ibid., p.96.
measurement are organizational goals, performance management systems,\textsuperscript{101} culture, and rewards & recognition.

3.3.1.1 Purpose, Goals & Alignment

"Perfection of means and confusion of goals seem—in my opinion—to characterize our age."\textsuperscript{102} - Albert Einstein

The first step in designing the performance measurement system comes during the initial phase of team development. Too many teams, in an effort to "get moving", place insufficient emphasis on clarification of the team's purpose and the development of specific, measurable goals. This is reflected in the findings of both the Wake Forest study of problems in product development teams (Table 4, p. 31, problem #2) and the study of common team barriers by Snee et.al. (Table 5, p. 31, barrier #3). A common, meaningful purpose and specific shared performance goals are basic elements of the team approach.\textsuperscript{103} They also set the foundation for team performance measurement. The team's purpose is normally a product of its organizational context. Whether formally specified in a team charter or a shared vision spawned from a recognized need or opportunity, the purpose is what brings the team together. In it's initial form, the team may have characteristics closer to a working group than a real team. This is the time to clarify the team purpose for all involved.

TPM Principle #1: Start with a clear, common understanding of the team's purpose.

The process (storming) may result in one or more group members' departure. Whether or not this is the case, a reevaluation of the team's composition may be appropriate now that the purpose has been clarified. It is essential that core membership is stabilized to the

\textsuperscript{101} Performance management as used here is defined as the combination of the organization's set job of expectations, goal-setting process, performance evaluation and compensations systems.

\textsuperscript{102} Albert Einstein, Out of My Later Years, Philosophical Library, New York, 1950.

\textsuperscript{103} Katzenbach and Smith, 1993, p. 45.
extent possible, early in the team process and prior to goal development. Performance goals represent the desired tangible outcomes of the group’s collective efforts.\textsuperscript{104} The process of defining specific performance goals crystallizes the team purpose and builds commitment and mutual accountability for the team’s success. For that reason, it is important for the core team to be active participants in goal development.

TPM Principle #2: Each member of the team should be an active participant in the development of specific team performance goals.

Performance goals by themselves can provide significant motivational value but to be actionable, i.e., to be useful in an operational sense, they must be measurable. The absence of clear, measurable goals was listed among the nine common barriers to team progress (Table 5, p. 31, barrier #4). In the simplest terms, measures are needed to let the team know when it is finished or when the quality of its output meets the specifications or minimally acceptable standards set by its customers, stakeholders or the team itself.

TPM Principle #3: Each performance goal identified by the team must have a corresponding measure.

Performance goals provide links to the sponsoring organization(s). In ideal situations, the team’s goals align easily with organizational goals. However, in cross-functional, cross-organizational, virtual and joint venture teams goal misalignment and conflict can be an issue (see Table 5: 9 Common Barriers to Team Progress, p. 31, barrier #8). To ignore goal conflict and press onward in these situations invites disaster for the team downstream. Likewise, modifying the performance goals solely to satisfy external interests may compromise or weaken their relationship to the team’s purpose. When goal alignment is not possible, the discussion must be elevated to include all stakeholders, at which time the team purpose and goals can be rationalized.

\textsuperscript{104} In this section, “performance goals” refers to the output of the team from an external perspective as distinguished from effectiveness or growth goals consistent with the Holistic TPM Framework.
TPM Principle #4: Team performance goals and measures should be aligned or rationalized with those of each stakeholder and organization represented within the team membership.

A practice recommended by management consultant, Jack Zigon is for the team to review existing organizational measures as the first step in designing team performance measures.\textsuperscript{105}

3.3.1.2 Links to Performance Management Systems

Measures of team performance may have utility beyond the borders of the team. In particular, organizational performance management systems will value objective measures of team contributions and individual teamwork behaviors. The existence of individual job expectations that include team-oriented behaviors helps to create a supportive context for team creation and operation. Team performance measures which are linked to team-based compensation, rewards and incentives, are negotiated and agreed to by the team and understood by each team member, can reinforce the importance of the team’s purpose and enhance team motivation and accountability. The temptation may exist to make certain measures dual-purpose, serving both the team and the organization’s processes. But teams should try to maintain functional independence of individual metrics, at least where potential conflicts exist. For example, an assessment of teamwork behaviors might be made to set a baseline for improvement or diagnose performance problems. The results could also be used for individual and team performance evaluation to determine compensation and rewards. However, knowledge of the assessment’s dual role would likely influence the nature of the individual responses, reducing the validity and effectiveness of the measurement. In general, teams should avoid the following uses of effectiveness measures:\textsuperscript{106}

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• as a basis for disciplinary measures
• to measure goals other than those of the team
• to rank team members or promote competition

TPM Principle #5: Maintain the functional independence of measures whenever possible to avoid conflicts.

3.3.1.3 Cultural Barriers

The team’s organizational context and culture can have a significant influence on the way individuals and the team as a whole approach measurement. Hackman and Walton identified two types of organizations based on management strategies and culture: control strategy organizations and commitment strategy organizations\(^{109}\). Control strategy organizations are traditional hierarchical structures in which power and status is reinforced through tightly controlled, vertical reporting relationships. A set of clearly defined work expectations, antecedents and consequences support these superior-subordinate relationships. Control strategy cultures do not typically foster trust, collaboration, teamwork or shared goals. However, that does not prevent them from creating teams and chartering them with ambitious missions. These teams must create a “counter-culture” that supports the team process elements lacking in the sponsoring organization. They also must overcome management’s reluctance to relinquish control and authority to the group. Team performance measures can play several important roles: 1) Clarifying the team’s purpose; 2) Assessing and building mutual accountability 3) Motivating performance and commitment and; 4) Providing management with objective indicators of progress and performance.

TPM Principle #6: In control-oriented organizational and cultural contexts, teams should co-develop performance and task process measures with management.

Commitment strategy organizations are flatter, utilize teams at multiple levels and foster trust-based collaborative relationships with a focus on process and product quality. They empower lower levels with the necessary decision authority and means to design and improve their own work-processes. A commitment-based culture is one that encourages goal-setting, alignment and tracking at all levels, where performance measurement and assessment is an integral part of all business processes and continuous improvement is the overarching objective. Teams with this organizational context will have little trouble getting started and will find goal-setting and group performance measurement a natural part of the teaming process.

TPM Principle #7: In commitment or performance-based organizational contexts, teams can put more focus on performance and task process measures relative to teamwork process measures.

Most modern organizations are in transition and lie somewhere in between the two extremes. The main point is to recognize and account for the organizational and cultural context in the design of the team's performance measures and measurement system.

The above discussion deals primarily with teams within organizations. Cultural barriers are often present in teams that are formed across organizational, corporate or geographic boundaries. Cross-functional project teams, joint venture teams, and international business teams are a few examples. The same performance measurement roles exist for these teams as for the counter-culture teams described above. An additional function of performance measures in cross-cultural teams is the development of a common language and shared mental models of performance (section 3.1.7).

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106 For more information on how to transform organizational culture to one that supports teams, see: Jocalyn Sherriton & James Stern, Corporate Culture/Team Culture: Removing the Hidden Barriers to Team Success, AMACOM, New York, 1996.
TPM Principle #8: Where cultural barriers exist within team boundaries, focus early on defining goals and measures and include periodic team process assessments.

3.3.1.4 Rewards & Recognition

The role of team performance measurement in rewarding and recognizing exceptional team performance was discussed in Section 3.1.5. As mentioned above, team performance measures that are linked to rewards and incentives can reinforce the importance of the team’s purpose and enhance team motivation and accountability. Conversely, reaching an important team milestone or surpassing a significant performance goal only to find organizational apathy can be disillusioning and demotivating to team members. To avoid this situation, performance goals should be reviewed and appropriate recognition negotiated up front with management sponsors. The agreement should be as specific as possible with respect to the criteria, timing and nature of the incentive, reward or recognition and clearly communicated to and understood by the team.

TPM Principle #9: The positive consequences of meeting or exceeding performance goals, in terms of recognition, rewards and incentives should be negotiated up front with team sponsors.

This can also be a good time to get agreement on a small discretionary budget for the team’s internal recognition and reward or R+ purposes.\textsuperscript{109}

3.3.2 Measurement System

Team performance measures do not exist as independent entities. They should be designed as part of an integrated system of measurement, feedback, learning and improvement and an integral component of the team process. From this perspective, the
TPM system is the implementation of the team learning process. The following sections discuss this concept in more detail along with three other important characteristics of the system: size – system scope and scale; context – integration with the team process; and output – communication of results.

3.3.2.1 TPM System as the Team Learning Process

The purpose of any measurement is to provide information needed to act, decide or inform. Measurement in a team context is no exception. For team measures to serve any purpose, they must be part of a process designed to enact change, drive decision-making or communicate results. As discussed in Section 3.1.10 and illustrated in Figure 13, feedback is the process by which measures are linked to action. When the feedback process includes reflection, learning can occur. Process adjustment becomes process improvement. When the reflection process takes on a long term or external perspective, team learning can be translated to organizational learning and growth. Figure 17 shows the measurement system as a learning process.

TPM Principle #10: Measurement must be linked to action through a process of feedback, reflection and improvement.

Figure 17: TPM/Team Learning System Model

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This simple model illustrates the major process components of the TPM/Team Learning system: Measurement, Reflection and Improvement. It also shows the relationships between the system and the three components of the Holistic TPM Framework: Performance, Effectiveness (team process) and Growth.

3.3.2.2 System Scope and Scale

The scope of the measurement system refers to the breadth of factors, conditions or dimensions that it is designed to address and the set of functions that it must perform. The later perspective was covered in the previous section. The scope of the system with respect to the dimensions of measurement has also been addressed. The TPM framework suggests that the elements of team success include performance, effectiveness and growth.

TPM Principle #11: A balanced TPM system includes measures of performance, effectiveness and growth.

The scale of the measurement system relates both to the total number of measures and the cumulative amount of effort expended. As mentioned previously, performance, process and learning goals and measures should be established in proportion to the scale of the team’s task and timeline. The team should select a balanced set of meaningful and useful metrics. But proliferation of measures can have a diluting effect on team goals and a defocusing effect on the team purpose.

TPM Principle #12: The team should focus on a small set of meaningful metrics.

Right-sizing the team measurement system begins with the identification of team goals and measures without initial concern for their numbers. The high level process described by the TPM Cycle (Figure 16) should be followed. Performance goals and measures should drive the development of the team process and effectiveness measures, which in turn will facilitate the development of learning and growth goals and measures. It may be helpful to manage the number within the three dimensions to between two and four goals and measures each. Once the team has completed the first pass through the cycle, a
weighting or ranking process should be used to prioritize the list of goals within each dimension.

The scale of the measurement system can be managed in several ways:

- Discard or put low-priority goals and measures on hold.
- Keep all goals but decide to apply certain measures only as needed. If this course is taken, rules or conditions for measurement should be developed.
- Partition goals and measures by sub-teams, project phases or stages of team development.
- Adjust the timing or sampling frequency of individual measures.

The result will be a balanced team scorecard that will serve as the team's control panel as well as its strategic framework.

TPM Principle #13: The size of the TPM effort can be managed through goal prioritization, followed by selectively discarding, suspending, scheduling or reducing the frequency of measurement.

3.3.2.3 System Integration

The system model presented in Figure 17 was not completely accurate. For illustration purposes, the TPM/learning process was shown outside the team process. In practice the measurement system is a sub-process of the team process. It must be tightly coupled to and integrated with the team's internal processes. The model also "hides" the measurement planning process within the team process. When the planning process is inserted into its proper location the learning system closely resembles the Deming or PDSA Cycle (Figure 18).\footnote{Deming (1986), p. 88.}
**Figure 18: Comparison of the TPM System and Deming Cycle**

In the PDSA Cycle, actions are planned, initiated, and then studied to determine if the action has driven the organization toward its objective. The information is then used to initiate new action. In the TPM Cycle, planning involves the development of balanced goals and measures. Deployment of the measurement system is integrated and coincides with the deployment of team and task processes.

An important aspect of the PDSA cycle is a systematic and regular review process. It has been found that performance measures that include a scheduled review process are more effective in driving performance than those without planned review points.\textsuperscript{111}

TPM Principle #14: The measurement system should include a planned review schedule for each measure.

When performance measurement is an afterthought or perceived as a lay-on by management, measurement system integration is difficult and disruptive to team processes. It is usually accompanied by a lack of perceived value and low commitment to use the measurement results. For this reason, it is important incorporate the measurement and review processes into the team approach (processes, tasks, roles and responsibilities) as it is being developed.

TPM Principle #15: Include measurement and review tasks when developing the team approach to ensure integration with the team process.

TPM Principle #16: The core team should be participants in the entire process of TPM system design, integration and deployment.

This not only ensures process integration but also helps maintain the relationship between the measurement and its purpose. In this way, measurement becomes a natural part of the team process. Furthermore, commitment to the team approach implies commitment to the measurement system.

A final system integration issue concerns responsibility and accountability for the measurement process. While the team has ownership for the overall system, it is important that individual team members have responsibility for specific measures. These are explicit team roles, which go beyond the measurement process to include the entire TPM cycle for a specific team goal and measure. The role does not include responsibility for the results of the goal or measure. It does include the timely, accurate acquisition of measurement data, its presentation and communication to the rest of the team, and proactively leading the team in the identification and resolution of gaps and improvement opportunities.

TPM Principle #17: Define “Goal Steward” roles to assign individual responsibility for the measurement, communication and improvement tasks associated with each goal.

To maintain mutual accountability for and shared commitment to the team process and purpose, and to avoid overburdening any single individual, these “goal stewardship” roles should be distributed among multiple team members.

TPM Principle #18: Ensure mutual accountability and balance workload by distributing or rotating individual Goal Steward roles across multiple team members.

The use of a Team Measurement Matrix such as the one shown in Figure 19 can help the team keep track of important details of its measurement system and provide a quick reference for planning team meetings and communications.
<table>
<thead>
<tr>
<th>Goal/Objective</th>
<th>Measure</th>
<th>Timing/Frequency</th>
<th>Next Review</th>
<th>Steward</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>On time delivery</td>
<td>% milestones met on schedule</td>
<td>Quarterly</td>
<td>Q1 review</td>
<td>GM</td>
<td>Management team, Marketing</td>
</tr>
<tr>
<td>Stakeholder satisfaction</td>
<td>C/S MRA survey</td>
<td>week after gate reviews</td>
<td>Q1 review</td>
<td>MP</td>
<td>Program sponsors</td>
</tr>
<tr>
<td>Meeting effectiveness</td>
<td>% agenda items covered</td>
<td>all team meetings</td>
<td>2/15</td>
<td>JK</td>
<td>Team</td>
</tr>
<tr>
<td>Team Learning</td>
<td># of documented learnings from GRs</td>
<td>Quarterly</td>
<td>Q1 review</td>
<td>DH</td>
<td>next generation and peer product teams</td>
</tr>
</tbody>
</table>

Figure 16: Example Team Measurement Matrix

Each measure should be listed along with its associated goal or objective, the timing and frequency of measurement, the review period or date, the individual responsible and the individuals or groups who are influenced by and/or should be informed of the results (stakeholders).

3.3.2.4 Communication of Results

Effective communication of measurement system results can be as critical to team performance as the measures themselves. Many, if not all of the roles of measurement, discussed in section 3.1, depend on the timely, comprehensible and accurate communication of results.

Measurement results must be easily understood to all team members and stakeholders. Referring back to the definition of communication presented earlier, the "negotiation of a mutually acceptable meaning" is critical to invoke an appropriate response. Data should be formatted with both the measurement purpose and the receiver's "context and environment" in mind. Standardization of reporting formats can save time and increase the consistency of internal and external communications. To borrow another quote from Einstein, communications should be “as simple as possible, but no simpler.” A simple form like the Balanced Team Scorecard shown in Figure 20 can be an effective tool for communicating high level results to the team and stakeholders in a concise manner. However, problem-solving and analysis processes will likely require more detailed presentations of individual measurement results. Tools such as spreadsheets, control charts, histograms, scatter plots or Pareto charts may be needed to convey information in a useable form.
<table>
<thead>
<tr>
<th>GOALS</th>
<th>MEASURES &amp; TARGETS [Min, ME, EE]</th>
<th>WT</th>
<th>RESULTS</th>
<th>ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE</td>
<td>Product development cycle-time</td>
<td>Time to market (weeks) [48, 42, 38]</td>
<td>20</td>
<td>On track for week 40.</td>
</tr>
<tr>
<td></td>
<td>Product/process quality</td>
<td>Defect rate (DPMO) [150, 100, 75]</td>
<td>25</td>
<td>Current pilot runs at ~200.</td>
</tr>
<tr>
<td></td>
<td>Customer Satisfaction</td>
<td>Product return rate (per 10^3) [&lt;50, &lt;30, &lt;10]</td>
<td>15</td>
<td>Beta test scheduled week 32-34.</td>
</tr>
<tr>
<td>EFFECTIVENESS</td>
<td>Concurrent engineering effectiveness</td>
<td># of ECO's generated after gate 4 [&lt;12, &lt;6, &lt;2]</td>
<td>15</td>
<td>current ECO count = 4</td>
</tr>
<tr>
<td></td>
<td>Team meeting effectiveness</td>
<td>Meeting effectiveness survey score [scale 1-10]</td>
<td>5</td>
<td>4th quarter average = 6.8</td>
</tr>
<tr>
<td></td>
<td>Schedule risk management</td>
<td>Critical path buffer remaining (days)</td>
<td>10</td>
<td>week 32: total = 7 days</td>
</tr>
<tr>
<td>GROWTH</td>
<td>Improve effectiveness of gate reviews</td>
<td>Reduce time spent in meeting &amp; follow-up. Baseline from historical gate review data, if available. [% of baseline, # of best practices identified]</td>
<td>10</td>
<td>Gate 3 review: 55% of baseline. Two best practices documented.</td>
</tr>
</tbody>
</table>

Figure 20: Example Balanced Team Scorecard

Timeliness of measurement communications is particularly important for dynamic and motivational measures. To be useful to the team, measurement feedback must follow the stimulus within a time frame that allows for a meaningful response. For example, reporting the results of a team member satisfaction survey during project ramp-down will likely have little influence on team performance.

TPM Principle #19: Measurement results should be made available as soon as possible after the event to allow for timely response.

The importance of systematic, regular reviews of team measures was mentioned previously. It may be helpful to partition outcome (performance and growth) and process effectiveness measures into separate review meetings. For longer term (>9 months) or permanent teams this may correspond to quarterly and weekly or monthly reviews respectively. When process measures are reviewed, the focus of the meeting is on analysis, planning and tracking of improvement plans. In quarterly reviews, the focus is
on the achievement of the team purpose and goals. Selected process measures may also be reviewed at quarterly reviews as they relate to or illuminate problems or gaps in overall team performance.

3.3.3 Measures & Metrics

"Not everything that counts can be counted, and not everything that can be counted counts."  - Albert Einstein

Einstein's famous quote points out an important limitation and a word of caution concerning team measurement. That is, not everything of importance to the team may be quantifiable and the existence of a quantifiable attribute does not necessarily mean that it is worth measuring. As the team develops its metrics, these points should be kept in mind. There's no reason to paraphrase genius:

TPM Principle #20: "Not everything that counts can be counted, and not every thing that can be counted counts."

In Deming's terms, good metrics must have an "operational definition". That is, one that "people can do business with."  Art Schneiderman, originator of the half-life metric, makes the following distinction between measurement and metrics:

"Measurement applies to anything that has a quantifiable characteristic. A metric, on the other hand, is a quantifiable characteristic one can manage against."

The International Council on Systems Engineering (INCOSE) defines a metric as:

"A mathematical composition of relevant, quantifiable, product or process attributes (measures) taken over time that communicate important information about quality, processes, technology, products, projects and/or resources."

112 Hacker and Brotherton, 1998.
113 Albert Einstein, 1950.
116 Joyce Warnokessel, System Project Management course notes, Massachusetts Institute of Technology, 1997.
These definitions imply that the selection and development of metrics must go beyond a
description of the concept being measured to describe the measurement process in a way
that is acceptable, verifiable and reliable. The following sections present seven critical
process elements in the development of high quality metrics.

3.3.3.1 Purpose of Measurement

The reason for a given measurement's existence must be the primary consideration for all
subsequent decisions concerning its design. What is the function of the metric? What
need for information will be satisfied? How, when and where will the information be
used within the team process flow? The answers to these questions will drive decisions
regarding the timing, frequency, method of measurement and useful lifetime of the
metric. Clarifying the purpose of the measurement also guards against the tracking of
meaningless metrics.

TPM Principle #21: Individual metrics should only exist for the duration of their
usefulness to the team.

3.3.3.2 Construct and Attribute Selection

Construct selection refers to the object of the measurement. Typical team measurement
constructs include teamwork, customer satisfaction, product quality or cycle time
reduction. The systems approach to construct and attribute selection is based in an
understanding of the interrelationships between the team architecture (i.e., members,
processes and interfaces), organizational context and objectives and guided by the TPM
Cycle (Figure 16). From the external perspective, constructs are defined as
characteristics of the team's output and embodied in team performance goals. From the
internal team perspective, construct selection involves locating the process pulse-points,
which influence team effectiveness. Team learning pulse-points and constructs are
identified by studying the relationships between team effectiveness and performance.

Attributes are the measured characteristics of the selected construct. Attribute selection
involves the choice of dimensions, factors, indicators or components that characterize or
predict the specific construct of interest. The terms measures, metrics and attributes are
sometimes used interchangeably. The measured attributes of performance measures are typically quantitative and expressed as part of the performance goal. For example, a service center team has a performance goal of improving customer satisfaction by reducing average response time by fifty percent. In this case, the team believes that service call response time is a valid attribute (i.e. predictor) of the customer satisfaction construct.

3.3.3.3 Validity

The validity of a metric applies on two levels: the content of the measurement and the measured construct. The *content validity* of a metric refers to the acceptability of the measurement procedure and attribute scores over all relevant situations (stimuli and responses). It represents the coverage that the measure exhibits over the content domain.\(^\text{117}\) For example, a survey-based teamwork assessment may be acceptable during periods of low to moderate task intensity but lose content validity during times of high stress. *Construct validity* is the empirical correlation of the relationship between a construct (characteristic) and one or more attributes (measures). Construct validity assessment applies to: 1) The construct itself - If the construct is a component of a broader characteristic, do the attribute scores reliably order the subjects according to the higher level characteristic? 2) A particular measure of the construct - Do attribute scores reliably order the subjects according to the construct? 3) A particular method of measurement - All methods of measurement of a particular attribute may not have equal construct validity. The degree of concern for validity and the corresponding rigor applied to its assessment will depend on the purpose of the metric, the size of the effort and it’s influence on the team’s success.

\(^{117}\) Ibid., p.34.
3.3.3.4 Reliability

The reliability of a metric refers to the repeatability of the measurement across multiple instances of identical responses. It has also been described as "a measure's freedom from measurement error." In general, the more objective a measurement is, the more reliable it will be. Metrics such as time-to-market for new product development or mortality rate in a coronary care unit will likely have high reliability. Qualitative or subjective metrics, such as customer satisfaction, software ease-of-use or team cohesiveness may require special attention to sample size, sampling techniques and statistical analysis of responses to assess reliability. As was the case with validity, the amount of rigor applied to the assessment of metric reliability will depend on the purpose and criticality of the measure. Often, the acceptability of a metric represents a trade between its reliability, its validity and its cost.

3.3.3.5 Method of Measurement

The first step in choosing the method of measurement is identifying the nature and possible sources of data. Data may be quantitative or qualitative in nature. Quantitative data can be obtained through explicit analytical measurement, statistical quantification of survey responses or existing process data (archival). Qualitative measurement data may be obtained through interviews, surveys or observation. As mentioned in the previous two sections, measurement methods can influence both the validity (context) and the reliability of individual metrics. A third criterion relates to the acceptability of the method. That is, the cost of measurement in terms of effort, time, expense and disruption to task processes. The best sources of data from an "acceptability" perspective are often existing team and process data available within the organization's information systems (e.g. project plans, schedules, production data, customer orders, etc.). However, one must be careful not to over emphasize acceptability at the cost of measure validity.

\[118\] Dickinson and McIn...e, 1997, p 33.
TPM Principle #22: When choosing the source of measurement data, look first for existing (archival) data, but do not trade validity for ease of assessment.

3.3.3.6 Timing and Frequency

The selection of an appropriate measurement method also includes considerations for its timing and sampling frequency requirements. Timing involves selecting the stimulus and/or schedule for the measurement process. Like the measurement method, timing also influences the validity and reliability of a metric as described in the above sections.

TPM Principle #23: Time the measurement to maintain the causal relationship between the stimulus and its measured response.

Timing and frequency can have a large effect on a metric's acceptability. A measurement process, which requires a suspension of the team process, will be less likely to gain acceptance and therefore provide reliable results.

TPM Principle #24: Choose the method and timing of measurement to minimize the disruption to team task processes.

This can be accomplished by making the measurement "event-based", e.g. scheduling measurement during a natural process transition point or a lull in process intensity.

TPM Principle #25: Make the timing of the measurement event-based. Avoid making measurement the event except in cases where it provides motivational value.

3.3.3.7 Target Values and Performance Standards

Measures may be used to gain process insights, i.e., to explore cause and effect relationships and extend process understanding. In these cases, it may not be necessary or useful to set initial target values or goals. However, in most cases exploratory measures become the baselines for subsequent performance and process improvements. To derive the desired motivational and performance-driving effects, measures must include criteria for action and decision-making. Measures can be translated into
performance targets (performance standards) or goals by defining the points or boundary conditions that partition the range of expected values. A common approach to partitioning results includes definitions for a minimum acceptable level (Min), expected level (meets expectations or ME) and superior level (exceeds expectations or EE) of performance. The source of performance standards and goal criteria can include:

- Internal team discussion and consensus
- Customer specifications
- Negotiation with management stakeholders
- Existing team performance data (i.e. baseline measurement data)
- External benchmarking

The process of setting performance standards can also provide an opportunity for the team to plan the appropriate responses and consequences of results, thereby reducing future decision making time and effort.
4. Summary

Teams are rapidly becoming the primary unit of performance across business and industry at virtually all levels. Advantages of the team approach have been well documented. Teams are commonly used to design, improve, produce and deliver products and services, to solve complex problems, to make better decisions and to formulate and implement strategies. Extensive empirical research in the areas of group and organizational theory has resulted in an enhanced understanding of team processes and dynamics. However, many challenges remain for teams and the organizations that spawn them.

One such challenge, which has received relatively little attention to date, is team performance measurement (TPM). Team performance measurement (TPM) is important for several reasons, including: 1) Team measures have a motivating and focusing influence on team processes; 2) Measurement provides necessary feedback for decision-making, problem diagnosis and intervention; and 3) Measurement is fundamental to team learning and continuous improvement. Universal measures of team performance do not exist. Furthermore, the complex, dynamic nature of external and internal influences on teams suggests the need for team-, task- and context-specific definitions of team performance measures.

An integrating framework has been presented based on a systems perspective of teams and drawing heavily from prior work in the areas of team effectiveness and performance theory. This was based on three fundamental premises: 1) teams are systems, 2) teams operate within an organizational super-system, which imposes contextual and environmental influences on their performance and 3) team performance measurement is itself a system with an associated function, interrelated elements, interfaces, influences and context.

The systems approach to TPM requires the development of a shared understanding of the elements of team performance along with their interrelationships and influences. The Holistic TPM Framework (Figure 15, Figure 16) provides both a model and a process for developing team goals and measures. The model describes the interrelationships
between performance (i.e. outcomes and objectives), team effectiveness and growth (i.e. organizational learning) and the three system perspectives: external (i.e. customer and stakeholder), internal team processes and team learning. The definition of a common, meaningful purpose and specific shared performance goals and metrics is the first step toward the development of a balanced TPM system.

Performance goals drive and focus the internal perspective on the development of the team’s common approach, its processes, tasks, norms, roles & responsibilities. Throughout this process, the Team System Model (Figure 5) and Architectural Framework (Section 2.5.2) provide the basis for the systematic identification of team pulse-points, i.e., the critical components (people), processes and interfaces that determine and drive performance. Pulse-points define the constructs for measuring team process effectiveness. These are predictive measures as compared to static performance or outcome measures.

Effectiveness shortfalls or gaps drive the Team Learning Perspective where they are translated into opportunities for process improvement and growth. An operational framework for deployment of the TPM system was presented as a variant of the Deming/PDSA cycle (Figure 17 & 18). This ensures the integration of TPM into the team process.

Completing the TPM cycle, the codification and formalization of team learning results in observable and measurable benefits from the External Perspective. Growth and organizational learning have a cumulative effect on the External Perspective over time. Organization, stakeholder and the team’s own expectations and confidence in its capabilities are elevated, resulting in more complex missions, loftier objectives and ambitious performance goals.

Finally, a set of twenty-five principles of team performance measurement has been proposed to assist teams in TPM system design and deployment. These principles relate to issues concerning 1) the organizational context, 2) the measurement system and 3) the design of individual measures.
Appendix A: Team Effectiveness Survey

**Instructions:** circle the number corresponding to the answer that best matches your response to each question below.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree nor Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

1. **Small enough in number:**
- The team can be convened easily and frequently
- I can communicate with all members of the team easily and frequently.
- Team discussions are open and interactive
- I understand my and others' roles and skills
- More people are needed to achieve team objectives

2. **Adequate levels of complementary skills:**
- Needed technical, problem-solving/decision-making and interpersonal skills are actually or potentially represented within the team
- I have the potential in all three categories to advance my skills to the level required by the team's purpose and goals
- Some skills that are critical to team performance are missing or under-represented
- Members, individually and collectively, are willing to spend the time to help themselves and others learn and develop skills
- The team acquires new or supplemental skills as needed

3. **Truly meaningful purpose:**
- The team purpose includes both near and long-term goals
- It is a team purpose as opposed to a broader organizational purpose or just one individual's purpose (e.g., the leader's)
- I feel that all the whole team understands the team's purpose and objectives
- Members promote the team purpose vigorously in discussions with outsiders
- The team purpose and its implications are frequently discussed
- I find the team purpose to be meaningful and memorable
- I feel that the team's purpose is important and exciting

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### 4. Specific goal or goals:
- Our goals are truly team goals versus broader organizational goals or just one individual's goals (e.g., the leader's) ........................................................................................................... 1 2 3 4 5
- Our team goals are clear, simple and measurable.................................................. 1 2 3 4 5
- Our goals are ambitious but realistic and allow small wins along the way................................................................................................................................. 1 2 3 4 5
- Team goals include a concrete set of team work-products................................. 1 2 3 4 5
- The relative importance and priority of individual team goals is clear... 1 2 3 4 5
- All members agree with the goals, their relative importance, and the way in which their achievement will be measured........................................... 1 2 3 4 5
- All members understand and can articulate team goals consistently..... 1 2 3 4 5

### 5. Clear working approach
- The team's approach is concrete, clear, and understood and agreed to by everyone................................................................. 1 2 3 4 5
- The team approach capitalizes on and enhances the skills of all members............................................................................................................................................. 1 2 3 4 5
- It requires all members to contribute equivalent amounts of real work. 1 2 3 4 5
- It provides for open interaction, fact-based problem solving, and results-based evaluation.............................................................. 1 2 3 4 5
- The approach provides for modification and improvement over time.... 1 2 3 4 5
- External input and perspectives are systematically sought out and considered......................................................................................................................... 1 2 3 4 5

### 6. Sense of mutual accountability:
- I am individually and jointly accountable for the team's purpose, goals, approach, and work-products......................................................... 1 2 3 4 5
- The team measures its progress against specific goals................................. 1 2 3 4 5
- I feel responsible for all team measures......................................................... 1 2 3 4 5
- I am clear on my individual and shared responsibilities on the team...... 1 2 3 4 5
- I have the sense that 'only the team can fail.'.............................................. 1 2 3 4 5
Appendix B: Assessment of Task and Outcome Interdependence\textsuperscript{120}

**Instructions:** circle the number corresponding to the answer that best matches your response to each question below.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree nor Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

**INITIATED TASK INTERDEPENDENCE**

- Team members depend on me for information and/or advice.
  - 1  2  3  4  5
- Team members depend on me for materials and/or assistance.
  - 1  2  3  4  5
- Members of my team depend on me for help and/or support.
  - 1  2  3  4  5
- I have a significant influence on the work quality of other team members.
  - 1  2  3  4  5

**RECEIVED TASK INTERDEPENDENCE**

- I depend on others on the team for information and/or advice.
  - 1  2  3  4  5
- I depend on others on the team for materials and/or assistance.
  - 1  2  3  4  5
- I depend on others on the team for help and/or support.
  - 1  2  3  4  5
- Members of my team have a significant influence on my work quality.
  - 1  2  3  4  5

**OUTCOME INTERDEPENDENCE**

- It benefits me when my teammates attain their goals.
  - 1  2  3  4  5
- My individual goals and those of my teammates are compatible.
  - 1  2  3  4  5
- It benefits me when my teammates succeed in their jobs.
  - 1  2  3  4  5
- When my teammates succeed in their jobs, it is at my expense.
  - 1  2  3  4  5
- My concerns and those of my teammates are harmonious.
  - 1  2  3  4  5
- When my teammates succeed, I succeed.
  - 1  2  3  4  5

Appendix C: Team Performance Measurement Principles

Organizational Context

TPM Principle #1: Start with a clear, common understanding of the team's purpose.

TPM Principle #2: Each member of the team should be an active participant in the development of specific team performance goals.

TPM Principle #3: Each performance goal identified by the team must have a corresponding measure.

TPM Principle #4: Team performance goals and measures should be aligned or rationalized with those of each stakeholder and organization represented within the team membership.

TPM Principle #5: Maintain the functional independence of measures whenever possible to avoid conflicts.

TPM Principle #6: In control-oriented organizational and cultural contexts, teams should co-develop performance and task process measures with management.

TPM Principle #7: In commitment or performance-based organizational contexts, teams can put more focus on performance and task process measures relative to teamwork process measures.

TPM Principle #8: Where cultural barriers exist within team boundaries, focus early on defining goals and measures and include periodic team process assessments.

TPM Principle #9: The positive consequences of meeting or exceeding performance goals in terms of recognition, rewards and incentives should be negotiated up front with team sponsors.

Measurement System

TPM Principle #10: Measurement must be linked to action through a process of feedback, reflection and improvement.

TPM Principle #11: A balanced TPM system includes measures of performance, effectiveness and growth.

TPM Principle #12: The team should focus on a small set of meaningful metrics.

TPM Principle #13: The size of the TPM effort can be managed through goal prioritization, followed by selectively discarding, suspending, scheduling or reducing the frequency of measurement.

TPM Principle #14: The measurement system should include a planned review schedule for each measure.
TPM Principle #15: Include measurement and review tasks when developing the team approach to ensure integration with the team process.

TPM Principle #16: The core team should be participants in the entire process of TPM system design, integration and deployment.

TPM Principle #17: Define “Goal Steward” roles to assign individual responsibility for the measurement, communication and improvement tasks associated with each goal.

TPM Principle #18: Ensure mutual accountability and balance workload by distributing or rotating individual Goal Steward roles across multiple team members.

TPM Principle #19: Measurement results should be made available as soon as possible after the event to allow for timely response.

Measures & Metrics

TPM Principle #20: "Not everything that counts can be counted, and not everything that can be counted counts."

TPM Principle #21: Individual metrics should only exist for the duration of their usefulness to the team.

TPM Principle #22: When choosing the source of measurement data, look first for existing (archival) data, but do not trade validity for ease of assessment.

TPM Principle #23: Time the measurement to maintain the causal relationship between stimulus and measured response.

TPM Principle #24: Choose the method and timing of measurement to minimize the disruption to team task processes.

TPM Principle #25: Make the timing of the measurement event-based. Avoid making measurement the event except in cases where it provides motivational value.
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