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**High Technology Performance
Management**

**CEO Publication
G 88-23 (136)**

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May 1994

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to be published by Oxford Press.

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ABSTRACT

High technology work is complex and dynamic, requires innovation, and is highly interdependent. These studies show that traditional individually-oriented performance management approaches such as merit pay and the annual performance appraisal do not fit well with this kind of work. Team-oriented performance management practices are more highly related to performance indicators. A framework for conceptualizing team-oriented practices is presented.

HIGH TECHNOLOGY PERFORMANCE MANAGEMENT

Allan M. Mohrman Jr.
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Introduction

Performance requirements in high technology firms have become increasingly stringent. Global competition, shortening new product development cycles, shorter product life cycles and the high cost of but unquestionable need for the organization to keep up with the rapid development of product, process and administrative technology are a few of the factors that require high performance on the dimensions of quality, cost, schedule and service. Organizations must innovate, adapt to change, be efficient and be responsive. To fail on any of these dimensions results in vulnerability.

Most high technology firms identify their cadre of highly trained and educated employees as their most important resource. These employees are expensive to attract, require ongoing maintenance of up-to-date skills and knowledge, and through experience develop local knowledge and networks of contacts useful to task accomplishment. Effective management of the performance of employees is key to the success of the firm. It can potentially constitute a competitive advantage as firms that manage their people well are better utilizing this important resource, and will find it easier to attract and retain the level of talent required in a difficult technical and competitive environment.

The nature of high technology firms pose special challenges that make performance management difficult. The requirements of high technology work and of high technology employees both work against classical bureaucratic notions of control, and require performance management practices that

acknowledge uncertainty, rapid change, innovation and professional standards and expertise. To some extent, the organizational requirements posed by the rapid paced and highly interdependent technology and the professional standards and norms of professional and technical employees can work against each other.

This chapter reports the findings from the studies of performance management in 12 operating divisions of 3 large mature high technology organizations. All have extensive research and development components, and scientists, engineers and technicians are major employee groups. Managers tend to come from the technical ranks. Organization A operates primarily in the defense sector. It produces sophisticated avionics systems. Organization B operates in both the commercial and the defense sector. It produces state of the art systems in the aerospace industry. Organization C is an oil and chemical company. It uses rapidly developing, state of the art technology in all phases of its enterprise, from exploration to production. One third of the enterprise is concerned with the development and production of innovative chemical products. Each of these organizations has extensive information systems groups as staff support which develop advanced administrative, design, and process systems.

In each of these corporations we conducted one hour interviews with over 50 employees who represented a diagonal slice cross section of the salaried workforce, and administered surveys to at least 10% of the salaried workforce, randomly selected. The studies were sequential, with information derived from earlier ones being used to frame new questions and to decide what needed to be replicated. More detailed results from each of the studies exist elsewhere (Mohrman, Mohrman and Worley, 1988; 1987; Mohrman and Mohrman, 1988). This chapter draws on both the qualitative and quantitative results, and integrates what we have learned so far. It then

develops a framework for performance management in high technology settings, presents some prescriptions, and addresses important unresolved questions.

High Technology

Since the kind of performance required partly depends on the technology being used, performance management techniques have to fit with the technology of the organization. In this vein high technology settings have certain characteristics that set constraints and requirements about how performance is managed. We must understand high technology before we can understand its performance management implications.

Technology is "any tool or technique, any physical equipment or method of doing or making, by which human capability is extended" (Schon, 1967). At the core of technology is the knowledge upon which it is based (Tornatzky and others, 1983). Technology consists of this knowledge base, its technical content, and the tools, artifacts and practices which embody this knowledge (Tornatzky et al, 1983; Pelz and Munson, 1980).

While there are many definitions of "high" technology most of them deal with correlate aspects such as the high numbers of technical professionals, heavy use of research and development and the rate of change in the product offerings of the industry, rather than with characteristics of technology itself. If the essence of technology is knowledge, then high technology refers to knowledge with certain characteristics. We posit that high technology is at the high end of a number of interrelated dimensions of knowledge: It is complex rather than simple, new as opposed to established, at the boundaries of development and incomplete rather than complete, rapidly progressing not static or slowly developing, systemic not isolated, and contingent rather than linear (see table 1). Its position on each of these knowledge dimensions has

implications for people.

High technology knowledge is complex. The source of the complexity lies in many of the other dimensions of knowledge. The result of the complexity is that it takes a long time to acquire the knowledge, and mastery requires a fairly high level of ability and frequently involves the securing of advanced degrees. Even those who do the lower level tasks in high technology organizations find that training times are considerably higher than in other organizations (Von Glinow and Mohrman, 1988). It is this attribute of high technology that prompts many to equate it with a high incidence of professionals (Von Glinow, 1988).

A high technology is new. It is based on the most recent developments in scientific knowledge. As a result there has not been much time for a general understanding of the technology to occur. There is a tendency for only a few "gurus" to have mastered it, and they are extremely valuable and scarce resources. They are at times individuals around whom whole product lines, companies and industries have been built.

High technology knowledge is right on the edge of ongoing development; consequently, it is incomplete. There are still gaps to fill in order to use the technology and the knowledge behind it to their fullest extent. Therefore there is a need for people who use the technology to constantly learn from their experiences, invent and innovate. This not only means that high technology ventures will tend to have large research and development components, it also means that all employees to some extent will confront situations that demand innovative responses because the technology is not well understood.

Accelerating development is an ironically constant aspect of high technology, and the development feeds on itself. Rapid progress leaves

more knowledge gaps. Profitable and competitive use of technologies depends on filling the gaps as quickly as possible, creating a base for further progress. People and organizations must respond quickly to these ongoing developments.

The knowledge behind high technology is systemic in nature. It cannot be isolated into neat packages and disciplines. For example, previously separate knowledge bases are joining forces to form the base knowledge of new technologies. This is happening in aerospace, for instance, where the new composite materials are literally revolutionizing aerospace engineering. Increasingly, high technology products and production processes are systems. They serve to link people and technological elements into mutually interdependent parts. The individual effects of a person's behavior are lost as they interact with the behaviors of others and aggregate to contribute to the performance of the system as a whole. These systems in turn are embedded in other systems. Interdependent systems are exemplified and exacerbated by networks of information technologies that permeate our modern organizations. As a result, in high technology settings, people are highly interdependent with one another and the contributions of individual efforts to the effectiveness of the system as a whole are not always known.

Finally, high technology knowledge is contingent upon which aspects of the technology have most recently been developed and which gaps in the developing knowledge domain people choose to fill next. The result is uncertainty. The development of technology content cannot be completely predicted so the overriding need is to be able to respond to developments as they occur and to strategically choose points where subsequent development should be aimed. Much of the high technology of the defense industry, for instance, is fueled by strategic developments and counter

developments between the eastern and western blocks. Sophisticated radar capabilities on one side will be countered by the development of jamming technology on the other which will lead to further radar development by the first, and so on. These developments happen quickly, during the life of a development project, and can result in frequent changes in design. These design changes are not isolated but typically have ramifications for design of the entire system. On the domestic front the jockeying for position among computer manufacturers creates a similar dynamic. This uncertain, unpredictable nature of the direction of the high technology exacerbates the implications of the other dimensions.

We have spelled out these aspects of high technology in some detail because of their significant implications for the way performance is managed in high technology firms. Our interviews confirmed that the technologies in all 3 firms had these characteristics. More than 80% of survey respondents indicated that they were highly interdependent with the work of others. More than half reported that they frequently had to change their own work in response to changing requirements, information and priorities from others. Almost 60% of the respondents were not able to immediately know the results of their work. Almost 60% reported that their job required them to use technical and scientific knowledge and keep it up to date. All of these factors correlated with one another; that is, if someone indicated one was true then it was likely that all the others were true also. Sixty-five to seventy percent said that they frequently had to innovate and try out new approaches just to get their jobs done. This factor correlated most highly and consistently with all the other high technology factors and therefore appears to be a basic underlying component of high technology settings.

One particularly interesting pattern was that each of these attributes, though high for all, was even higher for managers than it was for non-managers. In these firms, a lot of the uncertainty reduction was being performed by management. Any prescriptions we make for performance management in high technology settings will apply as strongly to the management of managers as it does to the management of professionals.

High Technology and Performance

Settings where there is a lag in the feedback one gets about performance, where tasks are often changing and being changed, that require experimentation with untested ways of doing things, and where interdependencies require ongoing interaction with others to get the work done pose special challenges for performing effectively. Our findings corroborated this. They show plainly that these characteristics of high technology settings can easily work against performance. Survey respondents who reported that requirements and priorities keep being changed and that they do not readily know the results of their efforts reported lower effectiveness of all types of performance: individual, workgroup, and project level; quality, schedule, and cost. Respondents who reported that they frequently have to try out new and innovative approaches in order to get the job done and that they work extensively with others with whom they are interdependent saw their own work and that of their workgroups and projects as being of higher quality. Nevertheless, the need for both innovation and extensive interaction negatively affected schedule and budget. Innovating and coping with interdependence by person-to-person interaction are critical to the quality of the work that is done, but are time consuming and costly.

In each of these organizations, the characteristics of the technology impose work requirements that appear to work against employees' sense of accomplishment and of being part of a high performance group. This is an especially important performance management issue given the professional nature of the employees and the fact that professional pride of accomplishment is an important motivator for professionals.

High Technology Employees

High technology workers are "knowledge workers". Many are highly educated and trained in specialized fields of knowledge and belong to professional groups that have norms, standards and are defined not only by the content of their knowledge but by accepted practices and approaches to solving problems or conducting investigations (Von Glinow, 1988; Resnick-West and Von Glinow, this volume). They arrive in the firm already "socialized" with a strong internalized set of expectations and values. They have internalized standards, expect to be able to exert professional autonomy within the narrow bounds of their expertise, and experience collegial influence and control as more legitimate than hierarchical control.

From the organization's viewpoint, a performance management problem arises because there are some natural clashes between the orientations of professional scientists and engineers and the business needs of the firm (Resnick-West and Von Glinow, this volume). The knowledge workers' concern for creative freedom, furtherance of the technology, and their own position in a professional community can conflict with the business concern for targeted investment in strategic areas, planning and control, and cost and budget. Interest in elegant solutions and autonomy clash with the business needs for a planned way to manage complex projects with many interrelated

parts in a cost effective manner that enhances competitiveness, and in a timely manner that brings the product to market before the competition.

Closely related to the adherence to professional standards and norms of autonomy is the individualistic orientation of many technical employees, particularly engineers (Adler, this volume). Organizational accomplishments are believed to be the sum of individual accomplishments, and individual creativity is valued more than working with and through other people. This analytic, individualistic notion of work conflicts with the required behaviors to work out the complex interdependencies of high technology work.

Because of these potential clashes between the professional and individualistic orientation of many high technology workers and the business and technological demands, the challenge of performance management is significant. It is not sufficient to simply hire employees with the requisite professional background and set them loose to utilize their talents, although this is frequently done. In fact, our interviews suggested that such an approach was quite common in these organizations, where little attention was paid to clearly defining needed performance, or to providing feedback and development plans. It is not uncommon to find managers who believe it unnecessary to help employees define their roles; in fact, they look upon such a need as a sign of lack of employee capability. Many scientists and engineers, in particular, reported that they knew what they were supposed to do and how they were to go about it by virtue of experience, modeling of others, and using their training and education. As a result, they were frequently unsure of how their activities fit into a larger set of business priorities.

The next section provides a framework for understanding performance

management that will then be utilized in examining what approaches were effective and ineffective in our high technology companies.

Performance Management

Performance management is the many things done in organizations to manage and shape the performance of employees. It attempts to align effort and performance with standards and types of performance needed for organizational success.

The value expectancy model (Campbell, Dunnette, Lawler and Weick, 1970) provides a framework for understanding performance management. It posits that employees will be motivated to expend effort to accomplish performances that they believe will lead to the outcomes they value. Their effort will result in the targeted performances if the goals are realistic, if they fully understand what is expected of them and have the necessary skills to do them. Ongoing motivation depends on the extent to which attainment of the targeted performances indeed results in valued outcomes. Thus, performance management is at least in part the processes and practices that clarify expectations, ensure that individuals have the adequate skills and information to accomplish them, and link valued outcomes to successful performance.

A large amount of performance management occurs through ongoing processes in the organization, such as organizational communication processes of various kinds, and daily interaction within workgroups and between supervisors and employees. Formal systems are also put in place to help manage performance. These include: job definition and goal-setting to define the needed performances, performance appraisal and various review and feedback systems, training and development to keep skills and abilities commensurate with needed performances, and reward and recognition systems to provide valued outcomes. Traditionally these practices have been looked

at as independent systems; increasingly it is coming to be understood that they all fit together into a performance management system, and must reinforce each other and support an overall approach to managing human performance (Mohrman, Resnick-West and Lawler, in press).

Complicating the picture is the fact that these formal systems, particularly in a mature firm, have been developed over a number of years, and exist for a number of purposes in addition to performance management. For instance, attraction and retention of scarce and valued employees and avoidance of legal charges of inequitable treatment are other important purposes of job evaluation, performance appraisal and various pay programs. Consequently, in many firms practices have evolved that are not strongly linked to performance.

Traditional performance management practices are based largely on the legacy of the concepts of bureaucratic organization and scientific management. Work is divided into tasks that were grouped into jobs. These jobs are described and evaluated, forming the basis for selection, appraisal, training and compensation (Mahoney and Deckop, 1986). Supervision exists to control organizational performance and to integrate the contributions of various jobs.

Related to this tradition, three fundamental assumptions have been the underpinnings of most approaches to performance management. First, it is assumed that managers are the appropriate and best managers of performance. Second, jobs are assumed to be relatively constant and definable. Third, it is assumed that the managing of performance means managing the performance of individuals. Each of these assumptions is challenged in the high technology setting, as we found in the open ended interviews that were conducted in our three organizations. Below, we discuss each of these

assumptions in more detail.

I. Hierarchical performance management. The belief that managers are the appropriate managers of performance stems directly from our beliefs about the role of hierarchy, and leads to the corollary that supervisors should manage subordinates' performance. The high interdependence among employees in high technology firms creates conditions in which this assumption must be questioned. The interdependencies are generally lateral in nature, between employees and internal customers or between employees and peers who are working on other components of the technological system. Managers frequently get involved in working out such interdependencies, especially within a traditional bureaucratic framework. However, interdependencies are also worked out between peers, as was illustrated by the comments of a software engineer, who echoed a sentiment we heard many times:

My boss insists on resolving all of the issues we have with all other groups. We generally have to pick up the pieces anyway--after a lot of time has been wasted waiting for a decision. He doesn't have any idea how we really resolve things since he's always in meetings. We try not to involve him if we can possibly keep him ignorant of what's going on.

This raises an interesting performance management challenge. If interdependencies are being worked out directly between employees, many aspects of an employee's performance are likely to be invisible to the supervisor.

In addition, many technical employees perform work that is not easily measurable and for which the behaviors are not readily observable. Often the supervisor does not have the kind or currency of technical knowledge of employees. Consequently, it is difficult for the supervisor to adequately evaluate the work of subordinates. Alternatively, many supervisors had been promoted into management ranks but remain in many senses technical

contributors themselves. They spend long hours in meetings addressing technical issues, and do not spend enough time with their employees to have a good sense of each person's contribution or to adequately manage performance.

There were other indications that making performance management practices the responsibility of supervisors was a failing strategy. On the surveys, less than half of employees reported receiving direction or goals from their supervisor. Scientists and engineers, in particular, frequently reported that they had little contact with their supervisors and that, indeed, the supervisor knows little of what they do unless complaints are received. When asked who determines what work they do, employees in organization C ranked themselves and their internal customers over their supervisors.

Performance appraisal systems were most often judged by the interviewees to be good systems on paper but not to work because supervisors did not put in the requisite effort and time, or in some cases did not have the necessary skills. A frequent complaint was that the supervisor, while expected to carry out appraisals, had little first hand knowledge of appraisee performance.

Nevertheless, it should be pointed out that most people interviewed believed that performance management is the responsibility of the supervisor and that more time and energy should be put into the process. Subordinates wanted their supervisor to spend more time helping them make developmental plans for their careers, and in general wanted the supervisor to keep them informed of "where they stood". They relied on the supervisor as their contact with outcomes--with pay, job assignments and promotional opportunities.

II. Constant and Definable Jobs: Traditional performance management

mechanisms are based upon the assumption that jobs and the organizational situation are relatively constant and stable, allowing for formalization of practices such as job definitions, job evaluations, written goals and standards, and other relatively permanent mechanisms of performance management. The characteristics of high technology settings dilute the effectiveness of these static mechanisms that violate the systemic nature of the work. Constant change coupled with the need to innovate, and high interdependence mean that specifications and goals are quickly eroded. Static job evaluation systems as the basis for compensation practices can work against the need for employees to continually update skills, perform new tasks and be flexible in their contributions (Lawler, 1986). In rapidly changing conditions, job definitions and goals have to be frequently updated. Organization A, for example, was busily spending thousands of hours updating job descriptions that the managers said would be obsolete within two years anyway.

In organization C, where appraisals and merit pay were based on a strong management by objectives (MBO) system, great dissatisfaction was expressed with the fact that the system was unable to keep up with the frequent need to change goals and objectives. To do so would have involved many interim checks and updates of goals. Many felt the goal-setting process was unrealistic for the nature of their jobs, which involved solving unforeseen problems of unknown magnitude and dealing with unknowable change orders that arose along the way. Employees in all three organizations reported spending time on tasks that were of lower priorities than emerging workflow needs because they were locked into objectives. More insidiously, they often reported working on low priority issues because their managers' yearly objectives and bonuses were at stake.

A strong lament from managers was the lack of flexibility in all the performance management systems. Within the context of rapid changes in strategy, technical specifications and project requirements, employees were continually being thrown into periods of seven day work weeks and extremely long hours just to get the product to market on time. Managers were especially unhappy with rewards systems which were "controlled by an inflexible set of rules", and "unable to address stellar performance or extraordinary effort in a timely way". Even special awards programs were often tied to levels of bureaucratic approval and obsolete provisions that required that the special performance be outside of the employee's job description. "What about my team that spent seven day weeks through the Christmas holidays so that we could get a proposal in on time?" In some operations teams were not eligible, or award limits were so small that to reward a team would seriously dilute the impact.

III. Managing Individuals: It is often assumed that managing the performance of people means managing the performance of individuals. For instance, appraisal systems are aimed at individuals, and rewards are most frequently based on the individual's job, performance, skills and potential. Nevertheless, because of the systemic nature of the work and the high interdependence in high technology firms, managing performance means managing the whole, which includes the interdependencies as well as the parts. This means treating the team, or group, as a unit of analysis for performance management purposes.

A theme that we heard, particularly from managers who were trying to establish and manage teams, was that the reward system not only did not provide for team rewards, but also worked against teamwork. The pay for performance systems in place in these companies were based on a fixed pool of money and thus rewarded some individuals at the expense of others. At

its very core, this system is competitive and could easily divide people who were interdependent. This was poignantly pointed out by one scientist who said that peer input to appraisals would be disastrous because appraisals determine pay and he and his peers were compared with one another for pay determination. "We're all out to get each other; they've turned us into enemies".

Perhaps partly to offset this dysfunctional consequence of merit pay, supervisors in practice differentiated very little between employees in either the raise or the performance appraisal unless they were required to force a distribution. A message we heard from some supervisors was that "The work of the group requires a true team effort. The foundation for cooperation would be destroyed if I began differentiating between people to any great degree." Where organizations required a forced distribution, many employees and supervisors took issue with the implicit assumption that every team or workgroup must include a normal distribution of weak and strong performers. They believed that a strong team could easily be composed entirely of excellent performers, and vice versa.

All three companies had formal practices of ranking all employees, either for pay or retention purposes. Many managers and employees were comfortable with this conceptually, although concerned about it operationally. True to the quantitative orientation of this population, the major concern was to develop better ways to measure and compare employees. Those who opposed the practice did it on the basis of the inability of managers to accurately make such fine distinctions between employees, and on the lack of viable standards upon which to compare. In organization A, which was the only company in which we asked about this practice on the survey, only 20% of managers felt the ranking process

worked well, and half believed it resulted in serious equity problems.

Although all three organizations were trying out a variety of new approaches to establishing teamwork, none had formal practices of team goal-setting or performance planning. All had systems of program or project reviews which were held with unequal regularity and vigor in different projects. In most cases, these reviews were a formal upward reporting of progress against plan with little or no actual team goal setting, planning of performance strategies or providing of feedback to one another. Often, individual contributors and even first line supervisors were not included in the reviews.

Nonetheless, informal group level practices had evolved. In each company respondents reported that group meetings to discuss group performance happened at least as often and sometimes twice as often (averaging from 2.5- 5.5 times per year) as individual performance discussions with supervisors. For example, an exploration group of the oil company reported regular morning meetings ("without supervisors") to determine who would do what.

Some individual contributors were unhappy with the relative lack of attention to building the team: "I have no idea how my work fits in with the bigger picture". "We're missing out on an opportunity to learn from one another and to coordinate better". "I don't even know what the guy in the cubicle next to mine is doing, even though we're working on the same program. Perhaps if we understood each other's tasks we could avoid reinventing the wheel". "My boss doesn't like to bring our team together. She's afraid we might challenge her decisions about how the work is divided up". "We've got about three different groups working on reliability issues for each product, but we never bring them together. There's a duplication of effort and endless arguments over which group is using the right

approach".

Indeed, all three companies had various kinds of efforts to establish increased teamwork, including quality circles, quality action teams, interfunctional business development teams, and design-to-production teams. Managers who were champions of these efforts were the most adamant in their message that individually oriented performance management systems were major blockages to teamwork in the organization.

Comparing the Effects of Performance Management Practices

The questionnaire portions of the studies were designed to test the predictions about what constitutes effective performance management in high technology firms that emerged from the interviews and that sprang from the assumptions that we had about the nature of performance in high technology firms. The model in Figure 1 shows the various aspects of performance management that we measured and how we expected them to relate to one another and to effectiveness.

Performance management practices include reward and appraisal practices that are established to ensure that performance is reviewed and leads to valued outcomes. Processes are the interpersonal processes that manage performance on a day-to-day basis. Performance Facilitators are conditions that exists in the job, the workgroup or the person that enable people to know what is expected of them in their job and to do it.

According to the Model, performance management practices can influence effectiveness directly, such as merit pay might do by motivating people. Practices can also encourage processes or facilitators. For instance, performance appraisal is often expected to encourage feedback or to result in the establishment of goals that may in turn promote effectiveness. Interpersonal processes such as supervisor structuring of work may directly

contribute to effectiveness, or may operate by setting up facilitators such as performance standards that then contribute to effectiveness.

Our general approach in analyzing the relationships among these variables has been to use multiple regressions. First, we regress each of the processes on the practices. This gives us a picture of how the practices contribute to the processes. Second, we regress each facilitator on both the practices and processes, giving a pattern of how each contributes to the establishment of the facilitators. Finally, we regress each of the measures of effectiveness on the practices, processes and facilitators. This gives us the pattern of how each of the practices, processes, and facilitators has contributed to effectiveness directly. This approach to analyzing the data allows us to discover paths that begin with practices and end with effectiveness, and enable us to see both direct and indirect relationships. In this chapter, we report only the paths that were consistently found in the three organizations, and discuss the variables in these paths as well as those that failed to lead directly or indirectly to the measures of effectiveness. More complete reporting of particular regression analyses is available elsewhere (Mohrman, Mohrman and Worley, 1988).

Practices. The five practices that were measured were chosen because they were the major performance management activities that occurred in these organizations. Three were appraisal practices and two were rewards practices. **Supervisor-Individual Appraisal** is the frequency with which the supervisor gives the subordinate performance feedback. **Formal Work Group Appraisal** refers to the degree to which the work group or project team is formally assessed by the organization. **Workgroup self-appraisal** is the extent to which work groups and project teams use self appraisal processes

to discuss their work. **Pay for Individual Performance** measured the degree to which respondents perceived the pay for performance system to be working. Similarly, each company had instituted a special awards program for various kinds of one shot awards to both individuals and groups. These programs were the only avenue available in these companies to reward teams with cash bonuses. **Special Awards** reflects how well employees thought these programs were working.

Two of these practices, supervisor-individual appraisal and formal work group appraisal do not consistently or significantly appear in the paths to any form of organizational effectiveness. These formal, hierarchical processes have very little performance impact in these companies.

Processes. Three supervisory and three workgroup processes measured the extent to which each: 1) gave feedback to group members; 2) structured tasks and set goals; and 3) stressed and exhibited a high performance orientation (performance norms).

None of the supervisory processes are consistently and significantly related directly or indirectly to any of the organizational effectiveness outcomes that were measured, supporting the prediction that hierarchical processes are not highly effectual in high technology settings.

Facilitators. We measured five facilitators. **Skill Level** measured the degree to which the employee felt adequately trained and sufficiently skilled for the job. **Clear Job Duties** refers to the degree to which employees report that they have clearly specified jobs and clearly prioritized job responsibilities. **Performance Standards** refers to the extent to which employees have jobs for which goals and performance standards can be and are defined. **Understanding Role in Group** refers to how well employees know how their work fits into that of the work group.

Teamwork is the active assistance that work group members give to one another.

Clear Job Duties and Performance Standards do not appear in any of the paths to organizational effectiveness. These relatively static (and common) approaches to performance management do not consistently contribute to performance outcomes in our high technology settings.

Effectiveness. By effectiveness we mean the degree to which the needs of various organizational stakeholders are met. We obtained survey measures of six aspects of performance: Individual performance; Workgroup effectiveness; Project effectiveness; On Schedule performance; On-Cost performance, and Human Affective Outcomes (satisfaction, pay equity, and trust). Below, we discuss the paths by which the performance management variables related to five of these outcomes. Cost performance is not presented because in each company less than 10% of the variance was explained by the performance management variables and no clear paths emerged.

Individual Performance. Employees rated their own performance on several dimensions and reported their perceptions of their supervisor's ratings of their performance on the same dimensions. Previous research had indicated that subordinates usually have an accurate sense of their supervisors' ratings (Lawler, Mohrman, and Resnick, 1984). Figure 2 illustrates the consistent paths through which the performance management variables were related to Individual Performance.

Performance is very strongly facilitated by the employee's skill level and by employee understanding of his or her role in the group. These facilitators strongly result from workgroup structuring and goal setting and by workgroup feedback. Thus, both skill and understanding of how one's

work fits into the larger context are the result of group processes to a significant extent.

Work group performance norms have a direct path to individual performance. Thus individual performance is both directly and indirectly related to all three group oriented processes. They in turn are strongly related to the practice of group self-assessment.

The two reward practices have an interesting relationship to individual performance. Pay-for-performance is surprisingly related to workgroup feedback, indicating that if people feel their pay depends on their performance they are more likely to give feedback to one another about what they need. The relationship of pay for performance to workgroup feedback is secondary to its main process effects which are the bolstering of the three supervisory processes. These relationships do not appear in the figures, however, because the supervisor processes of feedback, structuring and stressing productivity have no consistent link to the outcomes we measured.

Special awards has a direct and negative path to individual performance, but a positive indirect path through workgroup structuring and goal setting. Evidently, the fact that special awards were often used to reward groups has provided some support to encourage workgroups to set goals.

Group Performance. Workgroup effectiveness and project effectiveness measure the quantity and quality of work group and project performance. The paths leading to these two effectiveness measures are the same, and are indicated in Figure 3. Group performance was strongly related either directly or indirectly to every group level practice, process and facilitator except formal workgroup appraisal. In addition, group performance can be directly helped by the skill levels of its members,

which were also affected by workgroup processes, and by teamwork. Again, pay for performance and special awards operate only through the workgroup processes.

On Schedule. This aspect of group performance was singled out because of its central importance in the fast-paced world of high technology. On Schedule is directly impacted (figure 4) by the skill levels of employees, and by workgroup processes of structuring and goal setting and stressing of high performance. Again, the practices of workgroup self appraisal, special awards and pay for performance operate through the workgroup processes.

Affect is the dimension of effectiveness that reflects the degree to which the individual's needs are being met by the organization. We measured satisfaction, pay equity, and trust. These affective reactions are (figure 5) directly positively impacted by teamwork and by pay for performance. This is interesting because it is the first time that pay for performance has had a direct link to any outcome. Individuals have a favorable reaction to this practice when they think it is working. The workgroup processes of stressing performance and structuring and setting goals are indirectly linked to affective outcomes through their relationship to teamwork. And of course, workgroup self-appraisal and special awards relate to these workgroup processes.

It is important to note that individuals respond favorably to teamwork and to pay for individual performance. Thus the dual pressures on high technology are captured: the orientation of employees to individual creativity and autonomy, and the fact that they are engaged in a highly interdependent work.

In summary, these performance management paths to effectiveness

illustrate the erosion of the three assumptions underlying traditional performance management practices. First, none of the effective practices relied on the supervisor. Second, the centrality of the work group is abundantly clear. Even a traditionally individual practice like pay for performance, while it is important to the affective responses of employees, only contributes to performance by its support of the work group. Third, the reality of change has resulted in the erosion of traditional mainstays of performance management like job specifications and performance standards. Neither of these consistently showed impacts on effectiveness. In short, it does indeed appear that the nature of work in high technology organizations demands new approaches to performance management.

Performance Management in High Technology Firms: A Model and Some Prescriptions

The pattern of findings reported above substantiates the need for performance management approaches in high technology firms to be dynamic and multi-faceted. Figure 6 presents a model that illustrates the complete process. It shows performance management practices at the group and individual level within the context provided by the organization, its strategy and design. The sequence in Figure 6 is quite traditional. It begins with performance definition which leads to development of the capacity to perform, the review of performance, its rewards, and proceeds to a redefinition.

Performance management occurs at all three levels: the organization, its teams and groups, and the individual. The two-way arrow from each organizational performance management step to the comparable group step indicates that group and individual performance management must consciously and openly be linked to organizational performance needs, and vice versa.

Processes and practices should be designed to raise the level of awareness of teams and individuals of how they fit into this overall picture, and to involve them as much as possible in organizational goals and effectiveness.

The two-way arrow between group and individual performance management steps indicates the ongoing reciprocal relationship between the performance cycles at these two levels of analysis. Individual performance can only be defined and interpreted within the context of what the team is trying to accomplish and the performance strategies it utilizes. Individual performances that are excellent according to static or external standards but do not sum up to a team accomplishing its mission, are not organizationally excellent performances.

Although this model may appear quite traditional, there are some prescriptions for how it must be done in high technology settings that are quite different from traditional approaches:

1. The performance management cycle should be flexible and frequent. Most organizations operate with yearly operational planning cycle and quarterly updates. Their individual performance management cycle generally follows the yearly business cycle. In a high technology firm these sequences cannot easily be shoehorned into a yearly cycle. The competitive arena changes more frequently than that, technology advances steadily, at irregular rates and in unpredictable directions, and customer specifications and requirements are articulated and changed frequently.

Because of the rapid rate of these changes, the quarterly planning cycle drives many high technology firms. Group and individual performance management must occur many times a year as well. Furthermore, the cycle for these events will most likely not be regular or predictable. Ongoing monitoring of performance at all three levels should be able to trigger review of performance and redefinition of goals, performance strategies and

work plans at any time. Outstanding accomplishments that need reinforcement can occur at any time, arguing against relying on the yearly merit increase or bonus as the sole reward system. On the other hand, projects can have natural life spans longer than one year. Ultimate success of endeavors may not be known for quite some time. Performance management needs to reflect this reality also.

2. Lateral and self management are more important than hierarchical mechanisms. Group self-management includes processes by which the group can set its own goals, determine its own strategies, ensure that individuals within it have the needed skills and are being effectively utilized and that interdependencies are being worked out. Group self-management does not rule out that the supervisor has a legitimate role in the group, as was indicated by our survey data that showed that team self-appraisal enhances both supervisory and workgroup feedback, goal setting, structuring and performance norms (Mohrman, Mohrman and Worley, 1988). The message for the supervisor is that team mechanisms are a more effective route to influence than one-on-one relationships with subordinates.

Most professional employees expect individual self-management of technical task performance based on standards and accepted practices that were learned in school. It is essential, however, that processes are in place to link individual task performance directly to needed team objectives or goals. This requires that much attention be given to the team as a performing unit; to team development of its ongoing processes of goal-setting, reviewing and improving itself; and to rewards and recognition of team accomplishments. It also requires team input into the management of individuals: their tasks and goals, determining how individuals fit together into the team, their skill improvement, and the review and reward

of their performance.

3. An important role of supervision is to link performing units to the greater organizational performance requirements and to create a climate for effective self-management. It is essential that teams and individuals have full cognizance of organizational goals and performance, and of how they fit into this larger picture. Very clear performance values (Shuster, 1984) are required to align personal and team effort with organizational performance needs. Creating an overall climate that stresses performance and is information-rich is a key managerial task in the high technology firm.

Supervisors must create conditions for effective team and individual self-management by serving as communication links to the rest of the organization, ensuring that the teams have the resources they need, and building the team's capacity for self-management.

Supervisors are also the link between the individual and the organization in such issues as career and placement. Our interview data suggest that it would be a serious mistake to overlook the importance that individuals attach to learning "where they stand", and to their supervisor's responsibility to attend to their development and career issues. They also suggest, however, that it is important to develop mechanisms for co-worker and customer input into the evaluation of individual performances that lead to individual reviews, rewards and career actions.

4. Team-Management occurs in a series of embedded and interlinked processes. The above prescription makes it sound as if organizations are a sum of a number of self-contained groups or teams. In fact, teams are embedded within bigger teams, and interdependent with other teams. Performance management must take place at multiple levels and in many

overlapping teams. Inter-group performance management between two interdependent teams may have to establish the mission of each, within which team self-management may then occur. Individuals may be part of the performance management processes of several teams, and may find their roles being determined by several groups of people. Consequently, part of the roles individuals must play is to manage how they personally are utilized in multiple groups.

Traditionally, this complexity has been handled by managers, who specify who does what and how teams relate to one another. In high technology organizations, ongoing lateral processes are very common, as the rate of change and amount of uncertainty makes hierarchical decision making too slow a response mechanism. Since it is impossible to pre-structure all the needed interfaces and coordination functions, temporary task groupings will continually spring up. Team self-appraisal and improvement mechanisms must become part of the culture and be adapted to many forms of self-standing, overlapping, permanent and temporary teams.

Conclusion: Some Interesting Questions

Based on an analysis of high technology work and studies of performance management in 3 high technology firms, we have called for significant reframing of traditional performance management theory and practice. New approaches involve managing interdependencies as well as individual performances; consequently performance management practices must meet the performance requirements of both teams and individuals. They must be flexible enough to continually adjust to changing requirements. Furthermore, they must bridge the gap between the performance orientation of professional high technology scientists and engineers that stresses autonomy, creativity and furtherance of knowledge and that of business

managers who must ensure financial and market viability and live by plans and controls. Some interesting questions are raised that deserve much more investigation.

First, although these results indicate the current supervisory role has little relationship to effective performance, they do not describe a new role. Organizations have some hard decisions to make in this regard. Working through teams is certainly as time consuming and perhaps more difficult than working with individual subordinates. Furthermore, results clearly indicate that subordinates expect individual attention to their career and development needs, indicating that a team supervisory role does not alleviate the need for individual attention as well. Currently, technical, administrative and coordinative roles prevent many managers from doing a good job at either the team or individual levels of performance management.

Second, the notion of the team as the performing unit conflicts with cultural, professional and hierarchical tendencies to value individual creativity and initiative and to want to find an individual to hold accountable. Our data suggest that individual affective responses depend both on teamwork and on acknowledgement of personal contribution and career needs. What is less clear is whether performance management practices, rewards and appraisals in particular, can be designed at both team and individual levels that do not subtly undermine one another. Much more work is needed to define compatible approaches at these two levels.

Third, there is the question of to what extent performance management practices and processes can be or should be formalized in high technology settings. In our studies, formal group appraisal, for example, had no relationship to effectiveness, although self-appraisal by teams was a key driver of the performance processes that led to effectiveness. The

challenge will be to encourage dynamic lateral processes but not to formalize them to the extent that they are no longer responsive to the changing context and rapid innovation that must occur.

In sum, high technology drives its own special brand of performance management. As high tech firms grow and mature, they must evolve practices and processes that fit with their own nature.

Table 1

HIGH TECHNOLOGY AND ITS IMPLICATIONS

Dimensions of Technical Knowledge		Implications
"High"	"Low"	For People
Complex	vs. Simple	Hard to learn
New	vs. Established	Not generally understood
On Edge of Development	vs. Complete	Requiring invention
Rapidly Progressing	vs. Static or slowly developing	Requiring quick response to keep up
Systemic	vs. Isolated	Interdependence among people, individual knowledge bases incomplete for tasks, individual contribution has systemic effects
Contingent	vs. Linear	Unpredictable development, uncertainty

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MODEL

CONTEXT

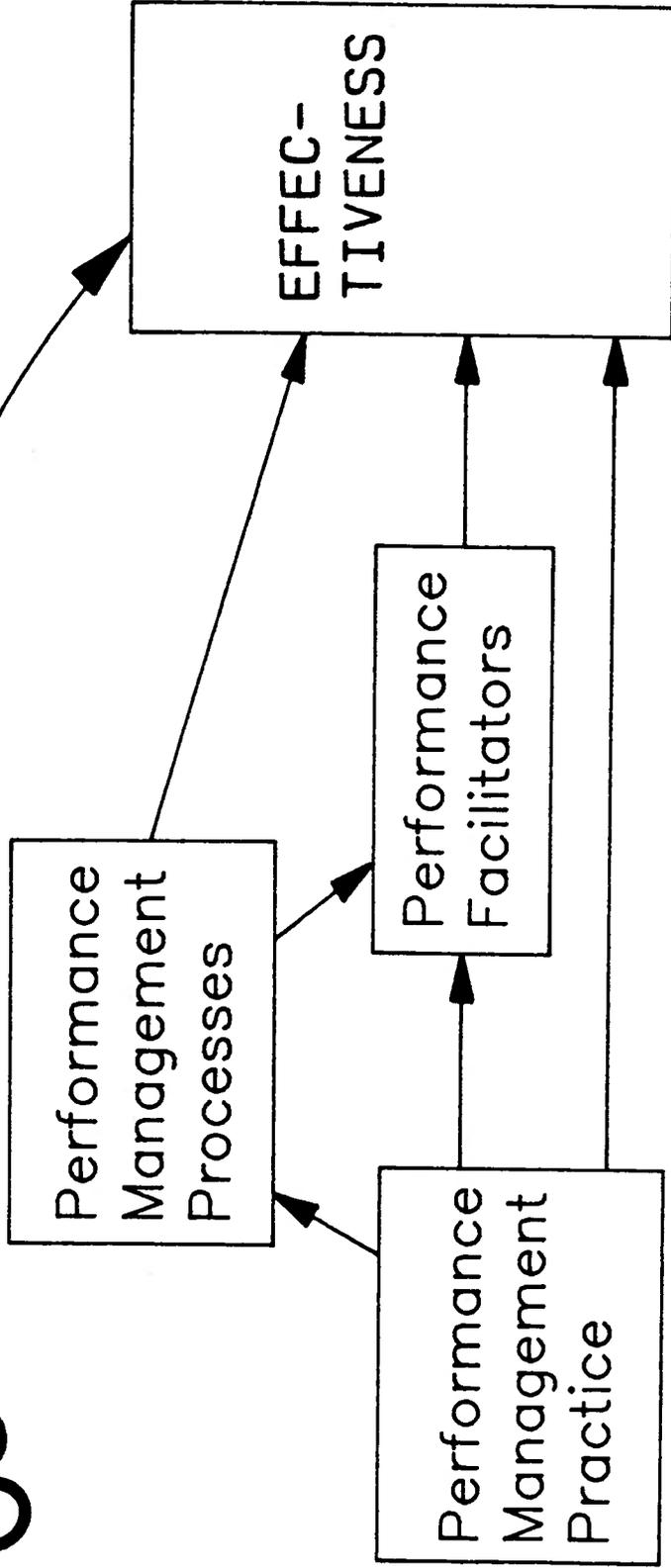


FIGURE 1

Figure 2

Paths Leading to Individual Performance

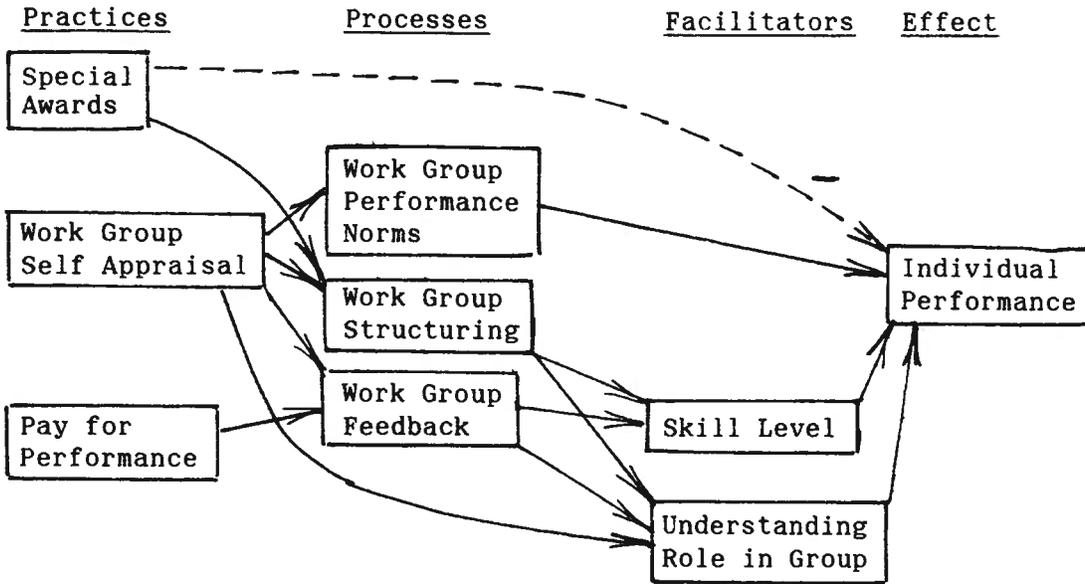


Figure 3

Performance Management
Paths Leading to Work Group Performance

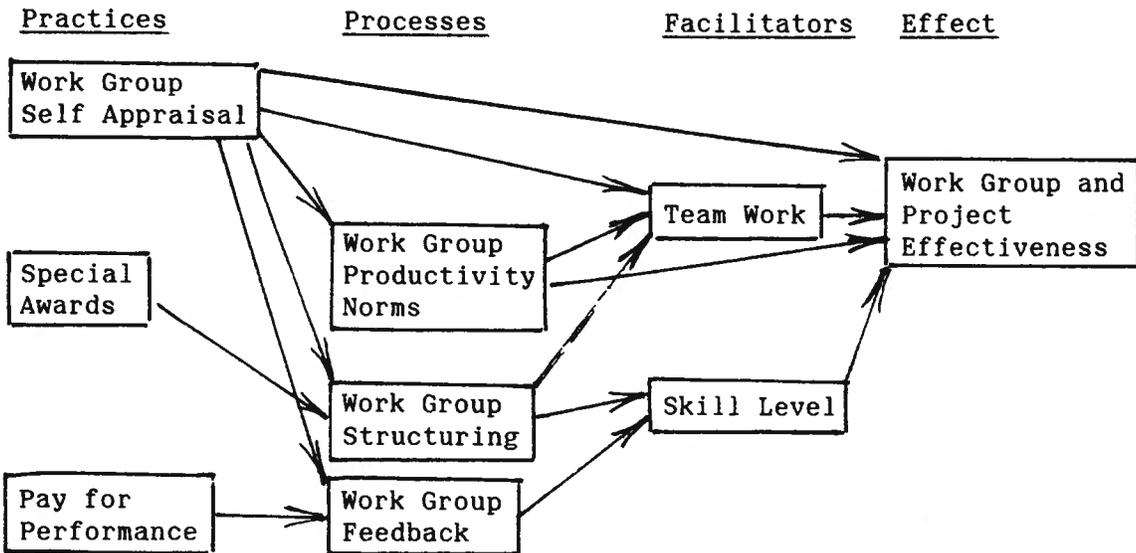


Figure 4

Performance Management
Paths Leading to Meeting Schedules

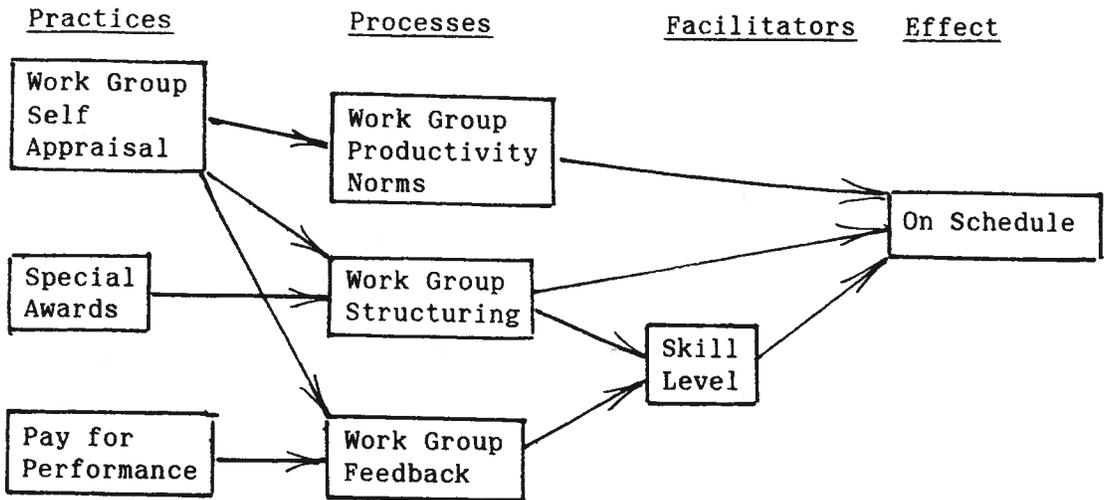


Figure 5

Performance Management
Paths Leading to Affective Outcomes

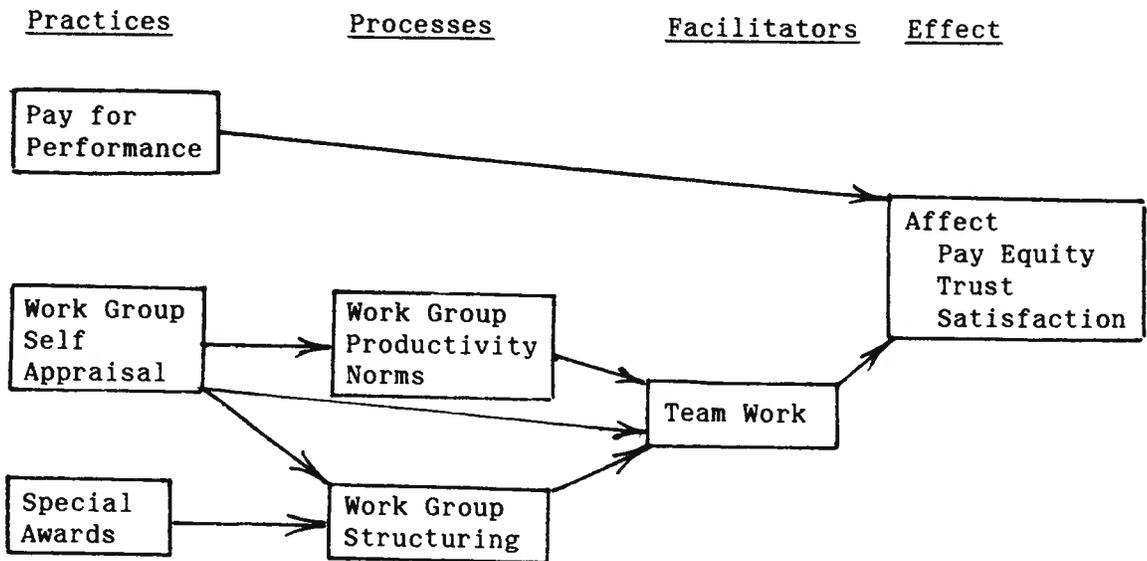


FIGURE 6
**TEAM AND INDIVIDUAL
PERFORMANCE MANAGEMENT**

ORGANIZATION **GROUP** **INDIVIDUAL**

DEFINE PERFORMANCE

STRATEGY ↔ MISSION ↔ GOALS, RESPONS.
BUSINESS PLAN GOAL SETTING & WORK PLANNING
PERF. STRATEGIES

DEVELOPING PERFORMANCE

ORGANIZATIONAL DESIGN ↔ TEAM DEVEL. ↔ DEVELOPMENT OF SKILLS AND UNDERSTANDING
ON GOING FDBK ↔ COORDINATION ↔ ONGOING FDBK.

REVIEW PERFORMANCE

REVIEW ↔ REVIEW, MEASURE & EVALUATE ↔ REVIEW

REWARD PERFORMANCE

ORGANIZATIONAL PERFORMANCE REWARDS ↔ TEAM REWARDS ↔ REWARD

REDEFINING PERFORMANCE

STRATEGY ↔ IMPROVEMENT ↔ GOALS, RESPONS.
BUSINESS PLAN STRATEGIES & WORK PLANNING