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An individual monetary incentive system was implemented in four shops at a Naval Air Rework Facility. Performance data were analyzed across baseline and incentive periods for four incentive shops and six other shops used as a comparison group. One of the four incentive shops showed a substantial improvement in performance while the other three showed none. The lack of performance improvement in three of the four incentive shops was attributed to such factors as insufficient workload and inadequate assistance from support groups. These problems were reported to be much less severe in the incentive shop showing performance improvement. There were no significant changes in any of the incentive shops in product quality, the amount of time a piece of equipment spent in a shop, indirect time usage, or worker attitudes. It was concluded that monetary incentives can improve performance in Naval Air Rework Facility production shops, but only if the necessary work conditions are present to support the system.

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A FIELD STUDY OF AN INDIVIDUAL INCENTIVE SYSTEM FOR PRODUCTION WORKERS

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FOREWORD

This research and development was conducted in support of PE63707N, task area Z1169-PN.01 (Civilian Productivity Enhancement) under the sponsorship of CNO (OP-01), the Chief of Naval Material Productivity Management Office, and the Naval Aviation Logistics Center. Additional support was provided under a task order from the Naval Air Rework Facility, Alameda, California.

This report describes the design, implementation, and evaluation of a monetary performance-contingent reward system. It is the last in a series of three technical reports outlining the work on a productivity enhancement project at the Naval Air Rework Facility, Alameda. The other two reports are (1) Crawford, K.S., White, M.A., and Magnusson, P.A., The impact of goal setting and feedback on the productivity of Navy industrial workers (NPRDC TR 83-4); and (2) Mohr, D.A., Shumate, E.C., and Magnusson, P.A., Individual performance measurement and reporting in a Navy industrial organization (NPRDC TR 83-35).

Finally, the authors wish to acknowledge the other members of the research team. Appreciation is expressed to Deborah A. Mohr, E. Chandler Shumate, Paul A. Magnusson, and Arthur Newman for their many contributions over the course of this project.

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SUMMARY

Problem and Background

A significant constraint on achieving the goal of a 600-ship Navy is the high cost of maintaining Navy ships and aircraft. A major component of this maintenance cost are the labor hours associated with work in Navy industrial organizations. Methods to achieve greater labor efficiency at these industrial activities must be developed and tested.

Previous research has shown that financial incentives have a positive impact on worker motivation and efficiency. Within the Navy, performance-contingent reward systems (PCRSs) have been found to be a cost-effective tool for encouraging higher levels of performance from key entry operators, small purchase buyers, and clerks in shipyards. However, PCRSs have not been tested in the more complex work environments found in production departments--an area with potential for realizing significant savings through increased efficiency.

Objective

The purpose of this study was to develop, implement, and evaluate a monetary incentive system. This PCRS was based on individual performance and used with production workers in a Navy industrial activity. In addition, the study attempted to determine factors that enhanced or detracted from the successful operation of a PCRS in a production department environment.

Approach

An action research approach was used to develop and implement the incentive system. This approach involved collaboration between the Navy Personnel Research and Development Center, San Diego, and the Naval Air Rework Facility (NAVAIREWORKFAC), Alameda, California. Together they determined the best design and implementation methodology for a PCRS in NAVAIREWORKFAC production shops.

Ten Power Plant Division production shops, each supervised by its own foreman, were selected for the study. Four shops were chosen to participate in the incentive system, the other six to serve as a comparison group. Workers in the experimental shops were able to earn incentive money in addition to their regular salaries, dependent upon their performance above pre-established standards.

Workers and foremen in the incentive shops were thoroughly trained in the design and operation of the incentive system. In addition, computerized performance measurement and incentive management systems were developed to calculate awards and to provide supporting documentation for the program. These systems provided individual reports for workers and backup summary and audit reports for foremen.

The effectiveness of the incentive system was assessed by comparing performance changes in the incentive and comparison shops from a 30-week baseline period to a 34-week period during which incentives were paid.

Results

During the incentive period, approximately $70,000 was paid out in monetary awards. On the average, 57 percent of the workers in the incentive shops earned weekly awards of about $50.

In only one of the four incentive shops was there evidence of significant improvements in the performance indicators. Workers in this shop increased their performance efficiency by more than 25 percent during the incentive period. Other results indicated that there were no consistent, significant changes in product quality, the length of time equipment spent in the incentive shops, indirect expended hours, and work attitudes among artisans in the incentive shops.

Interviews with workers receiving wage incentives suggested that there were a number of problem areas that prevented successful implementation of the incentive system. These problems were reported as less critical in the one shop where the incentive system appeared to be successfully operating. Overall, low workload was seen as the most significant impediment to the success of the incentive system.

Conclusions and Recommendations

Organizational change in Navy industrial activities is one of the most difficult and time-consuming tasks that a joint management/research team can undertake. It requires the commitment of personnel and material resources beyond those which the organization is currently using to conduct its normal business. Any change in standard operating procedures has a chance of failing even under the best of circumstances.

Implementaion of a new program prior to achieving most of the necessary conditions for success, (e.g., sufficient workload) can lead to unpredictable consequences. To reduce the chance of failure during implementation, top management needs to follow-up on the completion of program requirements at every level and monitor the project carefully even after implementation.

Monetary incentive systems can improve the efficiency of the NAVAIREWORKFAC production workers at Alameda given the right conditions; however, these work conditions, for the most part, were not found across most of its production shops. Problems include insufficient workload, lack of job security, inaccurate performance measurement, and lack of management support. Incentive systems for production workers at NAVAIREWORKFAC should not be attempted until these and other problems are resolved. If these resolutions are successful, designers of future incentive systems may want to consider including key support personnel in the project.

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INTRODUCTION

Problem

The Navy's goal is to have 600 ships by the end of this decade. Although the major costs of this expansion lie in ship acquisition and manning, a continuing cost will be the support workforce necessary to maintain and overhaul these ships. Similar maintenance costs will be associated with buildups in the air and subsurface components of the Navy. Recognizing that these maintenance costs will be substantial, it is of great importance to achieve the maximum in labor efficiency from the Navy maintenance workforce. There is thus a need to investigate strategies to improve the efficiency of this workforce.

Monetary incentives have often been used as a technique to improve individual worker performance. Locke, Feren, McCaleb, Shaw, and Denny (1980), in a review of the literature on methods to improve worker performance, found monetary incentives to be the most effective technique, with such programs generating a median performance increase of 30 percent. However, although performance-linked monetary incentives have generally been effective, most of this research has come from the private sector. Monetary incentives have not been widely used in the public sector. In fact, Perry and Porter (1982) speculated that incentive systems may not be as effective in the public sector because these organizations operate under many unique conditions and constraints. While the efficacy of incentive systems in the public sector remains an important research question, it is clear that the public and private sectors are sufficiently different (Rainey, Backoff, & Levine, 1976) so that incentive programs in the public sector will require additional design, implementation, and evaluation beyond that already performed in the private sector.

The Navy Personnel Research and Development Center (NAVPERSRANDCEN) has been involved in the development of performance-based monetary incentive systems in the Navy industrial community since 1975. Shumate, Dockstader, and Nebeker (1978) demonstrated that financial incentives provided a powerful incentive to Navy shipyard keypunch operators and generated significant improvements in worker efficiency. This incentive program was also shown to be highly cost-effective (Bretton, Dockstader, Nebeker, & Shumate, 1978). Nebeker, Neuberger, and Hulton (1983) found similar results in evaluating the effects of an incentive system on Navy small purchase buyers in a naval shipyard. Financial incentives, however, have not been investigated in the more complex and critical environments of production departments in Navy industrial organizations. The potential payoffs to the Navy for implementing effective incentive systems in the production arena are significant. These departments encompass the largest proportion of the industrial workforce and directly impact Fleet readiness.

Purpose

The purpose of the present study was to develop, implement, and evaluate a monetary incentive system within the production department at the Naval Air Rework Facility (NAVAIREWORKFAC), Alameda, California. The program was implemented using an action research approach, which involved collaboration between NAVPERSRANDCEN and NAVAIREWORKFAC, Alameda in gathering data, diagnosing problems, and implementing and evaluating an action plan. The goal was to improve the efficiency of production workers. Research focused on determining the feasibility of using an individual incentive system with production workers in a Navy industrial activity.

Background

In 1983, there were more than 146,000 Navy wage grade employees, representing approximately 47 percent of the Navy civilian workforce (Managers information digest, 1983). Most of these employees worked either directly or indirectly in logistic and maintenance support for the Fleet. With the increase in the number of Navy ships by the end of the 1980s, the size of the wage grade workforce could increase substantially, with a concomitant increase in the Navy's cost of ownership for its logistic and maintenance workforce. Increased worker performance efficiency may be one important way of restraining the size of this workforce and reducing the costs associated with expanding the Fleet.

Motivation and Performance

Motivation affects work performance in two ways: (1) It influences the level of effort expended on a job, and (2) it impacts on the choice of job strategies used in completing a job (Lawler, 1973; Porter, Lawler, & Hackman, 1975; Locke, Shaw, Saari, & Latham, 1981). Factors that contribute to a worker's level of motivation are therefore capable of significantly affecting job performance.

Expectancy theory (Mitchell, 1974; Porter & Lawler, 1968; Vroom, 1964) states that motivational force is partially the product of (1) the extent to which one values the rewards (e.g., pay, promotion) associated with one's performance and (2) the extent to which one actually expects a given performance level to result in a certain level of reward. High performance through increased motivation will be predicted to the extent that a high level of performance is rewarded, such as through pay, and to the extent that the reward is valued. While money has been well-established as a valued reward (Lawler, 1981), organizations usually construct pay plans that differentiate level of pay on the basis of job category and longevity rather than performance level (Lawler, 1979; Meyer, 1975). Reward systems that augment the existing pay system by linking rewards directly to performance may be one important way of encouraging higher levels of performance.

Characteristics of a Good Incentive System

Until recently, public sector organizations were seriously constrained in the extent to which they could actually reward superior performance. The Civil Service Reform Act of 1978 was designed, in part, to rectify this problem. This act authorized the increased use of merit pay based on the achievement of performance objectives. This act also encouraged experimentation with new and innovative programs aimed at increasing productivity.

More recent guidance has legalized the use of productivity improvement award plans that link monetary incentives to performance above objective standards (Federal personnel manual, 1982; Incentive awards program (OPNAVINST 12000.14), 1982). However, the problem still remains as to what are the critical characteristics of effective incentive systems and what are the best procedures for implementing them. Based on input from a panel of research psychologists familiar with the design and implementation of incentive systems, Dockstader (1982) has described the conditions, design factors, and implementation steps necessary for the successful use of a performance-contingent reward system (PCRSs). The factors he identified are listed in Table 1.

Table 1

Characteristics of a Good Incentive System

I. Basic Assumptions

Prior to a serious consideration of undertaking an incentive management program, it is necessary to determine whether certain "primitive" assumptions can be met. Without these, each and all, there is little hope to succeed.

A. The organization is capable of increased output.
B. Work is available.
C. Resources to develop the incentive management system are available.
D. Management is willing to make changes consistent with the incentive management philosophy.

II. Basic Design Parameters and Characteristics

A. Rewards should be positive and contingent upon performance.

1. The performance levels required for the rewards should be within the capability of the majority of the workforce.
2. The amount of the reward should be positively related to the amount of performance.
3. A reward system should address most, if not all, of the tasks performed on a job.
4. The amount of the reward should be worth working for.
5. As part of a productivity program, an incentive system should share as much of the savings with the employee as possible while remaining cost-effective.

B. Job security and basic salary are guaranteed (i.e., unaffected by the program).

C. Performance is defined in an objective, quantitative manner.

D. Performance feedback is provided to employees on a timely basis.

E. The system of rewards must be acceptable to management.

1. Should be positively associated with other management goals.
2. Does not place an unreasonable burden on supervision.
3. Does not threaten grade or compensation of supervisors.
4. Does not result in an inversion in pay.

F. The design of the system should be general enough to include most, if not all, production workers in the organization.

III. Desirable Conditions and Characteristics

A. The pace of the work being measured should be under the control of the worker.

1. The work tasks should be performed by individuals insofar as that is possible.
2. When conditions beyond the control of the worker interfere with the pace of work, there should be a procedure for accounting for this time.

B. A system of work measurement should be designed, developed, and implemented.

1. Measurement of work should be at the individual level, insofar as that is possible.
2. Measured work should include all of the critical elements of the job.
3. The work measures should be sensitive to changes in performance level.
4. Recording of work measures should be accurate.
5. The work measurement system should not be an unreasonable burden to the supervisors.

C. Expected levels of performance should be established for each job.

1. Job tasks should be matched to skill level.
2. Work standards or some alternative means of assigned work hours should be fairly established.

D. Management should be committed to the development, as demonstrated by:

1. Expressed willingness to change the existing system to one that is as objective as possible.
2. Provision (up front) of the necessary developmental, support, and maintenance resources.
3. Provision of time for a fair test and evaluation.

E. Trust in management, gained by:

1. A guarantee of security under new system.
2. Assurance that the new system has a net positive effect on employee satisfaction.
3. Assurance that the new system focuses on performance, not personalities.
4. Encouragement of union and employee participation in system design and implementation.

IV. Implementation Activities

A. Develop a productivity management information system.

1. Include work measures, standards, quality checks, and simple efficiency statistics.
2. Provide performance statistics and diagnostic checks at various levels of aggregation.
3. Include a production and delivery system.

B. Establish reward parameters.

1. Determine baseline performance and cost.
2. Set performance standard(s).
3. Establish the sharing rates.
4. Determine the reward formulae.

C. Produce an implementation plan.

1. Training methods and procedures.
2. System of program maintenance.
3. Methods of evaluation (performance, morale, cost).
4. Personnel requirements during test and evaluation.
5. Timetable.

D. Conduct pretest activities.

1. Coordinate the implementation schedule with unions.
2. Ensure willingness of the workforce to participate.
3. Establish organization structures for administration of incentive program.
4. Integrate the incentive program with the personnel system.

E. Implement a performance feedback program.

1. Establish a feedback schedule.
2. Train supervisors in effective methods of providing feedback.
3. Use feedback period to "fine tune" the measurement, reporting, and training systems.
4. Maintain continuous records of "feedback effects."

F. Conduct incentive management training.

1. Hold orientation program for all affected employees, support personnel, and management.
2. Ensure proficiency of system administrators (incentive awards, finance, authorizing officials, etc.).
3. Ensure proficiency of first-level supervisors and personnel supporting the measurement and reporting systems.

V. Controls and Maintenance Procedures

A. Controls

1. Procedures for fraudulent reporting of performance.
2. A system for developing new standards--including a provision for "buy out" resulting from a methods change.
3. Backup for supporting functions (production controllers, methods and standards technicians, MIS support, etc.).
4. Quality assurance.
5. Monitoring key indicators in the measurement system.

B. Maintenance

1. Methods and standards.
2. Incentive management training for new employees.
3. Periodic assessment of attitude/motivation/morale.
4. Production and delivery of feedback reports.
5. Timeliness of reward payouts.

C. Contingency procedures

1. Computer failure.
2. Loss of backlog.
3. Sabotage/fraud.
4. Tools, equipment, or parts shortage.
5. Worker disputes.
6. Poor performers.

D. System evaluation

1. Effects on performance, productivity (cost), morale.
2. Decision-making concerning continuation, expansion, reduction, or elimination.

As can be seen from Table 1, the factors for a good incentive system can be grouped into five categories. The first category, Basic Assumptions, lists the necessary conditions for a successful incentive system. These are characteristics that the organization should possess before it even begins the design of an incentive system. The second category (Basic Design Parameters and Characteristics) lists factors around which most successful incentive systems have been designed. Most of these factors are oriented toward effectively rewarding specific levels of job performance. The third category (Desirable Conditions and Characteristics) lists conditions that improve the functioning of an incentive system, conditions without which an incentive system could still run, but not as effectively. The fourth category (Implementation Activities) identifies steps necessary to make the system operational. These provisions have little to do with the explicit design of the system but are as important to the system's success as any aspect of the reward system itself. The final category (Controls and Maintenance Procedures) is concerned with the maintenance of the system. These conditions and procedures are necessary to guarantee the integrity of the reward system.

The factors identified above are based on experience and empirical research data; they are further consistent with recommendations from the incentive literature (e.g., see Beyer & Trice, 1982; Greiner, 1973; Meyer, 1975; Pond, Armenakis, & Green, 1984). Likewise, they are consistent with recommendations for establishing linkages between worker motivation and organizational practices (Goodman, 1982; Lawler, 1979). These factors, judiciously considered before an organization begins the design of an incentive system, should significantly improve the chances for success.

Action Research Approach

Although organizational characteristics and the technical aspects of the incentive system are important, the manner in which this system is developed and introduced in the organization can be of equal importance. A new system that changes the manner in which work is rewarded in an organization, if it is to be used and maintained, has to be designed with the organization's structure and culture in mind. Likewise, it must be introduced in a manner acceptable to individuals who are going to participate in the system.

This change process is often accomplished via a collaborative effort between the host organization and outside researchers/change agents. While many organizational researchers have stressed the importance of managing and understanding the change process and recommend different methods to this end (Beer, 1980; Seashore, Lawler, Mirvis, & Cammann, 1983), one of the most well-organized bodies of literature dealing with this issue is the one on action research. Crawford (1979) has reviewed this literature and has summarized the important stages in the action research approach. These steps are presented in Table 2.

As described in Table 2, every stage in the action research process is characterized by or is the result of a collaborative association between the organization and the research team. Problems to be investigated, research design and data collection, action plans and implementation as well as program evaluation are all outcomes of a collaborative effort. The process is also characterized by an interactive approach. Programs are developed through iterative stages of data collection and feedback rather than through independent design by an outside research team. One final characteristic of this approach is that it involves program evaluation. This means that unsuccessful programs will not be continued in the organization, while successful programs will be improved and expanded.

Table 2

Stages in Action Research Process

Action Research Stage	Description of Stage
I. Entering the Organization	
a. Pre-entry	• Organization perceives problem and seeks assistance; researcher agrees to enter situation.
b. Entry	• Collaborative relationship is established; joint determination of problem areas to be addressed is made; mutual expectations are agreed upon.
II. Data Gathering	• Joint determination is made of required data and methods of collecting information; hypotheses, where appropriate, are formulated.
III. Diagnosis and Data Feedback	• Data are analyzed; preliminary diagnosis is made; results are translated into terms meaningful to organization.
IV. Action Planning	• Translated results provided to organization; joint diagnosis and determination of alternative courses of action made; action plan and evaluation design are jointly developed.
V. Implementation	• Action plan is implemented.
VI. Evaluation/Research Design	• A joint determination is made of effectiveness and consequences of the actions taken. Results, if important, are written up for scientific journals.
VII. Iteration or Termination	• Future efforts are initiated at either Stage III or Stage V, or relationship is terminated.

Because of the interactive and iterative nature of the action research approach, it is well-suited to the implementation of incentive programs in complex and dynamic environments. The collaborative aspects of action research allow for the organization to learn the skills and knowledge necessary to continue the incentive program after the departure of the research staff.

APPROACH

This study involved the use of an action research methodology in conjunction with guidelines provided by Dockstader (1982) on how to implement an incentive system for production workers. It is the contention of the authors that the process by which organizational changes are implemented is often as important as the substance of those changes. Thus, the information in this section is presented within the action research framework discussed earlier. This should allow the reader to follow the iterative steps of this study and gain a better understanding of the implementation process.

Entry

This study was undertaken at NAVAIREWORKFAC, Alameda, which employs over 6000 civil service workers. The NAVAIREWORKFAC's mission is to provide major maintenance on naval aircraft, including the repair and overhaul of aircraft engines, components, and accessories. Researchers from NAVPERSRANDCEN had been previously involved in a collaborative effort with the Alameda facility. This first project entailed the design and implementation of a computerized performance measurement system for production workers. In addition, a goal setting and feedback program using performance reports from the above system was implemented and evaluated in one NAVAIREWORKFAC production department division (the Power Plant Division, responsible for the rework and repair of aircraft engine components). A thorough discussion of the goal setting effort can be found in a technical report by Crawford, White, and Magnusson (1983). Likewise, the performance measurement system is described in detail by Mohr, Shumate, and Magnusson (1983). Since this new measurement system was an important element in the current study, it is described in the following section.

Performance Measurement System

NAVAIREWORKFAC, Alameda uses in-shop computer terminals to collect labor data inputs for a computerized management information system (MIS). Upon completing a task, a worker transmits that information to a central computer. The computer calculates the time the worker spent on the task and makes a MIS record of the transaction that includes identification of the employee, task, actual time spent, and a standard time expected for completing the task. Using these data, NAVPERSRANDCEN developed an individual performance measurement system that was used to produce weekly performance feedback reports. One of these reports included a performance measure indicating how each employee performed against standards on all tasks completed in both the previous 1-week and 4-week periods. The report also provided information on overtime, leave, and time spent on nonproduction activities such as training and cleanup. To help ensure privacy, a coded number rather than the worker's name was used to identify the report. A copy of this report was available only to the worker, the shop foreman, and the research staff. In addition, other backup reports were available for the foremen to use in verifying and auditing information on the individual reports. This performance measurement system was already operational when the current study was initiated.

Authorization to Develop Incentive System

Because of the extensive work already undertaken by NAVPERSRANDCEN at this facility, a collaborative relationship between the two organizations already existed when the incentive project began. In this sense, the traditional entry phase of an action research project (see Table 2) had already occurred. The only remaining concern involved reassessing what problem the action research approach would address. The vehicle for discussing the problem area was the Productivity Steering Group (PSG), which had been formally established at the facility 2 years earlier. This group met monthly and included key NAVAIREWORKFAC department heads, the president of the union representing most employees, and representatives from NAVPERSRANDCEN.

During the early phases of the goal setting project, the PSG decided to begin work on a new problem area--how to implement a monetary incentive system for production workers. The PSG's general concern was centered on improving worker motivation and efficiency, and therefore it wanted to explore the impact of other productivity approaches. This new focus was consistent with a long-range NAVAIREWORKFAC research plan developed by NAVPERSRANDCEN.

The PSG initially specified that the incentive system should include 10 of the 11 Power Plant Division shops that were participating in the goal setting project. NAVPERSRANDCEN researchers were asked to work with personnel to determine if the newly developed performance measurement system could be used as the foundation for paying monetary incentives. This effort also included assessing and attempting to correct any factors that could negatively affect the fairness and accuracy of an incentive system.

Data Gathering

Many of the managers and production and support personnel had continually expressed doubts that accurate performance measurement was possible for production employees. Hence, an assessment of any problems in this area was critical to the successful implementation of an incentive system. Indeed, accurate performance measurement was the foundation for all productivity improvement research being conducted at NAVAIREWORKFAC, Alameda (see Mohr et al., 1983). Accordingly, considerable effort was devoted to identifying and alleviating problems that might affect performance measurement accuracy.

First, a structured group interview technique, the nominal group technique (NGT), was used with foremen of the 11 shops participating in the goal setting and feedback study. The NGT provided an effective means of overcoming many of the problems associated with group interviews while at the same time generating a comprehensive list of ideas or, in this case, problems (see White, Atwater, & Mohr, 1981, for a detailed description of the NGT). It also provided information about the relative importance of each item. This application of the NGT required the foremen to name problems that might affect performance measurement accuracy. Despite this focus, the majority of the problems mentioned were ones affecting workers' and shops' ability to complete their work (e.g., delays in calibration of test equipment and insufficient cross-training) rather than ones affecting performance measurement accuracy (e.g., inaccurate operation standards and problems in getting standards on tasks performed on emergent work). These results suggested that the foremen were, understandably, more concerned with constraints on work performance than with potential performance measurement problems. Other meetings and informal conversations with the foremen and their general foremen strengthened this conclusion. A few additional problems, some with performance measurement implications, were also identified during interviews with other supervisors, shop workers, and support personnel assigned to these shops (see Appendix A for a list of the identified problems).

Diagnosis and Data Feedback

This phase of the project involved two distinct steps. First, the problem areas that could affect successful implementation of the incentive system had to be resolved. Second, the final design of the incentive system had to be determined.

Resolution of Identified Problems

All performance measurement problems that had been identified were prioritized to reflect their relative severity and to determine which should be addressed first. In order to focus the effort on solving productivity measurement problems, the work measurement problems were given a higher priority than the constraints on work performance.

Next, Productivity Improvement Teams (PI Teams) were organized in the Power Plant Division. PI Teams were ad hoc groups convened to address specific problems. They were responsible for analyzing the identified problems and proposing both solutions and solution implementation plans. PI Teams were headed by the general foremen (second level supervisors) of the two sections participating in the initial goal setting study. The PI Team heads reviewed each problem and then included on the team those production and/or support personnel most likely to be able to help solve it. Although certain people were likely to participate in a number of PI Teams, each team was selected to address a particular issue. If the general foreman lacked the ability to handle an identified problem due to its scope or technical nature, the responsibility for heading the PI Team was passed to a higher level of supervision or to a nonproduction person more knowledgeable about the issue.

The PI Team heads were responsible for scheduling and leading PI Team meetings. Each PI Team studied and clarified the problem, discussed possible solutions, selected the most feasible solution, and developed an implementation plan. This plan identified (1) the steps required to implement the chosen solution, (2) individuals responsible for each step, and (3) estimated dates of completion for each step. Finally, the PI Team identified an authorizing official for the action plan. The authorizing official was the individual in the organization who had the authority to approve and initiate implementation of the plan. He or she may or may not have been a member of the PI Team. However, as initially conceptualized, the PI Team heads were responsible for following up on and briefly documenting the implementation of solutions.

Several problems with the PI Team process arose, which limited its effectiveness in resolving measurement problems. It appeared that solving these problems was not a high priority activity for general foremen and PI Team members, perhaps because their regular responsibilities did not allow them sufficient time to devote to PI activities. Top management provided little follow-up to assure the continued efforts of the PI Team heads. In addition, most of the identified problems were interdepartmental in nature and no one individual at the levels involved in the PI process had the authority to push for implementation of solutions. It appeared that these personnel were unaccustomed to dealing with such issues using task groups. Finally, the ad hoc nature of the PI Teams contributed to their limited effectiveness.

After the weaknesses in the original PI process design became apparent, three subsequent attempts were made to deal with the performance measurement and productivity problems. First, NAVPERSRANDCEN hired a consultant with considerable NAVAIREWORKFAC production management experience to serve as an on-site liaison to assist the Power Plant Division Director (see Figure C-1, Appendix C, for an abridged diagram of the Power Plant Division's organizational chart) in organizing and using the PI Teams. Unfortunately, the consultant had no authority to direct others within the organization to act. Thus, this approach met with very limited success. Next, following a rotation of division directors within the NAVAIREWORKFAC, the new Power Plant Director attempted to overcome some of the shortcomings of the PI Team process by formalizing team meetings. The Division Director assumed the role of the PI Team Coordinator and regularly met with division heads of the appropriate support codes and with the shop foremen to address productivity problems. Many problems persisted, however, apparently due to the support codes' unwillingness to commit the necessary resources because they were not directly accountable to the PI Team Coordinator. Further, an increase in the division's workload and other demands limited the availability of the division head to continue his direct involvement in the PI process.

The last formal attempt to resolve productivity problems began when NAVAIREWORKFAC, Alameda and NAVPERSRANDCEN agreed to begin the final work necessary to implement an incentive system in the Power Plant Division. Because of the previous difficulties in solving productivity problems, several new steps were taken. First, the PSG reduced the number of shops scheduled to try the incentive system from 11 to 4. These four shops were chosen on the basis of their foremen's support for the proposed incentive system and the presence of fewer work measurement problems than in the other shops. The PSG then decided to limit the productivity problems to be addressed during this phase to those nine items most critical to the successful implementation of a fair and accurate incentive system. These nine problems are described in Appendix B and ranged from workload issues to concerns with quality control. Next, one shop foreman was assigned responsibility for each problem. These foremen worked together with NAVPERSRANDCEN personnel acting as shop consultants to attempt to alleviate the problems. At least one of the shop consultants visited the facility each week to assist in the problem-solving process. During this phase of pre-implementation activity, a full-time program coordinator was named. His duties included working with key shop foremen and shop consultants on the implementation problems.

Work standards in the four shops selected for the incentive system received immediate attention. The PSG directed that the Methods and Standards Division review and update many of the oldest "C" standards (estimated time standards) to "A" standards (engineered time/industry-accepted standards). This effort was begun about 4 months prior to the beginning of the incentive system and took 3 months to complete. Although only about 5-10 percent of the shop standards were reviewed, this effort was considerably greater than normal standards reviews being conducted within other shops at the facility. As such, the workers in the four incentive shops were well aware that special attention was being paid to their work standards. The net effect of the standards review was to increase the average proportion of "A" standards in the four shops from about 52 to 58 percent.

Unfortunately, priority and resource issues prevented solutions to most other problems. Foremen were unaccustomed to taking a proactive role in their dealings with individuals outside the Production Department. The program coordinator, previously a general foreman in the Power Plant Division, also had difficulty in this area. NAVPERSRANDCEN personnel, on the other hand, had no real authority to act within the NAVAIREWORKFAC and faced various logistical problems resulting from their limited on-site time.

Therefore, during a PSG meeting, the nine problems were reduced to the four that were seen by NAVPERSRANDCEN and NAVAIREWORKFAC, Alameda to be the most critical to successful program implementation. These were: corrections to the work documents used by the shops, production control (PC) support for the swing shift, engineering and evaluation (E&E) support for the four shops, and use of indirect charges to account for nonwork situations. (See Appendix B for detailed descriptions of these four issues.)

As a result of top management emphasis on these four issues, some success was achieved. E&E personnel were hired, trained, and assigned to each of the four shops. A PC person was moved to second shift to support the two incentive shops that had a second shift. The PSG gave its approval for charges to indirect accounts as required to account for the activities in these shops. Finally, some emphasis was placed on correcting work documents through existing methods and staff.

Most of these changes occurred during the 4-week period just prior to commencement of the incentive system. As such, all four shops were subjected to a number of management changes during the time period when they were preparing for one major change--the new incentive program.

In summary, only about half of the identified performance measurement problems were fully or partially resolved. Because of this limited success, the NAVPERSRANDCEN research team felt that the four incentive shops were only somewhat prepared for implementation of the incentive system. Performance measurement in these shops was better than that found in most of the other production shops at this facility, but still not as accurate as would have been desired for basing monetary rewards on performance efficiency. Nonetheless, both the research team and the other members of the PSG felt that implementation of the incentive system should continue in order to better understand what shop conditions were absolutely essential for its success. Thus, the PSG approved a commencement date for the system of 6 June 1982.

Action Planning

Design of Incentive System. Current federal (Federal personnel manual, 1982) and Navy (Incentive awards program (OPNAVINST 12000.14), 1982) instructions allow Navy activities to develop and implement a productivity improvement awards plan as part of their incentive awards programs. These award plans, when approved, permit the activity to share with their employees up to 50 percent of the dollar value of an employee's objectively measured superior performance. These instructions were used as the guidelines for the design of the incentive system developed for the Alameda facility.

This program defined superior performance as work performed in less time than was allowed by the task's industrial standard. The calculation of the incentive award was based on the concept of saved labor hours. Labor hours were saved whenever tasks were completed in less time than the standards allowed for the work. For example, if a job was expected to take 10 hours (i.e., the industrial standard was 10 hours) and was completed by the employee in 7 hours, the employee saved the organization 3 labor hours.

Saved labor hours could then be translated into dollar savings by multiplying each saved hour by the hourly rate ($11.00) of a WG-10 Step 1 employee, the typical wage grade level for employees performing the work of mechanic at NAVAIREWORKFAC, Alameda. For the system developed here, the PSG decided that 50 percent of the value of each saved hour (or $5.50) would be returned to the artisan as an incentive award. (Approximately half way through the PCRS trial period the amount returned to the employee for a saved hour was changed to $5.70 because of an increase in basic pay rates.)

Saved hours were summed weekly for each worker and his/her incentive pay was calculated without regard to performance during previous weeks. It was hoped that allowing workers to "start fresh" each week would provide an incentive for low performers to gradually improve their performance until they could actually earn incentive awards. Hence, those individuals whose average weekly performance reflected negative savings in labor hours were treated, for the purposes of the incentive awards, as having zero saved hours.

Because the incentive system was to be based on industrial-type standards, it was important to determine whether the performance of all workers in the four incentive shops could be measured against standards. Three types of work situations were found. First, most workers performed almost all of their work on tasks requiring no more than one person to complete. Daily transactions of these tasks, documented by records of time spent on each job and standards met, were indicative of how well these workers were performing.

Second, the performance of a few workers could not be accurately measured using self-reported labor transactions. For example, some workers spent considerable time training new workers while others were test operators who had little control over their efficiency because they were required to monitor test units for specified lengths of time. As such, employees could not improve their efficiency on these tests. Nonetheless, such employees contributed to the performance of the shop as a whole. It therefore seemed appropriate to calculate and pay incentives to these people based on the performance of the entire shop.

Finally, there were workers who spent part of their time on indirect work that supported the shop, but which could not be easily measured, and part of their time on easily measurable individual tasks. For these employees, it seemed appropriate to calculate incentive awards based on both individual and shop performance.

To track hours worked on the myriad of tasks performed by many artisans in a week and then to calculate incentive awards for this group would be a tremendous task by hand. Thus, the automated individual performance measurement and reporting system (called the operations performance tracking systems, or OPTS) developed during the earlier feedback and goal-setting phase of the project (see Crawford et al., 1983, and Mohr et al., 1983) was used as the foundation for an automated incentive awards management system (IAMS). The IAMS calculated and recorded the weekly incentive awards for all employees in the four incentive shops (see Mohr, Shumate, & Dockstader in press, for a more detailed description of IAMS). The technical specifications of the IAMS were developed by NAVPERSRANDCEN and Alameda facility personnel, while system programming, testing and operationalization were performed by the Navy Regional Data Automation Center (NARDAC), San Francisco. The IAMS had the capability of calculating incentive awards in three different ways, corresponding to the three types of work situations described above.

<u>Administration of Incentive System</u>. NAVAIREWORKFAC, Alameda gained authorization for the trial implementation of the PCRS by submitting a productivity improvement awards plan to the Chief, Naval Material Command, in accordance with Navy instruction (<u>Incentive awards program</u> (OPNAVINST 12000.14), 1982). The plan described the trial program's development, design, and proposed administration. The administrative issues described below were addressed by the plan and/or the PSG.

Employee Participation. The PSG supported the idea of voluntary employee participation during the trial period for the incentive system. Thus, before the trial began, all employees in the four incentive shops were given the option of participating in this program. They were also authorized to change their participation status as desired during the trial period. Thirteen employees (14.7%) chose not to participate during all or part of the test period.

PCRS Coordination. A general foreman was designated as the coordinator for the PCRS. During the trial period, he was relieved of other duties and served as full-time incentive system coordinator. His responsibilities included the following areas:

1. Distributing OPTS and IAMS reports to foremen in the incentive shops.

2. Reviewing IAMS reports to ensure accuracy of performance and incentive earnings information.

3. Preparing information for manual input to IAMS.

4. Processing payment requests, verifying check amounts, and verifying that payments were deducted properly from employee balances.

5. Providing periodic status reports to the Power Plant Division Director.

6. Serving as principal point of contact for information about the PCRS.

An analyst from the facility's Management Methods Division was designated to serve as the IAMS coordinator. This was a part-time position involving automated data processing coordination for both OPTS and IAMS. Her responsibilities included:

1. Distributing OPTS and IAMS reports to the incentive system coordinator.

2. Reviewing IAMS reports.

3. Inputting all manual entries to IAMS.

Controls to Prevent Manipulation of Performance Measures

Mohr et al. (1983) discussed the need for strengthening the controls in the work assignment and reporting systems prior to using OPTS to support new productivity improvement programs. As mentioned earlier, the PSG took steps toward this end. First, E&E technicians were assigned to each shop participating in the PCRS. Their responsibility was to determine the required depth of rework for all units entering the shop and to tailor the work documents to this level so that employees could not increase their reported performance by simply transacting unnecessary tasks. In addition, E&E technicians prepared the necessary documents and then authorized all required additional work not already described on the documentation, again to prevent anyone gaining credit for work not done.

To help ensure that all employees had a fair chance to earn awards, the PSG directed the foremen to see that, insofar as possible, the particularly easy and difficult tasks were distributed equitably to their employees during the trial period. The foremen were to distribute tasks by taking into consideration the skills and abilities of their workers and the nature of the work entering the shop. Finally, shop foremen, the incentive system coordinator, the IAMS coordinator, and NAVPERSRANDCEN personnel closely monitored incentive and performance information provided by IAMS and OPTS reports to identify and correct any inaccuracies.

Implementation

Prior to implementation of the PCRS at NAVAIREWORKFAC, Alameda, training was conducted to ensure that those involved understood both the PCRS and the IAMS. The incentive system coordinator and foremen of participating shops were the primary focus of training. Training sessions were held with these individuals to present the rationale behind the PCRS and the IAMS as well as to explain their responsibilities during the trial period. A 4-week test run of IAMS was used to help the coordinator and foremen become familiar with the information on the new reports and understand how to use them.

At the end of the dry run, employees in participating shops received training about the PCRS and a modified individual employee performance report that they would be receiving. They were then given the opportunity to choose whether they wanted to participate in the program or not. Information concerning employee participation was inputted to IAMS by the IAMS coordinator before the trial period began.

Basis for Incentive Awards

The purpose of this study was to test an individual incentive award system for wage grade employees in a production setting. Indeed, the test site had been selected to ensure that most workers' award calculations would be based on individual performance. Foremen of the participating shops were, however, given the authority to change the basis of their employees' award calculations if they felt it was appropriate. At the start of the trial period, two of the foremen felt that award calculations based on shop performance were more appropriate for a few of their employees. Accordingly, the incentive earnings of ten employees were calculated based on shop performance at the start of the trial period. While some employees performed both group and individual tasks, foremen reported that they performed primarily one type of job. Records for these people were, therefore, computed on the basis of their primary jobs. No employees had calculations based on a combination of individual and shop performance.

Distribution of OPTS and IAMS Reports

During the PCRS trial, OPTS reports were distributed weekly. The employee performance report was given to each employee in the participating shops with a duplicate copy given to the respective shop foreman. Other reports, used to document in detail the work produced by individual workers, were also provided to the participating foremen on a weekly basis. Finally, two other reports were provided to participating foremen each week--one documented the individual weekly incentive earnings of their employees, and the other provided cumulative incentive earnings and the amount of these earnings paid to each of their employees to date. The incentive system coordinator also received copies of the latter two reports. The IAMS coordinator and NAVPERSRANDCEN personnel received copies of all OPTS and IAMS reports.

Payment Processing

Employees were allowed to request payment of incentive earnings within the following limitations set by the PSG. Payments were processed at the employee's request only when an employee's available balance of incentive award money was greater than

$25. This rule was waived in cases when an employee left the shop. However, no employee's available balance was allowed to exceed $500 before payment. Authority for approval of incentive awards during the PCRS trial was delegated to the head of the Power Plant Division.

After auditing the employee performance reports, shop foremen initiated formal payment requests using IAMS reports as documentation. The incentive system coordinator reviewed and verified payment request amounts, obtained award approval from the Power Plant Division Director, and delivered the payment requests to the Alameda facility's incentive awards personnel. The incentive awards personnel certified, approved, and logged award requests and delivered the paperwork to payroll. After deducting withholding tax from the award amounts, the payroll section prepared and issued incentive award checks for pickup by the incentive awards personnel. The incentive awards section verified award amounts, sent the incentive award checks to the Power Plant Division Director for distribution to employees, and sent a copy of the award requests to the IAMS coordinator for manual entry to IAMS so that payments were deducted from available balances. The total process took 2 to 3 weeks to accomplish.

Evaluation and Research Plan

A main concern of both NAVAIREWORKFAC, Alameda management and NAVPERSRANDCEN researchers was whether or not the incentive system would have a positive effect on worker performance. In addition, both parties were interested in identifying factors that could impede successful implementation of the program. In order to accomplish the above tasks, a research strategy was developed to assess the impact of the incentive system. This research plan is described in the following sections.

Research Design

The research design was quasi-experimental (see Cook & Campbell, 1979). Workers in two sections (A and B) of the Power Plant Division participated in the study. Each section consisted of five shops, two of which were incentive shops (A1, A2, B1, B2) and three of which served as comparison shops. Thus, the resulting groups were composed of four incentive and six comparison shops. Because the focus of the research was to independently examine the effects of monetary incentives in each incentive shop, the final research design involved comparing employees from an incentive shop with a sample of employees from the three comparison shops in the same section. Hence, there were two comparison groups--one for section A and one for section B. Because the sections performed slightly different work, were located in different buildings, and reported to two different general foremen, it was felt that limiting analyses to shops within the same section would result in the most relevant comparisons.

The total time period for the study was 64 weeks: a baseline period of 30 weeks followed by a 34-week period during which the incentive system was tested. In addition, efficiency data were monitored for an additional 20 weeks after the incentive program was discontinued.

Sample

The original sample included all permanent blue collar workers assigned to the four incentive and six comparison shops. However, a fluctuating workload resulted in considerable movement of workers between shops in the Power Plant Division. For this reason, the following two criteria were used to define permanent shop workers: (1) the employee must have transacted work in that shop for at least 25 percent of both the baseline and incentive periods, and (2) the employee could not have changed from an incentive to a nonincentive shop (or vice versa) during the 34-week incentive period.

Using the above criteria, the selected sample was distributed across the shops as follows: incentive shop A1 (n = 19), incentive shop A2 (n = 23), comparison group A (n = 37), incentive shop B1 (n = 17), incentive shop B2 (n = 13), and comparison group B (n = 44). For statistical analyses on the individual-based measures, it was important that the sizes of the comparison groups be approximately equal to those of the incentive shops within that section. Thus, a 50 percent stratified random sample (based on performance during baseline) was taken from each of the three shops in both of the comparison groups. This resulted in a final sample of 19 for comparison group A and 20 for comparison group B. Where analyses involved the total shops rather than individuals, the total comparison groups were used rather than the stratified samples.

Demographic data (e.g., age, race, sex, length of time at the facility) for each of the four incentive shops and the two comparison groups were analyzed. Chi-square tests were computed for relevant demographic variables, comparing each incentive shop with its relevant comparison group. No significant differences emerged between the demographic characteristics of incentive and comparison shop workers. The failure to find any major demographic differences between the incentive and comparison workers was reassuring, given the lack of random assignment to the different shops. Overall, these blue collar workers could be characterized as predominantly middle-aged males with high school educations.

Performance Measures

A key focus of the evaluation effort was to determine whether the incentive system had a positive impact on the performance of workers in the incentive shops. In order to accomplish this objective, performance data for both incentive and comparison workers were monitored during the baseline and incentive periods. Each of the performance measures is discussed below.

Performance Efficiency. Individual-level performance data were routinely generated by the OPTS and provided to workers on the weekly individual performance reports. These data were collected on computer tapes by the researchers for the 30-week baseline period prior to the beginning of the incentive system, for the 34-week incentive period, and for the 20-week follow-up period after the incentive system was discontinued.

For the purpose of the current study, aggregate performance scores were generated for each worker in the experimental and comparison shops for the baseline and incentive periods. For these periods, the performance scores represented the ratio of the total standard time for tasks completed during that period to the total time spent on those tasks. This ratio was then multiplied by 100. For example, if a worker earned 110 standard hours for work that took 100 hours to complete, the efficiency score would be (110 divided by 100) X 100 or 110. The NAVAIREWORKFAC referred to these performance scores as "efficiency" scores, and they will be referred to as such throughout the remainder of this report. The amount of time an individual spent in nondirect labor categories (e.g., leave, training, cleanup) was excluded from the computation.

Previous research by Crawford (1982) indicated that this type of aggregate efficiency score for NAVAIREWORKFAC, Alameda workers is highly reliable. Using an 18-week period, he found that aggregated efficiency scores had a high test-retest reliability

(r = .70) as well as a high internal consistency (coefficient Alpha = .87). Overall, his results suggested that combining weekly efficiency scores to form aggregate performance efficiency scores was an acceptable procedure for the purpose of program evaluation.

Efficiency Computation. Production work at NAVAIREWORKFAC, Alameda was performed under three different types of documentation and authorization. Each of these forms of work documentation provided a list of tasks required in the rework or repair of the unit as well as the standard time estimated to be necessary to perform the task. However, for the purposes of the incentive system, these three documentation methods had important differences.

By far the most frequent document type was the preprinted shop document. These documents were generated by the NAVAIREWORKFAC computer and accompanied the unit throughout its rework or repair operations. Tasks performed against these documents had timed or industry-accepted standards associated with them. The other two types of documentation used to perform work were added lines (ALs) and hand-written shop orders (HWSOs). ALs and HWSOs were used when a task needed to be performed that was not included on the preprinted shop document. The additional tasks were usually identified by the artisan and standards were then set by a representative of the Methods and Standards Division.

Both facility management and NAVPERSRANDCEN staff were concerned with the possible use of ALs and HWSOs to artificially inflate an artisan's earned hours and incentive pay. This could be done by claiming additional work that was not actually performed. Also, both ALs and HWSOs were more prone to errors (e.g., recording, keypunch, transcription), which could result in errors in determining the amounts of the incentive awards. To solve these problems, a modification of the procedure used to sum earned hours was designed and is described in Mohr et al. (1983). However, transactions performed against preprinted shop documents were by far the most prevalent and provided the most accurate record. Hence, for purposes of the evaluation of the incentive system (as opposed to the calculations of incentive pay), artisan performance computations were based only on tasks performed against preprinted shop documents.

Hours Expended Against Units. Although worker efficiency was a direct measure of performance, this measure could be "beaten" in a number of different ways (e.g., by taking more earned hours than were deserved). To determine whether increases in efficiency were genuinely due to improvement in performance, an alternate measure of efficiency needed to be developed. The worker efficiency measure used the individual artisan as the basis for analysis. However, any increase in artisan efficiency should also be reflected in fewer total hours expended on units reworked or repaired. If hours expended against units remained the same while efficiency went up, one might suspect that the efficiency improvement was artificial.

Examining hours expended against units required that the same unit types be tracked across time. Because of the great variety of units worked in each shop, a sample of unit types was selected based on three criteria: (1) those that required a large number of hours for rework or repair, (2) those that had been frequently repaired in the past and also were expected to be frequently worked on in the future, and (3) those that represented the different facility work sponsors (e.g., Air Force, Naval Supply Centers). Through a NAVAIREWORKFAC planning report, information was collected for 17 unit types in the incentive shops and 13 unit types in the comparison shops for the same time periods used for the efficiency data.

A particular unit was included in baseline period computation if work on that unit was finished before the beginning of the incentive period, but it was included in the incentive period computations if work was finished after the incentive period began. This designation resulted in a number of units being assigned to the incentive period although the work had begun in the baseline period. While this rule generated a degree of inaccuracy in the measure, the bias was a conservative one, operating against the predicted research hypothesis (fewer hours expended per unit type during the incentive period).

Two other problems complicated this measure. While the NAVAIREWORKFAC planning report used to obtain these data provided average expended hours against unit types, it did not provide the numbers of units reworked or repaired within unit types. This limited the power of statistical analysis that might be performed on these data. Also, since data were only compiled quarterly, a clean cutoff point for this measure could not be made between baseline and incentive periods. Also, the cutoff point for data compilation at the end of the incentive period could not be accomplished within any degree of precision. This latter limitation was due to a problem in the computer program itself. While this problem did not affect the quality of the data or their comparability between baseline and incentive periods, it did push the data cutoff for the incentive period well into the follow-up period.

Because of the number of problems inherent in these data, it was decided to increase the data's stability by extending the baseline period back in time as long as possible. A more stable baseline would result in a higher probability of detecting a treatment effect on the expended hour measure. In all, 24 months of baseline data (from June 1981 to May 1983) and 10 months of incentive and post-incentive period data (from July 1983 to April 1984) were collected.

Unit Turnaround Time. While the incentive system was designed to reward performance above standards, other performance areas that were not rewarded also could be affected by improved efficiency. NAVAIREWORKFAC, Alameda was very interested in meeting time schedules for completed units. Increased worker efficiency could result in faster movement of units through the incentive shops (i.e., improved unit turnaround time).

Each unit entering the facility has an estimated completion date, and general unit types are monitored to make sure that the completion schedule is maintained. However, although the facility monitors overall unit completion schedules, the work performed in any one shop is often only a part of the rework or repair process for any single unit. The facility maintains no centralized control record of how quickly individual components move through a given shop. These records are only maintained at the shop level in paper and pencil form, but were used in the current study to generate a measure of unit turnaround time. Unit turnaround time was computed as the number of days between the points when a unit was logged in and logged out of a shop. A 7-day workweek was used; however, holiday and mandatory leave periods were excluded. Because of the labor-intensive work required to compile these data, the same sample of unit types selected for measuring hours expended against units was also used for this measure.

To be included in the baseline period, rework on a unit must have begun after August 1981 and finished between November 1981 and May 1982. To be included in the incentive period, components had to be finished between June 1982 and February 1983.[1] For each

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[1] Dates for different pieces of data may not agree because different organizational reports were used for these data, and the reports themselves have different start and stop dates.

shop in the incentive and comparison groups, the average unit turnaround time was computed for the baseline and incentive periods described above.

EEO/Union Grievances. The introduction of a new reward system into an organization always presents the possibility that it will be perceived as unfair either individually or collectively from the union's standpoint. The incentive system could have been viewed as unfair in at least two ways. First, benefits could have been seen as unfairly distributed on the basis of race or sex. Second, workers may have believed that benefits were paid to employees who did not deserve awards. Thus, the incidence of EEO complaints or grievances might have increased from the baseline to incentive period.

Informal EEO complaints were monitored and recorded by the Civilian Personnel Office over the baseline and incentive periods. The number of informal EEO complaints by shop was then supplied to the NAVPERSRANDCEN research team along with a short general description of the basis for the complaint. Individuals generating the complaints were not identified.

While NAVPERSRANDCEN researchers and NAVAIREWORKFAC management made considerable effort to keep union officials informed of all plans concerning the incentive system, problem areas still could have arisen between union and management during the course of a new incentive program. To assess this, the number and nature of union grievances and unfair labor practices were monitored for the incentive and comparison shops during the baseline and incentive periods.

Quality Defects. There was great concern that increased efficiency might be accomplished at the expense of product quality. Any decrement in product quality was considered unacceptable and would void any other benefits an incentive system might provide to the NAVAIREWORKFAC. Therefore, measures of product quality had to be closely monitored throughout the baseline and incentive periods.

The Quality Assurance Department at the facility randomly inspects a sample of units from each production shop each week. Any defects in workmanship are recorded under one of three categories: (1) critical defects--a defect falling into this category would be one that might cause the unit to malfunction and jeopardize the mission of the aircraft in which the unit had been installed; (2) major defects--defects that could cause the unit to malfunction but probably would not affect the success of the plane's mission; and (3) minor defects--defects that technically run counter to the repair/rework specifications but ones that would probably not jeopardize either the functioning of the unit or the mission of the aircraft.

When defects are found, the unit is returned to the shop area for correction of the defect and additional units of this same type, not originally designated for inspection, are examined for similar defects. No formal attempt is made to designate and record the individual responsible when a defect is found. Each week, all production shops receive a summary of the type of defects that were encountered by Quality Assurance representatives over the previous week. For the present study, quality data were collected, in the form of weekly shop summary defect reports, and aggregated for the four incentive and six comparison shops during the same baseline and incentive periods used for efficiency data.

Indirect Expended Hours. A production worker's time at NAVAIREWORKFAC, Alameda can be accounted for under two general categories, direct labor and indirect labor. Direct labor includes all work related to the rework or repair of the product (e.g., repairing a damaged hydraulic pump). Indirect labor includes all work related to the support of rework or repair activities, but not actually involved in it (e.g., tool maintenance, training, cleanup).

Indirect labor hours were monitored in this study for two reasons. First, artisans could earn incentive pay only while involved in the direct labor. The number of indirect hours charged might be reduced under the incentive system simply because artisans pursued direct labor tasks more aggressively in order to earn more incentive pay. Reducing the number of indirect labor hours would represent a benefit to the facility.

Second, one way to "beat the system" would be to perform direct work and charge it to an indirect category. This would inflate a worker's indirect time but also would artificially reduce the number of hours expended on direct work and thereby inflate the artisan's incentive pay. While both foremen and top management at the facility as well as the NAVPERSRANDCEN research staff took precautions to preclude such practices, it was thought that monitoring indirect hours was a necessary step in documenting the effects of the incentive system. Indirect time was monitored and aggregated weekly for each artisan in the incentive shops and comparison groups over the same baseline and incentive periods used to measure artisan efficiency.

Sick Leave Hours. Artisans are entitled to paid sick leave but, for obvious reasons, cannot earn incentive pay while on sick leave. For this reason, the incentive system might lead to a reduction in the number of discretionary or marginal sick days (if such exist). Thus, as with overtime, a substantial benefit could be generated by the incentive system with no associated costs beyond those already incurred. For this reason, records of sick leave hours were collected and aggregated weekly for workers in both incentive and comparison shops over the baseline and incentive periods.

Overtime Hours. One of the key objectives of the incentive system was to reduce the number of hours taken to perform rework and repair tasks. If such a reduction occurred, more work could be done within the same period of time. A potential increase in work output would reduce need for overtime and thus generate a substantial gain for the NAVAIREWORKFAC beyond improved artisan performance. Overtime hours were aggregated weekly for each worker in the incentive shops and comparison groups over the same periods used to measure artisan efficiency.

Self-report Measures

A series of questionnaires and individual interviews with artisans and their foremen were used to assess their attitudes and opinions toward the incentive system. Changes in attitudes also were assessed. A questionnaire was developed and administered twice to incentive and comparison group foremen and artisans. The first administration occurred one week before the beginning of the incentive system and the second administration one week after the end of the incentive period. Individual interviews with incentive and comparison group workers and foremen were also conducted three weeks before the end of the incentive period.

Questionnaire Measures. The questionnaire was designed to assess four general areas: (1) group cohesiveness--this scale was taken from one developed by James et al. (1975) and contained three subscales related to the commonly used definitions of group cohesiveness: cohesion-attraction among group members (3 items), cooperation among group members (4 items), and esprit de corps (3 items); (2) job satisfaction was measured using the short form of the Minnesota Satisfaction Questionnaire (Weiss, Daws, England, & Loftquist, 1967), which measured intrinsic satisfaction (13 items), extrinsic satisfaction (6 items), and general satisfaction (19 items combined from the intrinsic and extrinsic subscales); (3) trust in management--this scale was constructed using items taken from two other trust scales (Cook & Wall, 1980; Jones, James, & Bruni, 1975) and five additional items written for the study's purpose and population; (4) general attitudes about the incentive system--this area consisted of 22 items constructed to assess opinions about different facets of the work environment and incentive system. Two additional sections of the questionnaire were not used in relation to this study and are not presented here.

Questionnaires were administered in group sessions, one shop at a time. Responding to the questionnaire was voluntary. Respondents were identified so that pre/post comparisons could be made. However, confidentiality of data was guaranteed; respondents were assured that their responses would only be reported in aggregate form. Any artisan who did not attend the group administration was contacted once at a later date and asked to fill out the questionnaire. At the first administration of the questionnaire, one week prior to the beginning of the incentive period, 58 percent of the artisans in the incentive and comparison shops completed the instrument. At the questionnaire's second administration, 68 percent of those completing the instrument at the first administration completed the survey the second time.

Interview Measures. At the end of the incentive period, both artisans and supervisors in the incentive shops participated in individual structured interviews to assess their reactions to the incentive system. Respondents were asked 17 questions; both structured response and open-ended questions were asked. Each interview took approximately 15 minutes. Ninety-three percent of those artisans involved in the incentive system participated in the interview. All shop foremen in the incentive shops were interviewed using the same instrument as that used for artisans.

Data Analysis Plan

As elaborated upon in the previous sections, a large number of research measures were used in the study. A brief description of each measure is provided in Table 3. Data on each of these measures were collected for both incentive and comparison shops during both the baseline and incentive periods. Efficiency data at the shop level also were collected during the 20-week post-incentive period. The central research/evaluation question was whether or not there would be improvements in the incentive shops relative to any changes in the comparison shops. While a number of analytical techniques were used to address this research question, the primary statistical approach used was a mixed design analysis of variance (see Hays, 1981).

This analysis of variance (ANOVA) allowed for a test between incentive and comparison workers on differences from the baseline to the incentive period. If there were differential changes, they would be reflected in one statistical test, the interaction test in the ANOVA model. When the interaction tests indicated that differential changes had occurred, follow-up tests were then conducted to determine in which group (incentive versus comparison) and in which time period (baseline versus incentive period) these differences occurred.

As stated above, 13 workers from the four incentive shops refused to participate in the incentive system. The statistical analyses evaluating the effectiveness of the

Table 3

Summary of Evaluation Measures

Type of Measure	Description of Measure
A. Performance Measure	
1. Efficiency	A measure of individual worker performance comparing the amount of time actually taken to perform work with standards of how long it should take on the average. The computation formula is: $\frac{\text{Time Expended on Work}}{\text{Estimate of Time Required}} \times 100$
2. Hours expended against units	A measure of worker performance computed at the level of the individual unit type being repaired/reworked and aggregated to the shop level. This measure represents the average work hours taken to rework or repair typical units entering a given shop.
3. Unit turnaround time	An indirect measure of worker performance, computed as the average number of days a unit spends in a given shop awaiting rework or repair, being reworked or repaired, and awaiting transfer to its next station.
B. Self-report Measures	
1. Questionnaire scales	
a. Group cooperation b. Group attraction c. Group effectiveness d. Esprit de corps	Structured response attitudinal scales taken from James et al. (1975). (Applies to "a" through "d.")
e. Trust in management	Structured response attitudinal scales composed of items taken from Cook and Wall (1980) and Jones et al. (1975).
f. Extrinsic satisfaction g. Intrinsic satisfaction h. General satisfaction	Structured response attitudinal scales taken from Weiss et al. (1967). (Applies to "f" through "h.")
2. Interview measures	
a. Attitudes toward incentive system b. Problems with incentive system c. Suggestions for improving incentive system	Structured and unstructured interview items constructed for PCRS evaluations at NAVAIREWORKFAC, Alameda.
C. Other Measures	
1. EEO complaints	Total number of informal EEO complaints logged with the Civilian Personnel Office for each shop included in the evaluation.
2. Union grievances	Total number of union grievances and unfair labor practices originating from shops included in the evaluation.
3. Quality defects	An indirect measure of worker performance computed as the percent of quality inspections finding quality defects, by severity of defect.
4. Indirect expended hours	An indirect measure of worker performance computed as the average number of indirect hours expended weekly by workers.
5. Sick leave hours	An indirect measure of worker performance computed as the average number of sick leave hours taken by a worker each week.
6. Overtime hours	An indirect measure of worker performance computed as the average number of overtime hours expended by a worker per week.

incentive system within the four shops included data from these nonparticipants as well. It was thought that the most meaningful evaluation for NAVAIREWORKFAC, Alameda would be an examination showing the effect of such a system on a typical shop, not just the incentive participants in the shop.

Finally, the evaluation data also were translated into dollar costs and benefits. This translation allowed for an assessment of the degree to which the incentive system was cost-effective.

RESULTS AND DISCUSSION

Level of Participation

Participation in the incentive system was voluntary for artisans working in the four shops selected for the study. Of the 81 artisans in the four incentive shops at the beginning of the study, 68 artisans (84 percent) agreed to participate. Those workers who declined to participate were still responsible for all their assigned work; however, they did not earn incentive money for performance above standard.

Participants were compared with nonparticipants on their performance efficiency during the baseline period. Results indicated that participants were performing above standard during the baseline period (average efficiency = 105.7) whereas nonparticipants were performing below standard (average efficiency = 94.5). The lower performance level of the nonparticipants suggested that they would be less likely to earn incentives than participants even if they had agreed to take part in the incentive system. As such, it is not surprising that many of them chose not to participate.

Incentive Payouts

During the 34-week incentive period, a total of $70,476 was awarded to participants in the four shops. Table 4 shows the average weekly incentive earnings of participating artisans in the four incentive shops. Although weekly incentive earnings varied by worker and by shop, on the average 57 percent of the workers in the incentive shops earned weekly awards of about $50. Clearly, workers in shop A1 had the greatest earnings and, as will be shown later, had the greatest increase in efficiency.

Direct Performance Measures

As discussed in the Approach section, six performance measures were used in the evaluation. Four measures were computed on a weekly basis for each artisan in both the incentive and comparison shops; these were artisan efficiency, indirect expended hours, sick leave hours, and overtime hours. Due to the nature of the data, one measure, product quality, was computed weekly at the shop rather than at the worker level. Unit turnaround time and hours expended against repaired/reworked units were computed for selected unit types passing through a shop, regardless of which workers actually performed the work. These data were then aggregated into two periods representing the baseline and incentive periods.

Performance Efficiency

The effect of the incentive system on worker performance efficiency was assessed by comparing changes in worker efficiency in each of the incentive shops with changes among workers from the respective comparison groups. These analyses are presented in

Table 5. As can be seen, workers in only one of the four incentive shops had a significant increase in their efficiency. Shop A1 workers, who also earned the greatest amount of incentive awards, had approximately a 25 percent improvement in efficiency from the baseline to the incentive period.

Table 4

Weekly Earnings of Participants in the Incentive System

Shop	Average Percentage of Participants Earning Incentive Money	Average Weekly Incentive Earnings
A1	73	$73
A2	47	$38
B1	44	$24
B2	59	$37

Note. Time period is 7 June 1982 to 28 January 1983. Dates for different pieces of data may not agree because different organizational reports were used for these data and the reports themselves have different start and stop dates.

Table 5

Performance Efficiencies for Workers in Incentive and Comparison Shops During the Baseline and Incentive Periods

Group	Baseline (B) Period	Incentive (I) Period	Performance Change (I-B)	n
Incentives				
Shop A1	104.0	129.7	+25.7[a]	19
Shop A2	102.6	97.5	- 5.1	23
Comparison Group A	105.2	105.3	+ .1	19
Incentives				
Shop B1	98.0	102.2	+ 4.2	17
Shop B2	112.6	102.8	- 9.8	13
Comparison Group B	98.8	99.6	+ .8	20

[a]Performance improvement is statistically significant ($p < .01$) when compared with changes in Comparison Group A.

Another question of interest was whether the participants in the incentive system showed any differential changes in efficiency when compared with nonparticipants from the incentive shops. Because of the small number of nonparticipants, this analysis had to be performed by comparing participants with nonparticipants by group rather than by shop. Results indicated that participants showed a significant ($p < .05$) improvement from the baseline to the incentive period when compared with the nonparticipants. Whereas the participants increased their average efficiency from 105.7 in the baseline period to 113.2 in the incentive period, the nonparticipants actually decreased in average efficiency from 94.5 to 84.7 during the same periods.

Hours Expended Against Units

While workers in one of the four shops showed a significant increase in efficiency, a benefit to the facility, this increase should also be reflected in fewer labor hours worked per unit. If there were an efficiency increase but no reduction in hours expended in repairing or reworking units, one might suspect that the efficiency increase was simply due to artisans "beating the system" rather than actually improving their performance.

As mentioned earlier, a sample of unit types was selected in each incentive and comparison shop for these analyses. This sample was chosen to reflect unit types that frequently required much work and that represented all unit sponsors (e.g., Air Force, Navy Supply System). Unfortunately, in two of the four incentive shops (A2 and B2) the workload and its composition changed so radically from baseline to incentive periods that virtually no units tracked during the baseline were recorded in the computer system during the incentive period. Therefore, these shops were excluded from this analysis. Also, in shop B1, so few of the units tracked in the baseline period were recorded in the incentive period that this shop also was excluded from the analysis. Only in shop A1 were sufficient numbers of units tracked and recorded during these periods. However, this was the most critical shop in which to examine expended hours because of its significant performance efficiency increases.

Results indicated that the average number of expended hours per sampled unit type in shop A1 was reduced substantially from baseline to incentive period. This change represented a 9.8 percent decrease in average expended hours on these selected units. While the reduction in hours expended was not as high as the 25 percent efficiency increase for the workers in shop A1, the two measures would not be expected to be perfectly consistent (see "Hours Expended Against Units" in the Approach section). Nonetheless, the fact that both measures changed in the same direction tends to support the contention that there were real performance improvements in shop A1.

Indirect Performance Measures

Measures of efficiency and hours expended against units provided direct measures of worker performance. However, indirect measures of performance, while not rewarded in the incentive system, were taken as well in order to evaluate the overall effects of the incentive system on worker performance.

Unit Turnaround Time

One indirect measure of the incentive system's effectiveness was the amount of time a given unit actually spent in a shop. While the amount of time spent working on a unit is important to the Alameda facility, the time taken between the point when a unit is logged into a shop, the rework or repair completed, and the point when the unit is logged out may be of equal importance. Adherence to schedule is a constant demand.

Although the incentive system did not reward workers for reducing the amount of time a unit spent in a shop (i.e., turnaround time, TAT), implementation of the incentive system could have produced this result simply due to the improved efficiency of workers. However, factors other than worker efficiency affect TAT. Lack of replacement parts or an insufficient number of workers to begin reworking or repairing the units as they enter the shop were just two ways in which TAT could be increased even though the actual work performed on a unit was highly efficient. While potentially a benefit from improved efficiency, reductions in TAT were not a guaranteed result.

TAT data were aggregated for baseline and incentive periods. Each shop and comparison group was examined separately, from baseline to incentive period, using repeated measures t tests. These tests indicated that there was no evidence to support the contention that significant increases in efficiency were associated with improvements in TAT. Shop A1, which showed an improvement in efficiency during the incentive period, had no change in unit TAT.

EEO/Union Grievances

There were no union grievances or unfair labor practice charges in the Power Plant Division during the baseline or incentive periods for incentive or comparison shops. Representatives from the Civilian Personnel Office provided data on informal EEO complaints for the Power Plant Division during baseline and incentive periods. These data are presented in Appendix C, Table C-1. Unfortunately, because of the small number of complaints and the unidentifiable nature of the data, statistical tests of significance could not be performed. However, examination of the data may be informative.

Table C-1 shows that informal EEO complaints increased from baseline to incentive period in only one incentive shop (B2), an increase from a single complaint in the baseline to four in the incentive period. Additional information showed that three of these four complaints were related to a single incident and that the incident itself could not be realistically related to the incentive system. Therefore, there is little reason to believe that the incentive system affected the EEO program in any way.

Quality Defects

The incentive system provided no rewards for improved quality. Thus, no improvement was anticipated in this area. However, a major concern was whether or not increased productivity would be detrimental to product quality. It was important, therefore, to measure product quality to determine whether there were any negative trends. No statistical tests were performed on the quality defect data because these data were maintained only at the shop level. However, the trends in these data were carefully examined, by shop, in two descriptive forms. First, the total inspections finding defects were monitored for baseline and incentive periods. Second, the critical, major, and minor defects, relative to total number of inspections, were assessed for the baseline and incentive periods. Table 6 presents the data as percentage of inspections finding defects. As can be seen, the percentage of inspections finding defects decreased in the four incentive shops from the baseline to the incentive period. Thus, there are no trends to support the argument that paying incentives for increased efficiency results in increased quality defects.

While it is important to know whether the overall defect rate changed, it is perhaps of equal importance to know whether the defects shifted to more serious categories during the incentive period. There were no critical defects in units from three of the four

Table 6

Quality Defects by Shop During the Baseline and Incentive Periods

Shop	Period	Total Number of Defects	Total Number of Inspections	Percentage of Inspections Finding Defects
A1	Baseline Period	50	1401	3.6
	Incentive Period	79	2265	3.5
A2	Baseline Period	61	1462	4.2
	Incentive Period	28	2509	1.1
B1	Baseline Period	47	4090	1.1
	Incentive Period	27	3686	0.8
B2	Baseline Period	2	392	0.5
	Incentive Period	2	509	0.4

incentive shops during either the incentive or baseline period (see Appendix C, Table C-2, for a summary of the data). In one shop (A2), there was one critical defect in both the baseline and incentive periods; however, the percentage of critical defects in relation to the total number of inspections decreased. Across all four shops, there appeared to be no consistent trends that indicated that defects were becoming more serious (i.e., shifting to major or critical). Overall, there seems to be little reason to believe that quality was affected by the implementation of the incentive system in these four shops.

Indirect Expended Hours

Indirect expended hours were monitored and recorded each week for every worker in both the incentive shops and the comparison groups. The average number of indirect expended hours for workers in each incentive period is presented in Appendix C, Table C-3. Shop A1 showed a slight reduction in indirect expended hours while the other three experienced a slight increase. However, none of these changes achieved statistical significance. Overall, the results suggest that the incentive system did not affect the amount of time incentive shop workers charged to indirect jobs.

Sick Leave Hours

Although artisans are eligible for paid sick leave, they are unable to earn incentive pay while on sick leave. For this reason, it was hypothesized that workers in incentive shops showing significant increases in efficiency also might have decreases in sick leave. This reduction in sick leave would represent an additional benefit to the NAVAIREWORKFAC.

The average weekly sick leave hours for artisans in the incentive shops and comparison groups during the baseline and incentive periods are shown in Appendix C, Table C-4. Statistical tests indicated that there were no significant changes in use of sick leave for workers in the incentive shops.

Overtime Hours

If the incentive system increased worker efficiency, more work could be performed within the same period of time and the need to assign overtime might be reduced. Overtime hours were monitored for each worker in incentive and comparison shops over baseline and incentive periods. The average weekly number of overtime hours expended by individual workers over baseline and incentive periods is presented in Appendix C, Table C-5. Relative to their respective comparison groups, no incentive shop showed a statistically reliable reduction in overtime hours.

System Cost-effectiveness

Overall, more than $70,000 was paid in incentive awards. While the incentive system was designed so that the NAVAIREWORKFAC saved one dollar in labor costs for every dollar paid in incentive money, start-up and overhead costs of the system could counteract any dollar benefits. Thus, a cost-benefit analysis of the PCRS is presented in Appendix D. Although the issues are complex, analyses indicate a clear potential for this system's cost-effectiveness.

Attitude and Self-report Measures

Questionnaire Results

Table C-6 in Appendix C presents the correlations between the questionnaire scales and the internal consistency of each scale (Cronbach's Alpha) generated from the questionnaire administered to the artisans in the incentive and comparison shops. All measures of internal consistency were within acceptable ranges. Likewise, the correlations between the different scales were, for the most part, acceptably low. However, the three satisfaction scales were highly correlated, suggesting that these scales might be measuring just one aspect of general satisfaction.

Two-way mixed analyses of variance were used to compare workers in each incentive shop with workers in their respective comparison groups on changes in questionnaire responses between the baseline and incentive periods. A few of the analyses attained statistical significance; however, given the large number of tests run, there was insufficient evidence to suggest that there were any consistently positive or negative changes in worker attitudes in the incentive shops that could be attributed to the incentive system.

Interview Results

Interviews with both participants and nonparticipants in the incentive system were conducted three weeks prior to the end of the incentive period. Sixty-three (91%) of the 69 artisans present in the four shops participated in the interviews. Six workers refused to be interviewed and four were on leave.

The artisans reported that they felt the employee performance reports were reasonably accurate and approximately 75 percent of them wanted to keep getting the reports even if the incentive system was discontinued. Workers also reported a number of problems that affected the fairness of the incentive system. These data are summarized in Table 7. As can be seen, lack of parts, reduced workload, and ratcheting of standards (reducing the amount of time on a standard) were problems reported by a majority of workers. However, workers in the shop (A1) that had the greatest increase in efficiency perceived problems of reduced workload and ratcheting to be less severe than did workers in the other three incentive shops.

Table 7

Incentive Shop Workers' Perceptions of Problems Affecting Fairness of Incentive Program

Problem	Workers' Perceptions by Shop (Percentage)			
	Shop A1 (n=20)	Shop A2 (n=13)	Shop B1 (n=16)	Shop B2 (n=12)
Lack of parts	95	69	69	100
Reduced workload	45	77	81	100
Standards/ratcheting	30	92	69	92
PC support	45	62	31	58
E&E	10	54	19	42
Program information	30	15	13	8
Work distribution	15	15	6	8

In the open-ended questions, both foremen and workers offered a number of positive and negative comments as well as recommendations for improving the incentive system. These data are summarized in Table 8. Workers' positive comments focused on the intrinsic and extrinsic benefits from the incentive system, whereas foremen tended to view positive benefits in terms of improved worker performance and shop work practices. On the other hand, both workers and foremen perceived a number of shop conditions and work impediments that made the incentive system potentially unfair to participants. Finally, both workers and foremen stressed the need to remove impediments and improve management of the incentive system.

One interview question was directed at whether or not workers would like the incentive system to continue in their shops. The results from this question are presented in Table 9. Clearly, the strongest response to continue the program was in shop A1--the one shop that showed the greatest improvement in efficiency. Workers who responded that they would like to continue the program but only with changes offered the same suggestions presented in Table 8.

Post-incentive Efficiency

One final question of interest concerned worker efficiency after the incentive system was discontinued. Figure 1 presents trends in shop efficiency for each of the four incentive shops over a 33-month time frame that included a goal setting intervention (see Crawford et al., 1983), the incentive program, and a 5-month period after the incentive system was terminated. This figure depicts several interesting points. First, the increase in shop efficiency witnessed in shop A1 declined dramatically immediately after the conclusion of the incentive system. Within a few months, efficiency in this shop returned to the pre-incentive level. This provides an additional strong piece of evidence supporting the incentive system as the causal factor for the improved worker efficiency in this shop.

Table 8

Summary of Foremens' and Workers' Responses to Open-ended Questions About the Incentive System

Nature of Comments	Workers (n=63)	Foremen (n=4)
POSITIVE	• Good workers finally being recognized by NAVAIREWORKFAC. • Enjoy program--it's a challenge. • Forces me to use my time better. • Chance to earn money without overtime. • Something to look forward to. • Has improved shop efficiency and morale. • Some people don't waste as much time now. • Program is a step in right direction.	• Makes my job easier--people come to me to get work. • Program has resulted in much better Master Data Records (MDRs) and standards. • Program is a good deal for both the NAVAIREWORKFAC and the workers. • Program resulted in a real performance increase in my shop of 20 percent. • My workers don't waste time.
NEGATIVE	• No work is killing program. • Standards aren't fair across different kinds of work. • People rushing--hurting quality and cooperation. • Too many changes in beginning (standards, E&E, workload, new reports). • One guy is cheating system--creates hard feelings. • Some managers are against program. • Standards unfairly cut at beginning of program. • E&E unfairly voiding lines.	• Why have incentive system if no work? • Lack of parts/poor PC support hurt program. • My shop can only produce to schedule--we can't do more. • Many standards and MDRs are still too bad for fair and accurate performance measurement. • Slight increase in number of test cell rejects. • Changing standards started program badly.
SUGGESTED IMPROVEMENTS	• Get more work/parts. • Give everyone fair chance to earn with better standards/cross-training. • Include support personnel and other shops in program. • Make system run more smoothly (i.e., late checks, late reports, corrections). • Correct MDRs and standards before starting program.	• Get more workload. • Get standards/MDRs improved long before program starts. • Have cross-training before program starts to ensure fairness. • Need to include support personnel. • Program needs to be better managed and an integral part of organization. • Should base incentives on parts out the door. • Should use a group system.

Table 9

Workers' Responses by Shop to Question of Whether or Not They Would Like Incentive System to Continue

Response Category	Percentage by Shop A1 (n=22)	A2 (n=13)	B1 (n=16)	B2 (n=12)	Overall Percentage (n=63)
1. Yes	77	15	56	17	48
2. Yes, but only with changes	5	47	0	17	14
3. No	9	15	31	17	17
4. Don't care or no opinion	9	23	13	49	21
Total	100	100	100	100	100

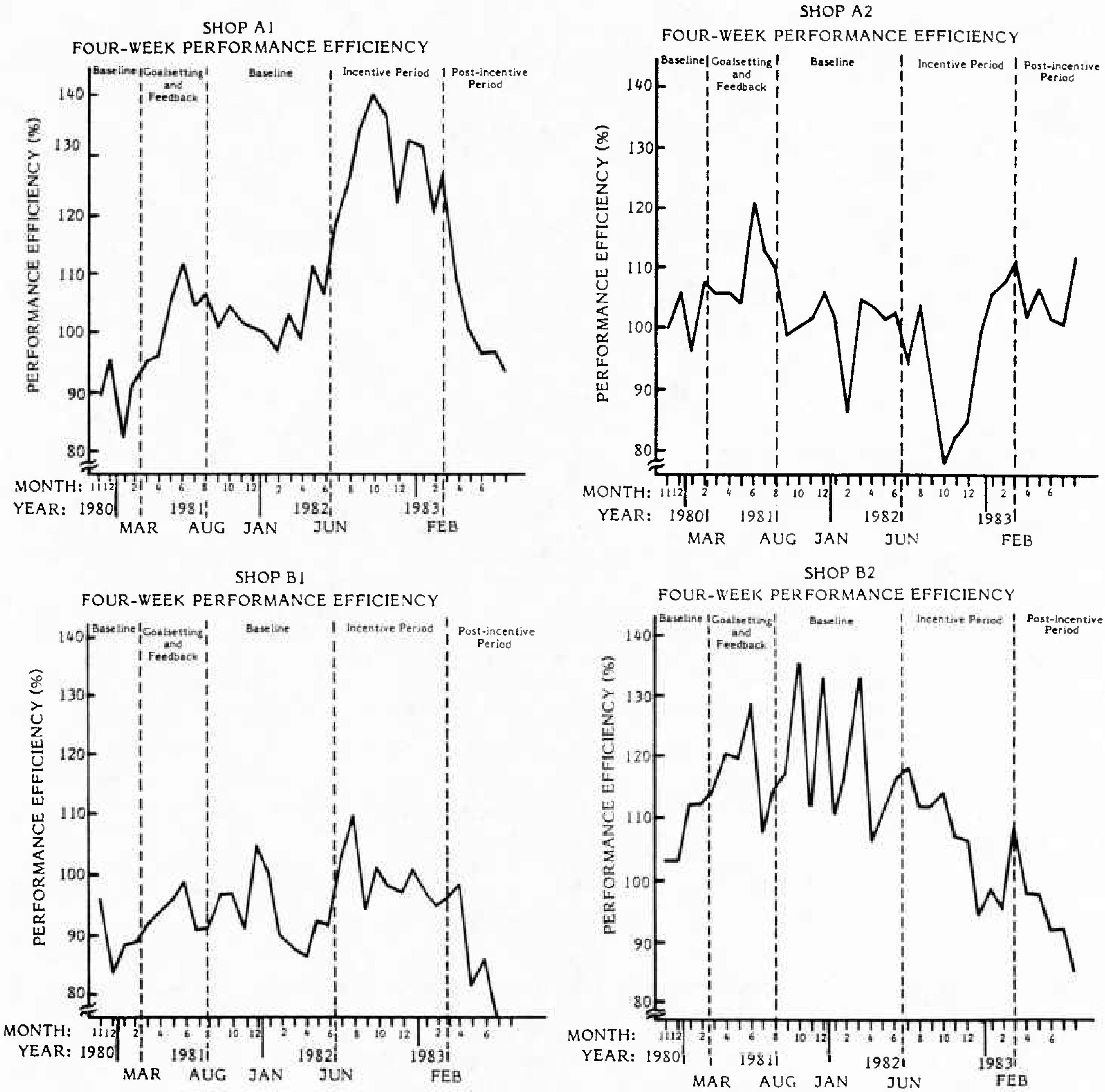

Figure 1. Average 4-week shop efficiency scores for the feedback/goal setting, incentive, and post-incentive periods at NAVAIREWORKFAC, Alameda.

Second, there was a decline in shop B1 efficiency similar to that seen in shop A1 after the incentive system was discontinued. While this shop did not show any systematic increase in efficiency during the incentive period, the dramatic reduction in efficiency in the post-incentive period may indicate that the incentive system prevented an earlier decline in shop efficiency. This relative improvement could not be identified by the initial data analysis.

The trends for shop B2 support the notion that there were no changes in efficiency in this shop from the incentive system. The general decline in efficiency during the incentive period seems to continue in the post-incentive period, rendering any conclusions based on the post-incentive trends impossible. Shop A2 also seems to have been non-responsive to the incentive system.

CONCLUSIONS

Incentive System

A performance-contingent reward system was implemented at NAVAIREWORKFAC, Alameda in four shops from two sections of the Power Plant Division. The results indicated that there were significant improvements in performance in only one (shop A1) of the four incentive shops. In this shop, workers significantly improved their performance efficiency, and the shop as a whole reduced its average expended hours against repaired/reworked units. Because this second measure was less susceptible to potential manipulations, the results from both measures strongly support the argument that there were real improvements in performance by the workers in shop A1. Likewise, the abrupt dropoff in efficiency after the incentive system was discontinued further supports this contention.

A number of other measures were examined in each of the four shops: quality defects, unit turnaround time, indirect and sick leave charges, overtime, labor problems, and job attitudes. No evidence was found to suggest that the incentive system had any positive or negative effects in these areas. Since the incentive system was not specifically aimed at improving the above measures, the failure to find changes was not surprising.

Performance on a number of these measures was constrained by factors beyond the control of the artisans. For example, work that had to be performed quickly to meet a demanding schedule may have required overtime regardless of the general level of artisan efficiency. Likewise, when one artisan had to train another on a new task, indirect time was expended irrespective of the trainer's level of efficiency. Other indirect charges operated in the same way (e.g., shop cleanup). Additionally, in some artisan labor hour categories, NAVAIREWORKFAC, Alameda set a maximum on the number of hours that could be charged, often a relatively low allocation. As such, it would be exceptionally difficult to reduce the number of labor hours charged to these categories.

The failure to find job attitude changes, especially in shop A1, may seem surprising. However, changes in work attitudes as a function of a new behavioral program not specifically designed to produce attitudinal change may be an unrealistic expectation (Kleinke, 1984). Improvement in work attitudes may not occur even in situations where the incentive system is successful. Nonetheless, while none of the shops showed an improvement in worker attitudes, neither did they show a degradation. Areas that logically could have been negatively affected by an individual incentive system (e.g., group cooperation) did not seem to change--even in the one shop showing a significant increase in worker efficiency.

Despite the positive performance results in shop A1 overall, the net results from the incentive system seem to be very mixed. The bottom line for NAVAIREWORKFAC, Alameda was whether or not the program was cost-effective (see Appendix D). Nonetheless, the incentive system was clearly not effective in three of the four incentive shops. Dockstader's list of organizational conditions that are necessary, or at least desirable, for the successful implementation of an incentive system seems relevant here (1982). These conditions were presented earlier in Table 1. The reason that only one of four shops participating in the incentive system showed a significant increase in efficiency can, in part, be explained by using these requirements as general guidelines and then comparing them to the conditions in the four shops.

First, Dockstader listed sufficient workload as a necessary "primitive" or essential condition for the success of an incentive system. One cannot expect to improve productivity through increased motivation if there is not enough work to support the increased effort. Yet, only one of the four shops (shop A1) reported that it had a high enough level of work so that efficiency could actually be increased. This was also the one shop that showed a reliable increase in efficiency. Reports from workers and the foreman in one of the other incentive shops (shop B1) indicated that workload in that shop was significantly reduced during the incentive period. This decrease in work resulted in a substantial portion of the shop's workers being transferred to other shops outside the incentive system. The foremen and workers in the other two incentive shops also reported their workload as lower during the incentive period when compared to the baseline period. Likewise, workers in all three of these shops reported during interviews that workload was a major problem affecting the incentive system. This limited workload may have been the most significant negative factor preventing increases in worker efficiency. Workers could not be expected to increase their output when it meant eventually running out of work and being transferred to another shop for an indefinite period.

Also listed as an essential condition for the successful implementation of an incentive system was management's ability to make changes consistent with incentive management philosophy. Many important changes necessary to support an incentive system were not made. Program requirements were reduced twice during the system's development because of insufficient action by the facility. These compromises in implementing important changes did not completely prevent the system from succeeding; one shop of the four did respond well to the system. However, in general, conditions were not optimal for the implementation of a monetary incentive system.

Dockstader listed as a "basic design parameter" that the goals of the incentive system be consistent with overall management goals. This was a problem at NAVAIREWORKFAC, Alameda. While management was interested in maintaining high levels of productivity in their blue collar workforce, performance efficiency was often considered of secondary importance to meeting the schedule. Foremen continually stressed to the research team that getting units out of their shop on or ahead of schedule was their number one priority. Thus, if there was a conflict between being efficient or being on schedule, the former goal was more likely to be compromised. In retrospect, perhaps a part of the incentive system should have rewarded workers for meeting or beating schedule. Another factor discussed by Dockstader, which might have contributed to the limited success of the incentive system, was the limited acceptance of the work standards by the workers. A majority of the workers in three of the four incentive shops reported problems with standards. The one shop (shop A1) in which the incentive system worked was the only place where the majority of workers said that standards were not a problem affecting the fairness of the incentive system.

Additional contrasts could be made between the necessary conditions for a successful incentive system and the conditions existing in the four incentive shops; however, this is probably unnecessary. It is sufficient to say that the environment simply was not conducive to a completely successful program. Nonetheless, it should be stressed that making the required changes involved a resource allocation decision. Facility managers had to decide whether or not the payoffs from the incentive system would justify committing the resources necessary to make the program work. Top management continually stated that they wanted to see if the incentive system would work under "normal" conditions. These conditions usually involved fluctuating workloads, limited resources devoted to standards development, movement of workers between shops, etc. Hence, what was seen from the perspective of the research team as necessary work to improve management controls may have been viewed by managers as unrealistic attempts to make conditions "perfect." As one department head said, "If the incentive system only works under special conditions, how can we realistically consider expanding it to other shops where normal conditions exist?"

In conclusion, the question of whether or not NAVAIREWORKFAC, Alameda should have expended greater resources to make the program work cannot be answered by this study. The productivity gains in shop A1 are encouraging, but workload, a critical requirement for the incentive system, is often beyond the control of NAVAIREWORKFAC, Alameda. Perhaps the question that must be answered first is whether the improved work controls demanded by the incentive system would, by themselves, have resulted in cost-effective improvements in planning and worker performance even if an incentive system had never been implemented.

Organizational Change

Over the three years that NAVPERSRANDCEN researchers spent developing, implementing, and evaluating productivity programs at NAVAIREWORKFAC, Alameda (see Crawford et al., 1983; Mohr et al., 1983), many attempts were made to implement significant organizational changes. From these efforts, the authors have generated a number of premises concerning attempts at organizational change in Navy industrial organizations. First, organizational change is probably one of the most difficult tasks that joint management/research teams can undertake. Organizations, especially public sector bureaucracies, are structured to maintain the status quo. Standard operating procedures are instituted to ensure predictability rather than encourage innovative changes. Organizations are thus structured to resist change. Management must therefore realize that even in a healthy, effective organization, beginning a new program such as an incentive system and changing standard operating procedures may be a difficult and time-consuming matter. Management must be completely dedicated to making the needed changes and seeing the job through if success is to be achieved. The importance of management commitment cannot be overstated.

Second, any change in standard operating procedures has a chance of failing even under the best of circumstances. Unforeseen situations may arise and undermine even a meticulously planned and implemented program. Priorities may change and key management personnel committed to the change may leave the organization. Under such circumstances, expecting a new effort to successfully compete with the existing requirements of the organization is unrealistic. Organizations will pursue "business as usual" rather than push new programs with uncertain outcomes.

Third, in implementing a complex project, top management should follow-up on the completion of program requirements at every managerial level and monitor the project carefully even after implementation has been achieved. Key implementing managers must be held accountable. It is unwise to assume that a complex effort can be implemented simply by "the stroke of a pen" or the assignment of the project to any available management representative as a collateral duty. Careful monitoring of the project at all stages of development, implementation, and evaluation is necessary if a reasonable implementation schedule is to be maintained and ultimate success achieved.

Fourth, implementing a new program prior to achieving most of the necessary conditions for success can lead to unpredictable consequences. This is not to say that implementation without perfect conditions should never be done. Probably no new program will ever be implemented with all necessary prerequisites met. Still, the risk of failure should be realistically evaluated against the probability of success (or even marginal success) before a decision to proceed is made. It may be unrealistic to expect a program to succeed under poor conditions before management is willing to expend the resources necessary to implement the new program correctly. Hence, careful consideration has to be made of the ramifications of implementing a new program when all desired conditions have not been met.

Fifth, implementing new programs or making changes in organizations is not only a difficult process but a time-consuming one as well. For the continuity of the program, management should be fairly stable over the course of the program. At NAVAIREWORKFAC, Alameda during the three years that a productivity program was being developed, implemented, and evaluated, two different commanding officers and two different division heads were associated with the project. The resultant loss of information about the history of the project and the change in perspective of these key individuals represented an additional factor to be dealt with in an already difficult situation. Organizations need to institutionalize procedures to ensure that the process of constructive change continues in the organization despite the turnover of key individuals.

The sixth premise concerning organizational change is, in part, related to many of those issues discussed above. Any organizational change requires the commitment of personnel and material resources beyond those which the organization is currently using to conduct its normal business. If there is organizational slack (i.e., uncommitted resources), then meeting the new demand for resources may not be a problem. However, if the organization is currently experiencing productivity problems and is largely ineffective in meeting current organizational demands, it is very unlikely that "new resources" can be devoted to successfully implementing a totally new effort. In a way, poor organizations do not have the time or resources to improve themselves--at least not through new and innovative changes to standard operating procedures. These organizations must deal with the current problems first before they attempt new productivity efforts. The sobering implication of this premise, if it is correct, is that new productivity techniques and programs may be better suited for improving effective organizations than for helping ineffective organizations that are experiencing severe productivity problems.

Finally, the organizational change effect reported here used an action research approach. It is difficult for the authors to believe that another approach could have served as well in this endeavor. The action research approach provided the required combination of structure and flexibility necessary for the implementation of organizational change in a complex social situation. While this approach cannot guarantee complete success or even partial success, it can produce a change strategy agreed upon by both organization and research staff, and one that is sensitive to the unique requirements of a given organizational environment.

RECOMMENDATIONS

1. The following conditions should be met before implementation of incentive systems designed to improve performance among Navy production workers:

   a. Sufficient workload to support the incentive system and ensure job security.

   b. Consistent and supportive management for the incentive system.

   c. Resolution of problems limiting productivity of individual shop members.

   d. Fair work standards for the system's participants.

2. To promote interdepartmental cooperation and achieve greater improvement, designers of future incentive systems should consider including support personnel and all lower level management.

3. Those who perform organizational change tasks, such as the implementation of incentive systems, should give thorough consideration to the action research approach as the vehicle for implementing that change.

4. For NAVAIREWORKFAC, Alameda, it is recommended that the performance measurement system (OPTS) be maintained and used to evaluate individual worker performance regardless of the ultimate decision concerning the PCRS.

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APPENDIX A

PERFORMANCE-CONTINGENT REWARD SYSTEM (PCRS) IMPLEMENTATION PROBLEMS

PERFORMANCE-CONTINGENT REWARD SYSTEM (PCRS) IMPLEMENTATION PROBLEMS

WORK INPUT TO SHOP

1. Insufficient workload
2. Master data record problems
3. Problems with standards
4. Lack of production control (PC) support (transportation, logging, parts and materials)
5. Lack of engineering and evaluation (E&E) support (hand-written shop orders (HWSOs), adding and voiding lines)
6. Problems with standards on examination and routing (E&R) tasks

WORK ASSIGNMENT AND PERFORMANCE

7. Unfair work distribution (regular work, priority items, hard items, overtime)
8. Problems with skill level/cross-training of employees
9. Problems with artisans determining additional work content, requiring HWSOs or added lines
10. Lack of coordination of parts and materials with units requiring them
11. Unfair assignment of indirect work (e.g., training, alternate foreman, cleanup)

TRANSACTING WORK

12. Problems with using indirect charges (including delay) appropriately
13. Lack of control over transaction cards (for direct and indirect work)
14. Lack of control of HWSOs, added lines, transacting voided or unworked lines
15. Late input of HWSOs and added line standards to system
16. Transactor errors, transactor downtime, and saving lost transactions

WORK MEASUREMENT

17. Late receipt of daily labor error reports (DLERs) or objective performance tracking systems (OPTS) reports
18. Inaccurate performance efficiency scores
19. Difficulties in following up on and changing inaccurate efficiency scores

WORK OUTPUT

20. Difficulty in ensuring quality of work
21. Problems in fairly and accurately accounting for rework and reprocessing time
22. Problems with standards coverage for final mechanics
23. Lack of PC support (logging, transportation)

INCENTIVE SYSTEM ISSUES

24. Difficulties in including all shop members fairly
25. Employee unwillingness to help each other
26. Employee unwillingness to perform necessary nonincentive tasks
27. Employee distrust of system (e.g., fear of ratcheting standards)

OTHER ISSUES

28. Union steward time
29. Income tax implications (extra pay taken in taxes)
30. Getting time freed up for foremen to solve problems

APPENDIX B

REDUCED LIST OF PERFORMANCE-CONTINGENT REWARD SYSTEM (PCRS) IMPLEMENTATION PROBLEMS AND THEIR DESCRIPTIONS

REDUCED LIST OF PERFORMANCE-CONTINGENT REWARD SYSTEM (PCRS) IMPLEMENTATION PROBLEMS AND THEIR DESCRIPTIONS

1. Insufficient Workload

Incentive systems require either a backlog of work or a commitment by management to use indirect charges to account for time when there is no work. There may be no reason to increase productivity if there is not a requirement for increased work output or availability of additional work. Also, if workers perceive that they will work themselves out of a job, they would be "cutting their own throats" by increasing productivity. Workers' job security must not be threatened by their productivity increases. Furthermore, earning a few extra dollars may not be sufficient incentive if another result of increased productivity is being transferred out of the shop or losing overtime earnings because of insufficient workload.

2. MDR Problems[1]

Some of the Master Data Records (MDRs) are outdated and do not reflect current operations. This is especially a problem in B1 where inaccurate MDRs have resulted in up to 25 percent lost time from errors (unaccounted for hours). Inaccurate MDRs are also a serious problem in shop A1. For example, some MDRs in shop A1 do not have correct work sequencing and, as a result, the foreman must recode the document to establish the correct routing. Time may be charged out of sequence because the actual work sequence no longer matches that of the MDR. In addition, people may not understand the foreman's recoding system and may route work to the wrong place, causing further delays in the work process.

3. Problems with Standards

Approximately 50 percent of the standard time earned in the incentive shops is non-engineered. As such, the time allocated for these jobs is based either on outdated procedures or on a best guess. Acceptance of the work standards as valid and fair from the perspectives of both management and the worker is critical for a successful incentive system.

4. Lack of Support[1]

Shops A1 and A2 report coordination problems with production control (PC) and lack of sufficient PC support, especially on the second shift. Production workers feel they must sometimes do PC's job in order to "get the work out." Also, there is not a clear understanding of where PC's job ends and production's job begins. Overall, the problem for the incentive system is that production workers often do PC-type functions (e.g., chase parts, open containers) for which they receive no standard time. Also, production workers are impeded from doing their job well because of lack of support. On the other hand, attempts by PC to do an adequate job and maintain control are subverted by production workers who assume PC functions.

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[1] This problem represents one of the four ultimately chosen by the Productivity Steering Group as the most critical to the successful implementation of the incentive system.

5. Lack of Engineering and Evaluation (E&E) Support[1]

E&E support is essential to the integrity of the work measurement system. Without this control, it is very difficult for foremen to prevent workers from artifically inflating the standard time provided for a job. However, as one foreman noted, this support must be more than just paperwork screening. E&E personnel must be in the shop and knowledgeable enough about shop operations to determine the level of rework or overhaul required and to tailor the work documents accordingly. Thus, there should be an E&E person assigned to each shop.

6. Work Assignment

Workers in the pilot incentive shops must feel that they all have an equal chance to earn incentives. That is, assuming that workers have equal ability and motivation, the work must be assigned fairly and equitably. Some workers must not have a better chance of working on the easy units or "money makers." Likewise, certain workers should not always be assigned to tasks that prevent earning individual incentives (e.g., training employees, difficult tasks, and indirect activities).

7. Late Receipt of Reports

Shop labor reports and objective performance tracking systems (OPTS) reports are not delivered in a timely manner. As a result, transaction errors cannot be corrected and accurate performance measurement suffers. Also, the failure to distribute the OPTS reports on time threatens the credibility of the new OPTS system. Furthermore, when the incentive system starts, failure to distribute the OPTS employee reports on schedule may create complaints by workers who are keeping track of their incentive earnings.

8. Performance Measurement Problems[1]

Accurate work reporting is essential for implementation of an incentive program based upon individual performance. With this concept in mind, the following practices must be corrected:

a. Use of Indirect Charges

Incentive award amounts should be based upon direct labor performance against "A" through "D" standards. Currently, indirect tasks are being charged to direct labor because foremen have been told not to use indirect accounts. The result is that highly productive employees will see their direct performances drop below what they think and know they should be when they do indirect work and will judge the measurement system to be inaccurate. This judgment will be correct.

b. Emphasis on 100 Percent Efficiency

Many artisans and foremen believe that reporting a 100 percent efficiency level is more important than accurately reporting their work tasks. As a result, a great deal of time is spent trying to beat the system (e.g., transacting lines that are not worked). Management needs to convince artisans and foremen that accurate work reporting is more important than achieving high "paper" efficiency.

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[1] This problem represents one of the four ultimately chosen by the Productivity Steering Group as the most critical to the successful implementation of the incentive system.

c. Labor Corrections

The Daily Labor Error Report (DLER) must be corrected on a daily basis and submitted to the Management Control Department in order for an artisan to receive credit (earned hours) for transactions that resulted in errors (unaccounted for time). In many instances, the foreman may not receive the DLER on time, or, even if he does, he does not have time to match errors to the correct link and line number. In such cases, a job order number is used to cover the time, the artisan loses the earned hours he/she deserves, and the expended hours are not eligible for incentive earnings. In some instances, foremen have conscientiously matched discrepancies with the proper link and line numbers, but management control analysts have submitted these corrections using job order numbers because they do not have the time to enter all the detailed link and line number corrections. This situation occurs primarily on Mondays and Tuesdays. When Code 21200 was asked if the situation could be remedied, the response was essentially, "No, we do not have the personnel." The result is that the artisan loses earned and expended hours and the foreman sees little value in wasting his time by conscientiously correcting his DLER. The net result for the facility is inaccurate work measurement.

d. Remote Terminals

Some important functions of the terminal are to allow more timely entry of hand-written shop orders (HWSOs), to call up and examine current MDR work status, and to make DLER corrections. Each of these functions would contribute substantially to an accurate performance measurement system. However, due to the way the terminals are connected to the main computer, it is very difficult to use them because the dial-up line is almost always busy. As a result, the terminals are rarely used and their potential contributions to performance measurement accuracy can not be realized. Hard-wiring these terminals to the computer would help reduce this problem.

9. Difficulty in Ensuring Quality of Work

It has been argued that the incentive system might result in increases in efficiency at the expense of quality. Acceptable product quality is an absolute requirement for the NAVAIREWORKFAC and standard operating procedures must be developed that ensure that quality is not sacrificed for gains in efficiency.

APPENDIX C

SUMMARY DATA FOR EVALUATION OF THE EFFECTS OF THE INCENTIVE SYSTEM

Table C-1

Number of Informal EEO Complaints

Shop	Informal Complaints: Baseline Period	Informal Complaints: Incentive Period
A1	0	0
A2	0	0
Comparison Group A	2	1
B1	0	1
B2	1	4
Comparison Group B	4	3

Table C-2

Severity of Quality Defects by Shop During Baseline and Incentive Periods

Shop	Period	Total Number of Inspections	Inspections Finding Defects: Critical Defects (%)	Major Defects (%)	Minor Defects (%)	No Defects (%)
A1	Baseline	1401	0	3.6	0	96.40
	Incentive	2265	0	3.4	0.09	96.50
A2	Baseline	1462	0.14	3.5	0.56	95.80
	Incentive	2509	0.10	1.0	0	98.90
B1	Baseline	4090	0	1.1	0.02	98.88
	Incentive	3686	0	0.7	0.10	99.30
B2	Baseline	392	0	0.3	0.3	99.40
	Incentive	509	0	0.4	0	99.60

Table C-3

Average Weekly Indirect Hours for Incentive and Comparison Shop Workers During Baseline and Incentive Periods

Group	Baseline (B) Period	Incentive (I) Period	Change in Indirect Hours (I-B)	n
Incentives				
Shop A1	3.41	1.82	-1.59	19
Shop A2	2.15	2.65	+ .50	23
Comparison Group A	1.32	1.23	- .09	19
Incentives				
Shop B1	2.14	2.29	+ .15	17
Shop B2	1.47	1.57	+ .10	13
Comparison Group B	1.70	1.28	- .42	20

Note. None of these changes are significant based on a repeated measures analysis of variance comparing incentive and comparison shop workers.

Table C-4

Average Number of Sick Leave Hours Taken per Week for Incentive and Comparison Shop Workers During Baseline and Incentive Periods

Shop	Baseline (B) Period	Incentive (I) Period	Performance Change (I-B)	n
A1	.78	.61	-.17	19
A2	1.79	1.40	-.39	23
Comparison Group A	1.27	2.09	.82	19
B1	.91	1.02	.11	17
B2	.91	1.01	.10	13
Comparison Group B	.57	.30	-.27	20

Note. None of these changes are significant based on a repeated measures analysis of variance comparing incentive and comparison shop workers.

Table C-5

Mean Number of Hours Per Week Expended on Overtime by Artisans

Shop	Baseline (B) Period	Incentive (I) Period	Change (I-B)
A1	2.37	1.59	-.78
A2	.89	.33	-.56
Comparison Group A	1.88	1.27	-.61
B1	2.33	.47	-1.86
B2	2.14	2.30	+.16
Comparison Group B	4.04	2.31	-1.73

Table C-6

Correlations Between Questionnaire Scales and Scale Internal Consistencies

Scale	Internal Consistency (Cronbach's Alpha)	Scale Intercorrelations						
		2	3	4	5	6	7	8
1. Group Cooperation	.75	.75	.39	.61	.44	.76	.53	.56
2. Group Attraction	.77		.38	.55	.46	.43	.60	.57
3. Group Effectiveness	.76			.61	.25	.41	.34	.41
4. Esprit de Corps	.61				.34	.48	.51	.55
5. Trust in Management	.70					.48	.67	.61
6. Extrinsic Satisfaction	.82						.62	.93
7. Intrinsic Satisfaction	.87							.85
8. General Satisfaction	.90							

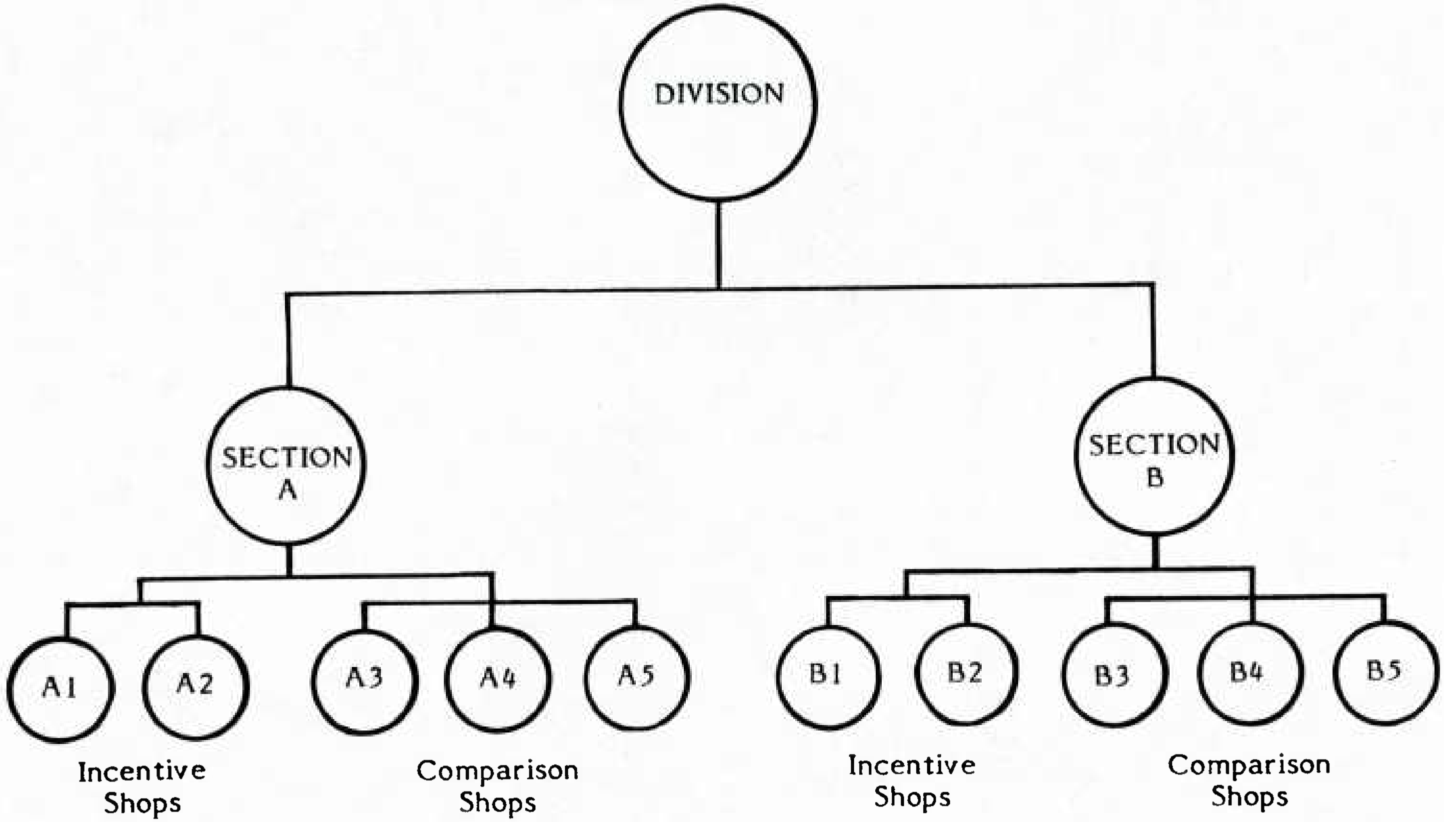

Figure C-1. Abridged organizational chart of the NAVAIREWORKFAC Alameda Power Plant Division.

APPENDIX D

COST-BENEFIT ANALYSIS FOR THE PERFORMANCE-CONTINGENT REWARD SYSTEM (PCRS) AT NAVAIREWORKFAC, ALAMEDA

COST BENEFIT ANALYSIS FOR THE PERFORMANCE-CONTINGENT REWARD SYSTEM (PCRS) AT NAVAIREWORKFAC, ALAMEDA

Variables Measured

Fourteen measures of monetary costs and benefits were included in this analysis of the incentive system. A list of these variables is included as part of Table D-1. Measures of direct and indirect labor hours, worker sick leave, overtime, and reprocessing time (time taken to rework a unit with a quality defect) were taken from extant data bases maintained by Naval Air Rework Facility (NAVAIREWORKFAC), Alameda. Navy Personnel Research and Development Center (NAVPERSRANDCEN) personnel and training costs directly related to implementation of the incentive system were obtained from a number of sources. Whenever possible, information was obtained from hard records such as travel vouchers. When such records were not available, members of the research staff made estimates of the time spent on the project and resources utilized with the aid of a questionnaire developed for that purpose.

Table D-1

NAVAIREWORKFAC, Alameda PCRS Cost-Benefit Analysis: Actual Project Costs and Benefits

		Costs	Benefits
1.	Labor Hours	0	$46,256.0
2.	Indirect Labor	0	0
3.	Sick Leave	0	0
4.	Overtime	0	0
5.	Reprocessing	0	0
6.	E&E	$129,888.0	0
7.	PC	28,327.2	0
8.	PCRS Coordinator	46,607.5	0
9.	NAVPERSRANDCEN Personnel	315,992.4	0
10.	Foremen Time	37,938.5	0
11.	Steering Group Time	6,186.5	0
12.	Artisan Training	8,181.3	0
13.	Computer Program Development Costs	179,500.0	0
14.	PCRS Operating Costs	52,200.0	0
	TOTAL	$805,121.4	$46,256.0

Information on NAVAIREWORKFAC personnel and training costs related to the implementation of the incentive system was obtained from NAVAIREWORKFAC, Alameda personnel, accounting, or other archival records. However, some estimates had to be made in computing these personnel costs. Foremen estimated the average number of hours they spent weekly in support of the incentive system, and their personnel costs were based on that estimate. Also, while the number of PSG meetings were known, as well as their length and those attending, the proportion of time taken in each meeting for incentive system planning and direction had to be estimated. Finally, costs for the development and operation of the computer programming related to the PCRS were obtained from the Navy Regional Data Automation Center (NARDAC), San Francisco; NARDAC, San Francisco had developed these programs and were responsible for their weekly operation. When definitive documentation did not exist, NARDAC management estimated costs associated with the support of the incentive system programs from known expenses charged to NAVAIREWORKFAC, Alameda during the relevant time periods.

Determining Reliable Costs/Benefits

NAVPERSRANDCEN and NAVAIREWORKFAC, Alameda incentive system personnel and training costs were assigned as incentive system costs. However, other costs and all potential benefits had to be more carefully determined. For instance, an increase in the average number of sick leave hours in an incentive shop could have been assigned to program costs or could have been considered simply a random phenomenon. Similarly, an efficiency increase in an incentive shop may have been due to the incentive system or some other factor. To determine effects that could be attributed to the incentive system, statistical tests were performed (when possible) on data related to all measures not considered a direct cost to the program. Statistical analyses comparing incentive and comparison groups were performed on data related to direct and indirect labor hours, sick leave hours, overtime, and reprocessing hours. When effects were assessed for the incentive shops, these differences were included as a cost or benefit attributable to the incentive system.

Results from these analyses indicated that only in shop A1 was there a reliable change/increase in efficiency that could be attributed to the PCRS. No other indirect costs/benefits could be attributed to the incentive system. Hence, all benefits are based on the efficiency increase in shop A1. The costs and benefits ascribed to the 34 weeks during which the incentive system was in operation are presented in Table D-1. As can be seen, the short-term benefits of approximately 46K were far outweighed by the total costs of about 805K.

Cost/Benefit Projections

The incentive system at NAVAIREWORKFAC, Alameda had many development costs associated with it, yet it was only implemented in four production shops for a relatively short period of time. Under this circumstance, it is probably unreasonable to expect such a demonstration project to be cost-effective. The objective of the project, if the incentive system was successful, was to expand it to other production shops and continue its operation over a long period of time. Therefore, a number of assumptions and projections were made in performing the incentive system cost/benefit analysis. First, this analysis was based on the estimated benefits from the expansion of the PCRS to the entire Power Plant Division of 34 shops. Second, an assumption was made that benefits as large as were seen in the one incentive shop showing an increase in efficiency would be seen in one of every four shops to which this program was expanded. Finally, this analysis was based on projected costs and benefits over a 7-year period. The assumption was that both program costs and benefits would remain relatively constant over these periods.

Table D-2 shows the results of two cost-benefit analyses. Tables D-3 and D-4 present a more detailed breakdown of the estimated costs included in these analyses. One cost-benefit analysis includes the costs of the additional PC and E&E personnel placed in the incentive shops to support the incentive system; the other excludes these costs. Technically, these support personnel should have been in these shops during the normal course of business, not simply to support the incentive system. It is the opinion of the NAVPERSRANDCEN research staff that these personnel costs should not be attributed to the incentive system; however, they were costs that were incurred during system implementation. Table D-2 shows that the cost-benefit outcome is radically different depending on whether or not these costs are assigned to the incentive system. If support personnel costs are included, there is a net loss of over 11 million dollars over 7 years. If these personnel costs are not included, there is a net gain of almost 1-1/2 million dollars over the same period. NAVAIREWORKFAC management must ultimately decide which of these analyses is more reasonable.

Table D-2

NAVAIREWORKFAC, Alameda PCRS Cost-Benefit Analysis: Projected Costs and Benefits Over a 7-year Period

1.	Total Costs (excluding PCRS shop support personnel)[a]	$ 2,574,458.0
	Total Benefits	3,987,754.0
	Net Gain over 7 years	$ 1,413,296.0
2.	Total Costs (including PCRS shop support personnel)[b]	$15,202,992.0
	Total Benefits	3,987,754.0
	Net Loss over 7 years	$11,215,238.0

[a]See Table D-3.

[b]See Table D-4.

Table D-3

NAVAIREWORKFAC, Alameda PCRS Cost-Benefit Analysis: Projected Costs Excluding PCRS Shop Support Personnel Over a 7-year Period

1.	PCRS Coordinator	$ 353,258.7
2.	NAVAIREWORKFAC Production Department supervision; all Power Plant Division foremen	1,303,687.9
3.	PSG support	21,602.5
4.	Training costs, all Power Plant Division artisans	69,541.2
5.	Computer program development	179,500.0
6.	Production of weekly performance reports	330,876.0
7.	NAVPERSRANDCEN personnel costs	315,992.4
	TOTAL COSTS	$2,574,458.3

Table D-4

NAVAIREWORKFAC, Alameda PCRS Cost-Benefit Analysis: Projected Costs Including PCRS Shop Support Personnel Over a 7-year Period

1.	PCRS shop support personnel	$	12,628,533.0
2.	PCRS Coordinator		353,258.7
3.	NAVAIREWORKFAC Production Department supervision; all Power Plant Division foremen		1,303,687.9
4.	PSG support		21,602.5
5.	Training costs, all Power Plant Division artisans		69,541.2
6.	Computer program development		179,500.0
7.	Production of weekly performance reports		330,876.0
8.	NAVPERSRANDCEN personnel costs		315,992.4
	TOTAL COSTS	$	15,202,992.0

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