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Productivity Improvement Efforts in Army Organizations: An Overview

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This paper presents an overview of the types of productivity improvement efforts being conducted in both the civilian and military segments of the Army during 1983. The activities of the formal Army programs, which are associated with comptroller offices, typically reflect the traditional industrial engineer approach stressing efficiency, with relatively little emphasis on behavioral science concerns. An exception is the Productivity Enhancement, Measurement and Evaluation Program, which includes projects such as quality circles that

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are based on behavioral science principles and techniques. The activities of the Army's Organizational Effectiveness (OE) Program do not usually make productivity improvement their principal focus, although productivity indicators may be used to evaluate OE operations. Examples of Army productivity improvement projects based on behavioral science approaches are presented. These include gainsharing, quality circles, and organizational interventions founded in sociotechnical systems theory. Problems encountered in the measurement of productivity are discussed, and a pilot study to develop and test measures of scientist/engineer productivity is also described. Recommendations made include (1) greater coordination and collaboration among people managing, planning, and implementing productivity improvement efforts; (2) use of multidisciplinary teams in such efforts; (3) increased awareness of the difficulties involved in productivity measurement; and (4) the need for designing productivity measurement systems to ensure that they reflect organizational goals and are integrated with employee's personal goals.

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PRODUCTIVITY IMPROVEMENT EFFORTS IN ARMY ORGANIZATIONS: AN OVERVIEW

In recent years, there has been an increasing concern in the United States about our national declining rate of productivity gain. This concern has resulted in numerous productivity improvement efforts and a corresponding increase in books and articles on the subject. The April 1983 American Psychologist, for example, devoted 42 pages to "Economic Productivity and the Behavioral Sciences."

Concern about productivity has been voiced not only in private industry but also in the public sector, including the military. During the last few years, the United States Army has initiated a number of programs whose goal is to increase productivity in a variety of Army organizations. Accordingly, the purpose of this paper is to present an overview of the types of programs being conducted in the Army to improve productivity. An additional purpose of this paper is to comment on some of the issues associated with the implementation and evaluation of such programs.

Method

There were two main sources of information of Army productivity improvement programs: (a) productivity offices, which are generally located within the comptroller function in various Army organizations, and (b) Organizational Effectiveness offices, which may be located at Army installations, at the Organizational Effectiveness Center and School (OECS), at Major Command (MACOM) Headquarters (and their associated subcommands), and the Department of the Army Headquarters (HQDA).

Although the original intention was to collect information on each productivity effort in the Army, this approach was discarded due to the scope of the task. There were too many productivity projects in operation to identify them all. Consequently, the objective was changed to acquiring information on types of programs. Information was obtained through telephone conversations, face-to-face interviews, and printed material.

Findings

Army Productivity Programs

Most of the formal productivity programs are located in Comptroller offices through the Army. The efforts which emanate from the Organizational Effectiveness (OE) offices generally do not have productivity improvement as their primary focus. These two types of programs are described briefly below.

Comptroller office programs. Most Army productivity improvement programs are associated with Comptroller offices. Figure 1 depicts these programs, and Appendix A describes them in detail. The Comptroller is charged with the management analysis function (at all Army levels below Department of the Army Headquarters), and these programs typically reflect the traditional industrial engineer approach stressing efficiency with relatively little, if any, emphasis on behavioral science concerns. The Productivity Enhancement, Measurement, and Evaluation program is an exception. For example, the US Army Materiel Development and Readiness Command (DARCOM) counterpart of this program ("RESHAPE") includes productivity improvement programs such as quality circles and gainsharing, which are clearly based on behavioral sciences principles and techniques.

OE-related projects. The objective of the Army's OE program is to provide assistance to commanders for improving mission performance and increasing combat readiness. This assistance is supplied by OE consultants (commissioned officers, noncommissioned officers, and civilians) who use management and behavioral sciences technology to improve the effectiveness of Army organizations. Most of the interventions conducted by OE consultants are not specifically directed at productivity improvement, although productivity indicators may sometimes be used. Table 1 summarizes the frequencies of a variety of indicators OE consultants reported using during a six-month period (Oliver, 1981). The three most frequently used indicators were user comments, "gut feeling," and interviews, with productivity indices such as personnel turnover, equipment maintenance, accident rate, and materials reduction much less frequently used. Appendix B contains a discussion of the OE approach and its relationship to productivity improvement.

Examples of Some Army Projects

Gainsharing. Gainsharing is a systematic approach to increase productivity through monetary inducements. Gainsharing in Army organizations is similar to profit sharing in business and industry. The RESHAPE program, previously mentioned, is DARCOM's counterpart of the DA-level EEMI program. RESHAPE encourages managers throughout DARCOM to find ways to increase productivity. One of the tools managers can use to attain this goal is through Productivity Gainsharing. A productivity gain (PG) is achieved when actual hours taken to perform a task are less than the predetermined time estimate (earned hours). This gain is translated into dollars by applying a per hour base labor rate (BLR). The resulting figure is then distributed to eligible employees on a basis determined by local management (but which cannot exceed 50% of the total saved). To summarize:

$$\text{PG} = \text{Earned Hours} - \text{Actual Hours} \times \text{BLR}$$

$$\text{Employee Share} = \text{PG} \times \leq 50\%$$

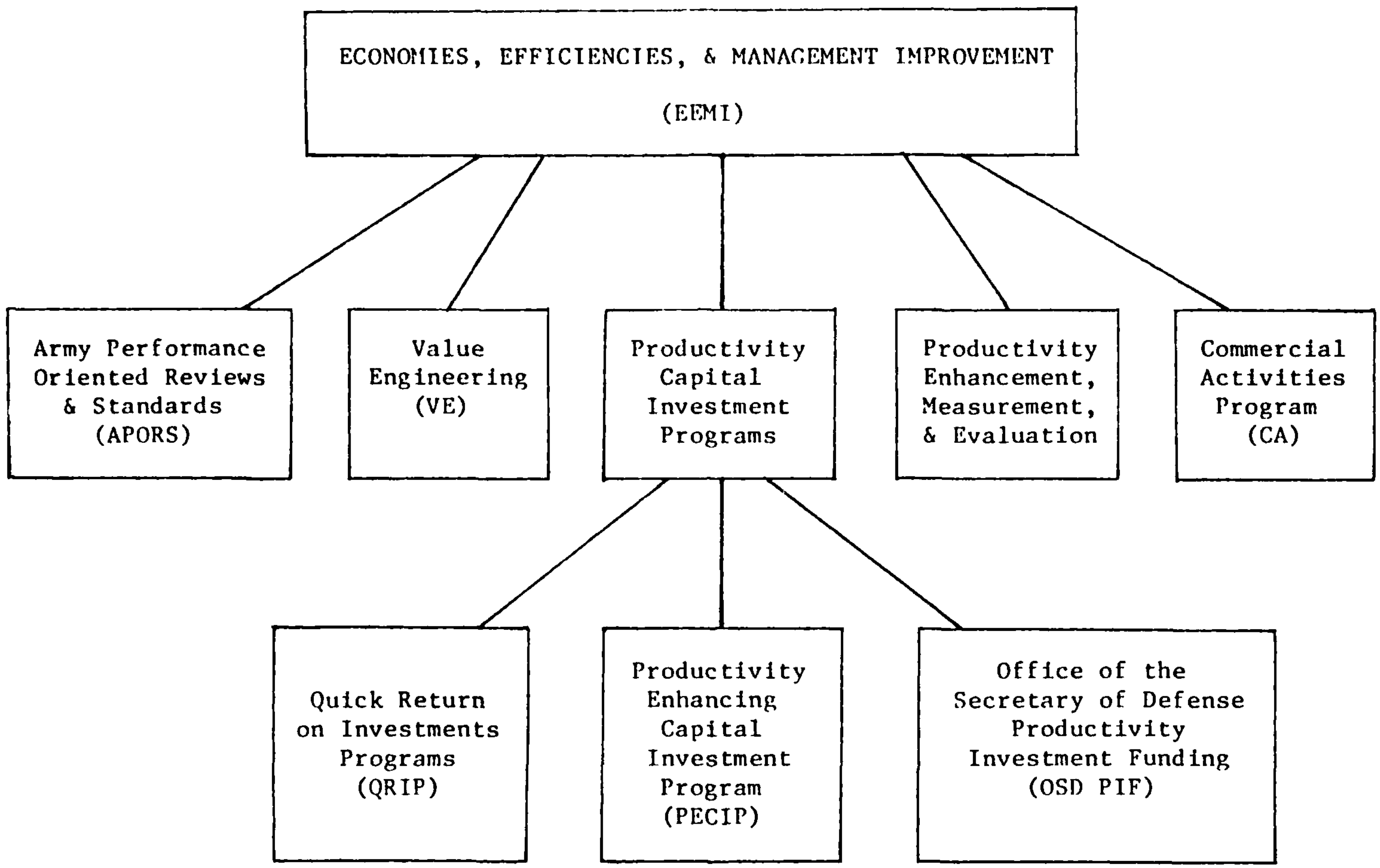

Figure 1. Army Productivity Improvement Programs Associated with Management Analysis Function

Table 1

Use of Selected OE Evaluation Indicators during A Six-Month Period[a]

Indicator	Number of Consultants Using Indicator (N=150)	Average Number of Times Used
User comments	136	9.4
"Gut feeling"	123	13.2
Interviews	122	7.5
Self-designed questionnaire	91	4.5
GOQ[b]	63	3.5
Civilian personnel turnover	37	2.6
Equipment maintenance	37	3.8
Time reduction (for task)	21	2.0
Accident rate	15	2.0
Materials reduction	1	30.0

[a]Adapted from Oliver, 1981

[b]The General Organization Questionnaire (GOQ) is a military version of the Survey of Organizations (SOO). The SOO was developed by the Institute for Social Research at the University of Michigan.

Gainsharing programs are now being implemented at eight sites: at the Armaments Research Development Command, at the Army Missile Command, and at six Army depots. The number of persons involved in the Gainsharing projects ranges from 17 in a travel voucher processing group to 455 in a depot which overhauls and repairs tank engines and transmissions. DARCOM has concluded that, for the short term at least, productivity has been increased as a result of the implementation of Gainsharing. In the initial tests at the eight sites involving a total of 853 employees, over 74,000 personhours were saved. The amount paid to employees of the amount saved amounted to approximately $376,000.

As a result of their initial experience with Gainsharing, DARCOM has concluded that certain positive conditions are needed for successful implementation of a Gainsharing program. For example, both management and employee involvement are very important, and the site must be a manageable size (e.g., a depot with 26 work centers may be too large). In addition, performance must be measurable and workload forecasting feasible. DARCOM also cautions not to use Gainsharing in a static or declining workload situation.

Quality circles. There are several hundred quality circles now operating in Army organizations. DARCOM has about 350 quality circles, about two-thirds of which are in the Depot Systems Command (DESCOM), a subcommand under DARCOM. The DESCOM program is the largest such program within the Army. The basic principle underlying quality circles and related efforts is that, given the opportunity to do so, people at any organizational level can generate creative solutions to operational problems. Although quality circles vary from location to location, they usually involve a dozen or so volunteers who meet together regularly, typically for about an hour a week. The general approach is for the group to identify problems, to analyze the problem situation, to develop solutions, and to implement those solutions after management approval. Although evaluation requirements are built into the quality circle approach, measurement of change has not proved to be particularly easy or satisfactory.

In general, little attitudinal change has been documented as a result of quality circles. Specific measures, tailored to the individual site, seem better able to tap into changes. Sometimes the problem solutions require a trade-off in resources. At one location, salvaging parts of a stressed rotor assembly led to an overall saving in money in spite of the increased manpower required to repair the item. It is estimated that the DESCOM quality circle program has resulted in about a two for one return on investment (ROI). That is, when the program costs (startup, sustenance) are taken into account, the cost avoidance is on the order of that ratio (T. Siciliano, personal communication, July 25, 1983).

It has not always been easy to identify tangible changes resulting from quality circle projects, and management support for such projects has sometimes been lacking (S. Strub, personal communication, August 5, 1983). In an effort to overcome the problem of supervisors being unable to detect measurable changes in their work centers, a goal-setting approach is being undertaken in the quality circle program at the Corpus Christi

Army Depot. The members of the quality circle first identify the goals of their work center and look at all the data that tell them how well those goals are being attained. If, for example, the work center is tasked to repair, say, 50 items per month and they actually do 65, this outcome may seem exemplary until they find out that 20 of the items are returned for rework due to defects. Their goal, then, might be to reduce those defective items by a given number within a certain period. The idea behind the goal-setting approach is to reduce resistance by supervisors to a group of workers spending an hour a week in a meeting away from the job. Supervisor resistance can be expected to diminish significantly if this expenditure of time results in measurable benefits to the work center.

Konarik and Reed (1981) and Reed (1982) have described a military adaptation of the quality circle concept called the Work Environment Improvement Team (WEIT). This approach was developed at the Organizational Effectiveness Center and School (OECS) at Fort Ord, California. Konarik and Reed (1981) have defined WEITS as "voluntary groups of people who have a shared area of responsibility, report to the same supervisor and are able to address the same problems using problem-solving techniques (p. 95)." These authors stress that the members of the WEITS are average soldiers, who not only identify problems in their work environment but also analyze and seek solutions to those problems. In addition, the soldiers brief higher organizational levels on their analyses and recommendations. Because of personnel turnover at OECS, it has not been feasible to ascertain the overall impact of the WEITs on the Army.

It was possible, however, to follow up on the quality circle approach employed by OE consultants at the White Sands Missile Range. Quality circles have been initiated there with four different types of groups: computer scientists, secretaries, mechanics, and an all-military group. The all-military team redesigned the procedure for handling a leave and control form (DA Form 31) by eliminating 18 steps of a 32-step process for a cost savings of $18,000 per year. The overall results of the initial seven-month quality circles trial at White Sands demonstrated that a $10K expenditure had led to a $400K savings (J. Kirkland, personal communication, August 2, 1983). The success of this project is attributed to the training program emphasis on documentation.

Sociotechnical systems. Another approach to productivity enhancement is based on sociotechnical systems theory. Briefly, this formulation holds that an organization comprises two systems--a technical system incorporating the technological or procedural aspects of an organization and a social system representing the people or human component of an organization (Villagomez & Price, 1981). Although there are some differences among practitioners, the sociotechnical systems approach generally specifies an overview or scan of the organization to identify its goals, operations, boundaries, environment, etc. followed by analyses of both the technical and social systems. The technical systems analysis details the unit operations of the organization in terms of their inputs, outputs, and the transformations that occur from the time the inputs enter the system until the outputs exit the system. Part of the technical analysis is concerned with identifying the "variances"--i.e., problem areas caused by discrepancies between the way things are actually done and the way they should be handled. Some of these deviations from the norm are identified as "key variances" because they are critical to the overall functioning of the technical system.

The social system analysis delineates the work-related interactions among the people in the organization. The social analysis indicates which group or individual interactions are suboptimal and where existing organizational structures are not conducive to good communication. The social analysis also shows how the goals of the organization are related to the social system and the degree to which the organization is able to adapt to its environment.

Another aspect of the social system analysis reveals the long-range plans of the organization and the role the development of its individual members plays in the organization's orientation and future. These analyses of the social and technical systems are carried out by a task force or core group of volunteers representing the various areas and levels of the organization. This group then reviews the analyses to determine whether any changes are needed in the organization. If changes are called for, the group recommends redesigning the organization in order to obtain a better match between the technical and social systems. Sometimes this process is referred to as "joint optimization" to indicate that neither the social system nor the technical system is optimized at the expense of the other, but rather they are jointly optimized to design an organization which maximizes both systems.

OE consultants in the Army have employed the sociotechnical systems approach in a number of OE operations. A sociotechnical systems intervention in an Army transportation company has been described by Villagomez and Price (1982). The recommendations made and implemented by the transportation company task force, after their analysis of the social and technical systems, had substantial impact. The changes which were made resulted in the elimination of 51 personnel spaces (one complete platoon), yet the company continued to perform its assigned mission and to do so more effectively than it had previously. In addition, reenlistments increased.

A project now underway at the Corpus Christi Army Depot (CCAD) is the largest sociotechnical intervention that has been conducted in an Army organization. CCAD is a helicopter repair and overhaul facility employing some 4000 people. The intervention, focused on the Air Frames Division of the facility, involves about 900 persons. Originally guided by two outside consultants, the Depot is now on its own in the process of implementing the recommendations for organizational redesign made by the core group which conducted the analyses of the social and technical systems. Most of these recommendations involved organizational realignments to facilitate communication and cooperation. Other recommendations concerned the creation of two new positions and the initiation of (overdue) training. The US Army Research Institute (ARI) is evaluating the project by monitoring the process and feeding back the results of this formative evaluation to the Depot.

ARI is also responsible for a summative evaluation which will document the outcomes of the intervention. As with all attempts at organizational change, this intervention has been met with cynicism, suspicion, and hostility by some and with hope, high expectations, and exuberant enthusiasm by others. Because of the very strong support by top leaders and managers at the Depot and the dedicated work of the core group, conditions seem favorable to the eventual success of this sociotechnical intervention. Difficulties encountered in attempting to measure change in the organization will be described later.

Discussion

Need for Coordination and Collaboration

There are a multitude of productivity efforts being conducted in the Army. These range from mandated, large-scale programs to limited one-shot interventions designed to solve a specific problem. The resource constraints which the Army has experienced, and which it will continue to experience, dictate the continuance and expansion of efforts to increase productivity in Army organizations.

There are benefits to be gained from coordination and collaboration among the various organizational elements responsible for Army productivity efforts. Accomplishing such interaction is especially difficult when there are no formal mechanisms for doing so--for example, between DoD and the services and among the services themselves. This is not to suggest that formal mechanisms for insuring coordination be established. There is, however, a real need for all the actors in the productivity arena to develop an awareness of each other and plan to devote a portion of their work to exchanging ideas and information about their activities. Much can be accomplished by a substantive interaction between Army productivity efforts rooted in the behavioral sciences and those emerging from industrial engineering and management analysis. OE operations could profit from the rigor of the industrial engineer, while the comptroller-related programs could benefit from a greater sensitivity to the people aspect of their productivity projects.

ARI and its counterpart organizations, the Navy Personnel Research and Development Center (NPRDC) and the Air Force Human Resources Laboratory (AFHRL), could play key roles in enhancing the coordination and collaboration among DoD and the various services. Since these three laboratories are already engaged in productivity research, it would be desirable to disseminate their efforts more broadly among the military community. The research function of these three organizations could, in conjunction with the Department Productivity Program Office (DPPO), provide a linkage among the various agencies and organizations within DoD that are concerned with productivity enhancement. (DPPO is in the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics.)

Measurement of Organizational Change

Need for measurement. One of the major obstacles to the successful implementation of an organizational change lies in the difficulty of measuring the effects of that change. Developing reliable and valid measures of organizational productivity, for example, can be an extraordinarily difficult task. The more complex the system and the more numerous its interactions with the environment, the more difficult it is to measure the productivity of the system. The severity of the measurement problem is well recognized by the Defense Productivity Program Office (DPPO), and they stand ready to help as well as to learn from those who are attempting to devise reliable and valid productivity measures.

Measurement problems are not unique to productivity measurement. The "criterion problem" has troubled psychologists and others for many decades. Organizational researchers have found (e.g., Pennings, 1981) that measures of the same variable at different organizational levels may even be inversely related to each other. It is also puzzling and discouraging when participants and observers perceive change but cannot seem to document that change. Brickell (1982) has related an account of repeated attempts to develop instruments to measure the outcomes of an intervention which all concerned believed had had positive effects.

Selection of productivity measures. Many organizations have literally hundreds of productivity measures from which to select, and a researcher must first develop some criteria for selecting some measures and rejecting others. In addition to reliability and validity, some criteria which have been suggested include objectivity, nonreactivity, availability, ease of administration or collection, ease of scoring, and specificity (Oliver & Spokane, 1983). Multiple measures are generally desirable, especially for a large organization, and the measures must be relevant to the variable they are intended to measure. Ideally, key variances can be used to create work group or larger system measures (J. C. Taylor, personal communication, September 26, 1980). If key variances represent organizational problem areas, then being able to track changes in these areas would indicate whether improvements are taking place. Taylor also has stressed that, where possible, the system should own the measures and "not the accountants, social scientists, or time study men."

The level of analysis is another factor which needs to be taken into account. Many conventional performance measures have been at the individual level, but group (even system-wide) measures may be more appropriate for many applications. The heterogeneity of the availability measures may also complicate the selection of measures. When measures are selected from among those available, the specific variable must be identified. For example, instead of requesting the "number of rework manhours," one must specify which rework manhours from which data source. Data are available on some variables at all levels from the individual to the entire system, and the reporting periods may vary from level to level. This lack of uniformity inevitably complicates interpretation of data.

Confounding of variables. Interpreting productivity data is often made difficult by the occurrence of changes which are not directly related to the intervention. At CCAD, for example, the size of the work force is increasing independently from the implementation of the intervention. In one respect, this change alone would seem to assure an increase in productivity. But this is not always the case, since many of these new workers are inexperienced. The result of this inexperience may be a decrease in the per capita productivity of the Depot, at least initially, until the new workers have acquired enough training to be fully productive workers. Unscheduled special projects may also interrupt the normal work flow and make it difficult to determine the relative effect of the unpredicted event. Co-occurrence of other interventions, such as quality circles, may also result in productivity increases. The joint effects of the several innovations may be so confounded that it is impossible to attribute specific changes to each intervention.

One of the results of the sociotechnical systems analysis at CCAD was to highlight the urgent need for various kinds of training. Since training requires time away from the job, instigation of system-wide training will likely work to decrease productivity before any increase can be noted. The interdependence of work centers within a system also serves to obscure the causes of observed change, while environmental events occurring outside the system can affect a carefully monitored measure. For example, change in an Army regulation, or a directive from DESCOM Headquarters concerning overtime, might drastically affect the usefulness of overtime as an index of productivity.

Need for multiple measures. Productivity is a multidimensional concept. As such, it calls for varied types of measures: different variables (domains), different modes of data collection, measurement at different organizational levels, etc. The average number of manhours to complete one unit might be one aspect, the number of customer complaints might be another. The number of manhours can be for regular time, overtime, direct labor, indirect labor, etc. Customer complaints may represent different kinds of problems depending on whether they occur before delivery or after delivery. Lost time due to sickness may be another productivity variable of interest. However, average sick leave for a small work center may be badly distorted by one individual who is absent for weeks or months because of a serious illness. One might then wish to examine more than one type of sick leave--that falling into the one-day category, sick leave of two to four days duration, and sick leave of a week or more.

More than one method can be used to collect data: observations, interviews, experts' ratings, surveys, and archival records. If similar results are obtained for variables measured by different methods, one can be more confidant that one is tapping a legitimate effect and not an effect due to the measurement (Campbell & Fiske, 1959; Webb, Campbell, Schwartz, Secrest, & Grove, 1981).

In addition to planned measures, one should be alert for serendipitous outcomes. At the Corpus Christi Army Depot, Combined Federal Campaign contributions were far higher during the 1982 drive than they had been the year before. Could this result have been, in part, due to the spinoff from the sociotechnical intervention being implemented at that time? To answer this question, one needs to determine if there are other differences between the way the Combined Federal Campaign was conducted in the two years being compared. There may have been differences in training campaign workers, or there may have been some other local reason--economic or social--that prompted employees to respond more generously than during the preceding Federal campaign.

Other measurement issues. In an insightful essay on productivity, John Campbell (1983) refers to the substantial literature documenting the powerful effect feedback can have on behavior (e.g., Komaki, Collins, & Penn, 1982). Here again measurement is important. Feeding back information about individual and group performance can provide a powerful motivational force. Campbell (1983) states, "To the extent that productivity type indices can be developed that can be validly communicated in some fashion and the individuals in the (organization) view them as credible, fair, and congruent with the organization's goals, the effect on performance should be significant" (p. 13). Campbell cautions that such an approach can be mismanaged and that it is not an easy task to make it work.

Campbell (1983) also raises the question of how hard people should be expected to work. If motivational techniques such as feedback can dramatically increase productivity, how far should these increases go? This issue has not been thoroughly addressed by productivity researchers, although it has been a traditional concern of labor unions.

Development of System to Measure Productivity of Scientists and Engineers

The US Army TRADOC Systems Analysis Activity (TRASANA), located at White Sands Missile Range, New Mexico, conducts land combat research and specializes in cost and combat effectiveness of proposed and developmental weapon systems. In 1979, TRASANA addressed the requirement to measure the productivity of the approximately 240 professional technical personnel in the organization. TRASANA management first surveyed existing productivity measurement systems by reviewing the literature and by consulting with management experts. But almost all of the existing measurement theory and practice concerned manual processes such as manufacturing, hardware assembly, or clerical output. No existing systems were found for measuring the productivity of scientific or professional individuals or organizations. Consequently, TRASANA was forced to design a system in-house to measure the productivity of its own scientists and engineers. The TRASANA Productivity Measurement System (TPMS) was developed over a period of about 15 months, including a six-month pilot program. As a result of the pilot test, some design changes were made, and full-scale implementation of the program began in 1980. The plan was for the system to be in a test mode for three years, at the end of which time a management decision would be made concerning its continuance (Meier, 1982).

At TRASANA, projects constitute most of the technical workload. The output or product of these projects is typically a report or an analytical tool. Examples of projects would be to evaluate the cost/effectiveness of an artillery training system or developing a new ground combat simulation. Project products could be a report for the training system project or software plus documentation for the simulation.

Under TPMS, each project is evaluated and given a project score when it is completed. The project score is based on four factors: (a) product quality, a rating given by a Product Review Board of peers; (b) project timeliness, determined by how closely product completion met the target completion data; (c) manpower utilization efficiency, the ratio of planned man-months to actual man-months required on the project; and (d) computer utilization efficiency, the ratio of planned central processing unit (CPU) hours to actual CPU hours. The four factor scores, which are multiplied to obtain the project score, can theoretically range from .54 to 2.614.

Productivity points are calculated by multiplying each project score by the number of man-months spent on the project. Time chargeable to overhead is also converted into productivity points. In addition, managers have the discretion to adjust points, within limits, when inequities arise. These productivity points are distributed to the organization managers who assign points to the organizational elements (e.g., division or branch) involved and also to the people who worked on the project. A productivity index is calculated by summing the individual's productivity points and dividing by the total time expended on all projects by that person. A productivity index for an organizational element is calculated similarly--dividing the total productivity points by the total man-months.

A comparison of the first (nine-month) TPMS scoring period with the second (one-year) scoring period revealed that the productivity index was higher for the second period. This increase was due both to higher project scores and to a reduction in time charged to overtime (which is allotted productivity points at a rate somewhat below the average productivity points for projects).

TRASANA also evaluated TPMS at the end of its first year of operation. The evaluation team used first year scoring data and data collected from interviews and questionnaires. The team concluded that TPMS was generally relevant to the organization and that the factors on which the productivity scores were based were related to classical definitions of productivity. However, the manpower efficiency factor required some refinement due to the difficulties in estimating manpower required by projects. Some of the component elements of the system did not work as well as others. The productivity index values for individuals did not correlate well with confidential supervisory ratings, although the productivity index values for organizational elements seemed fairly well in line with expectations. Also, the use of discretionary points proved not to be uniform throughout the organization. At the time of the evaluation, no conclusions could yet be drawn concerning the system's affordability (the added administrative cost appeared to be under one percent of total technical manpower) or its flexibility to cope with a dynamic workload due to insufficient data. One of the primary benefits of the system seemed to be in its emphasis on better planning, forecasting, and resource expenditure reporting. Besides measuring productivity, TPMS clearly affected the behavior of the participating work force. TPMS had a strong motivating effect, and considerable design effort was expended in dealing with the motivational aspects of the system. The initial trial period made clear that what is measured becomes the goal. Consequently, management goals must be directly measurable in a system which serves both as a measurement system and as a motivational device.

The TRASANA experience has been described in some detail because it is an innovative approach to the problem of measuring the productivity of technical professional personnel.

Conclusions and Recommendations

This paper has presented an overview of Army efforts to increase productivity. It was found that a great many Army programs and projects have productivity enhancement either as their primary goal or as an ancillary purpose. Programs are being planned and implemented by a wide variety of persons--industrial engineers, management analysts, psychologists, OE consultants, and others. Because of the complex nature of the productivity concept and the fact that it deals with systems of technology and of people, this diversity is desirable. What is not as desirable is the fact that productivity improvement efforts rarely take advantage of this diversity of disciplines. The authors of this paper believe that Army productivity improvement programs would benefit greatly from the cross-fertilization of the skills and knowledge of people representing a variety of backgrounds.

Sociotechnical systems analysis is an approach which seems particularly suited to multi-disciplinary efforts to increase productivity. This approach places equal emphasis on the technical system and the social system and attempts to optimize both in designing or redesigning an organization. The sociotechnical intervention at the Corpus Christi Army Depot was initiated with the help of two consultants, one of whom was a psychologist and the other an engineer. Thus this project had the advantage of drawing on behavioral science as well as technological expertise.

One of the disadvantages of the Army system is that commanders are not in a position long enough to initiate and carry out long-range solutions to problems. This being the case, sociotechnical approaches may be most practical for Army organizations composed largely of civilians. As the example of the transportation company suggests, sociotechnical interventions can also be very successful in a military setting.

Both practitioners and researchers agree that monitoring productivity changes poses a difficult measurement problem. First, one must decide which variables, of innumerable possibilities, to measure. Making such decisions before an intervention takes place simplifies the collection of baseline data. It is also necessary to recognize that unintended outcomes will occur and to plan to observe and measure these unpredictable events.

Second, one must determine how to measure the selected variables. The multitude of computer printouts available in most organizations complicates the selection of measures, and often one is limited to existing data. If it is feasible to design specific measures ahead of time, then more appropriate variables may be measured. Devising measures which directly tap the key variances in a sociotechnical systems intervention, for example, should result in more meaningful measurement. Even when good measures have been planned and the data collected, interpretation of the results may be problematic. It is often difficult to untangle the confounded causes and results in a complex organization. Thus it is of extreme importance to document all occurrences that might have an effect on the variables being tracked.

After reviewing the scope and nature of Army efforts to increase productivity, the following recommendations are made:

1. A much greater degree of systematic coordination and collaboration is needed among people managing, planning, and implementing Army productivity enhancement efforts. As research organizations, ARI, NPRDC, and AFHRL could play a role in disseminating their productivity research results and serving as technical resources. The DPPO, with its DoD perspective, could also serve as a coordinating agency as well as provide technical assistance to managers, planners, and implementers. Recently there have been a number of productivity conferences and meetings. It would be helpful to have some central clearing house for such conferences and meetings. Since business and industry have been increasing their activity in the productivity area, defense productivity people could benefit from increased interaction with productivity activities outside of the military world.

2. To the greatest extent possible, productivity enhancement programs and projects should involve people representing a variety of disciplines. Behavioral scientists, for example, could likely contribute to the comptroller-related programs which tend to be less concerned with social systems than with the technological aspects of those programs. The OE-related projects, on the other hand, would clearly profit by the application of greater scientific and technological rigor. Results-oriented OE is a move in this direction (Mitchell, 1980).

3. Everyone involved in productivity enhancement needs to be aware of the problems associated with the measurement of productivity and work intensively toward the solution of those problems. One of the two functions of DPPO is productivity measurement and evaluation. This office, along with researchers at ARI, NPRDC, and AFHRL, can provide guidance to the field with respect to measurement.

4. Since that which is measured becomes the goal (Meier, 1982), great care must be taken in designing measurement systems to insure that they reflect goals and are integrated with the personal goals of the employees.

Final Comment

Productivity improvement programs are currently very much in fashion in both the public and private sectors. Accordingly, their initiation may arouse unrealistic expectations with subsequent disillusionment. Thus it is imperative to keep in mind Campbell's (1983, p 11) warning, "There are no quick fixes, and nothing will substitute for careful problem analysis and long-term commitment to painstakingly worked out solutions."

References

Brickell, H. M. (1982). Needed: Instruments as good as our eyes. In J. D. Krumboltz & D. A. Hamel (Eds.), Assessing career development (pp. 103-122). Palo Alto, CA: Mayfield Publishing, 1982.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multi-trait multi-method matrix. Psychological Bulletin, 56, 81-105.

Campbell, J. P. (1977). On the nature of organizational effectiveness. In P. S. Goodman, J. M. Pennings, and Associates, New perspectives on organizational effectiveness (pp. 13-55). San Francisco: Jossey-Bass.

Campbell, J. P. (1983). I/O psychology and the enhancement of productivity. The Industrial/Organizational Psychologist, 20, pp. 6-16.

James, U. S., & Oliver, L. W. (1981). A preliminary assessment of the impact of the Army's Organizational Effectiveness (OE) program (ARI Working Paper LMTA 81-4). Alexandria, VA: US Army Research Institute for the Behavioral and Social Sciences.

James, U. S., McCorcle, M. D., Brothers, A. J., & Oliver, L. W. (1983). Analysis of the impact of the US Army Organizational Effectiveness (OE) program (ARI Working Paper No. LMTA 83-1). Alexandria, VA: US Army Research Institute for the Behavioral and Social Sciences.

Konarik, R. B., & Reed, W. (1981). Work Environment Improvement Teams: A military approach to quality circles. OE Communi[illegible], 5(2), 94-101.

Meier, D. H. (1982, October). Productivity measurement for operations researchers. Paper presented at the Army Operations Research Symposium, Fort Lee, VA.

Mitchell, E. (1980). Results oriented OE. OE Communique, 4(3), 68-73.

Oliver, L. W. (1981). Organizational Effectiveness Staff Officer (OESO) perceptions of the Army's Organizational Effectiveness (OE) program (ARI Research Note 83-16). Alexandria, VA: US Army Research Institute for the Behavioral and Social Science.

Oliver, L. W., & Spokane, A. R. (1983, April). Construct validity in career counseling outcome measurement. Paper presented at the meeting of the American Educational Research Association, Montreal.

Smith, P. C. (1976). Behaviors, results and organizational effectiveness: The problem of criteria. In M. D. Dunnette (Ed.), Handbook of industrial and organizational psychology (pp. 745-775). Chicago: Rand McNally.

Susman, G. E. (1983). Action research: A sociotechnical systems perspective. In G. Morgan (Ed.), Beyond method: Strategies for social research (pp. 95-113). Beverly Hills, CA: Sage:

Vallagomez, E. T., & Price, J. E. (1982). Socio-technical systems intervention in an Army transportation company: A case study. OE Communique, 6(1), 24-33.

Webb, E. J., Campbell, D. T., Schwartz, R. D., Sechrest, L., & Grove, J. B. (1981). Nonreactive measures in the social sciences (2nd ed.). Boston: Houghton Mifflin.

APPENDIX A

ARMY PRODUCTIVITY PROGRAMS

Comptroller Programs

Many of the Army productivity projects come under programs associated with the management analysis staff function. The Comptroller of the Army has traditionally been charged with the management analysis function at all levels below the Department of the Army Headquarters (HQDA).[1] Hence most of the productivity projects in the Army are originated in the comptroller offices of Army organizations.

During the past few years, the Army has implemented a number of management practices programs whose objectives are to enhance resources management. These programs include: Economics, Efficiencies, and Management Improvement (EEMI); Army Performance Oriented Reviews and Standards (APORS); Value Engineering; Productivity Capital Investment; Productivity Enhancement, Measurement, and Evaluation; and Commercial Activities.

Economies, Efficiencies, and Management Improvement (EEMI). The Army's EEMI program is an umbrella program that brings together all the Army programs and practices which achieve resource savings. These saved resources remain within the command that earned them to accomplish high-priority unfunded requirements. Major commands have developed EEMI-counterpart programs--e.g., the Training and Doctrine Command (TRADOC) program is SPIRIT (Systematic Productivity Improvement Review in TRADOC), and the Department of the Army Material and Readiness Command (DARCOM) program is RESHAPE (Resource Self-Help/Affordability Planning Effort). The purpose of the EEMI program is to identify, coordinate, collect, and document all management improvement actions and related benefits within the context of the Planning, Programming, Budgeting and Execution System (PPBES). Therefore, the specific programs which follow are all part of the overall umbrella program, EEMI.

Army Performance Oriented Reviews and Standards (APORS). Also an umbrella program, APORS implements the DoD direction to conduct efficiency reviews of all non-deployable activities not subject to contracting out. The objective of APORS is first to coordinate as many of the Army's ongoing management improvement programs as possible, including Value Engineering, Quick Return on Investment, Commercial Activities, Manpower Staffing, and others. The six-year program, which begins 1 October 1983, will have four phases. Phase 1 results in a performance work statement. This statement contains a review of the necessity and authority of the organization's functions, organizational input and output, output quality, and a resources baseline. Phase 2, an efficiency review, will tap available data to detail

[1] At HQDA, management studies are the responsibility of the Army Staff Management Directorate.

the organization's input, its processes and procedures, and the relationship of these to organizational output. Phase 3 is the work measurement phase, which uses the performance work statement and the approved recommendations of the efficiency review to determine the type of standard (e.g., manpower staffing or summary level) to be developed. Phase 4, the final phase, consists of implementing the approved efficiency recommendations and standards. This implementation may involve changes in program and budget, in organizational structures or procedures, in equipment, in addition to establishing performance indicators.

Value Engineering (VE). The VE Program provides a methodology by which to analyze each high cost element of design, procurement, production, and operation to determine how to obtain equivalent performance at lower cost. A VE program generally involves both in-house and contract efforts. The in-house aspect taps the expertise of in-house personnel in analysis and developing recommendations for cutting costs while maintaining quality. The contract aspect of VE is designed to encourage contractors to challenge unrealistic aspects of Army contracts and specifications and to share in the savings brought about by their successful proposals for changes that cut costs while maintaining quality.

Productivity Capital Investment Programs. These programs provide funds to Army commanders and managers for facilities, tools, and equipment that will result in a fast payback on the investment. There are actually three such programs,[2] which differ in amount funded, time to amortization, etc. But the purpose is to provide supplementary funding when regular budget funds are insufficient to support fast payback productivity investments.

Productivity Enhancement, Measurement, and Evaluation. This program involves three aspects of productivity. Productivity enhancement efforts are actions designed to increase productivity by increasing output (goods produced or services rendered), quality (of goods or services), timeliness of delivery, customer satisfaction, or quality of working life. Productivity measurement provides an objective means of assessing or planning an organization's attainment of predetermined goals. Productivity evaluation is an assessment of productivity changes by comparison with program guidance, goals, standards, prior results, and others performing similar functions.

Commercial Activities (CA) Program. The CA program implements a general policy (prescribed in the Office of Management and Budget (OMB) Circular A76) that the Government will rely on the private sector for goods and services when it is appropriate and economical to do so. In the Army, activities of combat, combat support, and combat service support

[2] They are: the Quick Return on Investments Programs (QRIP), the Productivity-Enhancing Capital Investment Program (PECIP), and the Office of the Secretary of Defense Productivity Investment Funding (OSD PIF).

units as well as overseas activities are excluded from the Army CA program. All other Army activities that provide services available from private commercial sources are reviewed to determine if the activity should be performed by Government civilian or military personnel. There are a number of reasons why in-house performance may be required. For example, the activity may be needed for deployment, to support contingency plans, to maintain positions for the military overseas rotation base, to retain a core capability for intermediate and depot maintenance, or to support military training. In these cases, operation of the activity by a contractor could delay or disrupt an essential program.

When the review of an activity is completed, a decision is made to retain it as an in-house operation or to conduct a cost study to ascertain whether conversion to contract operation would produce significant savings to the Government. The cost study is made only when the review has shown that there are no noncost reasons for in-house performance and that contractor performance would not degrade readiness in any way. A performance work statement is prepared that specifies the services to be provided and sets standards for quality and timeliness. Bids are solicited from commercial firms, and efforts are made to insure that the costs of in-house and contract performance are comparable. Upon completion of the cost study, the decision to remain in-house or contract is made by comparing their respective costs. The activity is converted to contract only if the estimated cost advantage of conversion will exceed 10% of the in-house personnel cost.

APPENDIX B

ORGANIZATIONAL EFFECTIVENESS (OE) PROJECTS

Organizational Effectiveness (OE) Projects

The other major source of productivity improvement projects is the Army's Organizational Effectiveness (OE) program. The Army's OE program involves the use of behavioral science technology to improve mission performance and to increase combat readiness. In the civilian community, these management and behavioral science skills and techniques are known as Organization Development, or OD. In the Army, OE is the application of selected OD methods in a military environment. The objective of the OE program is to provide assistance to Army commanders and managers for improving mission performance and increasing combat readiness. This assistance to the commander is generally provided by an Organizational Effectiveness Consultant (OEC), who may be a commissioned officer, noncommissioned officer, or civilian, and who has been trained in a 16-week course at the Organizational Effectiveness Center and School (OECS) at Fort Ord, California.

OE training is based on an action research model. The OE process occurs in four steps: assessment, planning, implementation, and evaluation (APIE). Action research is a mode of inquiry with a dual purpose - it contributes to practical problems on the one hand and to social sciences goals on the other (Susman, 1983). Thus in theory, action research provides an opportunity to test solutions to problems (hypotheses) and to feed back those findings into the applied setting. This is supposed to be an iterative process, with the results of each action research effort modifying the next attempt to resolve the problem. In practice, many OD practitioners (including OE consultants) neglect the evaluation phase of their work (James & Oliver, 1981; James, McCorcle, Brothers, & Oliver, 1983).

Most of the interventions conducted by OE consultants are not specifically directed at productivity, although productivity indicators may sometimes be used. In a survey of OE consultants' perceptions of the OE program (Oliver, 1981), the three most frequently reported OE evaluation indices were user comments, "gut feeling," and interviews. More objective productivity indices were much less frequently used. Table 1 summarizes the use made of selected indicators during a six-month period.

In a discussion of the OD approach to organizational effectiveness,[3] Campbell (1977) asserts that outcomes such as profit or turnover are seldom mentioned by OD writers, researchers, or practitioners. If such variables are mentioned, Campbell notes that it is done "...in a fairly

[3] The reference here is to the effectiveness of an organization, not to the Army's Organizational Effectiveness (OE) program.

unsystematic and casual way and only after much discussion of such factors as increased individual openness, better communications...and other indicators of what is considered a healthy system" (Campbell, 1977, p. 32). Although the training at OECS originally reflected Campbell's generalization, the training has shifted from an emphasis on intergroup and intragroup interventions toward a more results-oriented approach which specifies quantifying outcomes (O. Kahn, personal communication, August 4, 1983). Mitchell (1980) presents a taxonomy which groups OE problem issues into four quantitative categories (personnel, material, dollars, and time) and two qualitative categories (decision making and readiness/job efficiency). In a later article, Mitchell (1981) reports a cost/benefit analysis of 97 OE operations. Since there is no formal requirement for submitting reports or case studies on individual OE interventions, no central repository of productivity outcome data exists.

Author Notes

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the US Army Research Institute or the Department of the Army.

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