GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: 10/14/80

Project Title: A Behavioral Approach to Productivity Specification and Reinforcement of Desired Performance in City Government

Project No: A-2655

Project Director: Dr. Judi Komaki

Sponsor: U.S. Office of Personnel Management

Agreement Period: From May 1, 1980 Until ~~January 31, 1981~~ April 30, 1981

Type Agreement: Grant No. 80-GA-08

Amount: $24,135 (A-2655)
$24,135 Cost Sharing (E-122-208)
$48,270 TOTAL

Reports Required: Quarterly, Final; Grant Project Data Summary (CSC Form 1290)

Sponsor Contact Person (s):

Technical Matters	Contractual Matters (thru OCA)
	Kathleen D. Signaigo U.S. Office of Personnel Management Southeast/OIPP 75 Spring Street SW Atlanta, GA 30303 (404) 221-3494

Defense Priority Rating: N/A

Assigned to: EDL/ARD (~~School~~/Laboratory)

COPIES TO:

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- Project Code (GTRI)
- Other [illegible]

B53 321

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 5/15/81

Project Title: A Behavioral Approach to Productivity Specification and Reinforcement of Desired Performance in City Government

Project No: A-2655

Project Director: Dr. Judi Komaki

Sponsor: US Office of Personnel Management

Effective Termination Date: 4/30/81

Clearance of Accounting Charges: 4/30/81

Grant/Contract Closeout Actions Remaining:

- x Final Invoice and Closing Documents
- x Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- x Other Grant Project Data Summary (CSC Form 1290)

Assigned to: EDL/ARD (School/Laboratory)

COPIES TO:

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Project File (OCA)
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Other _____

CA–4 (1/79)

A-2655

A-2655

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

August 1, 1980

Kathleen Signacio
U. S. Office of Personnel Management
Intergovernmental Personnel Programs Division
Suite 904
Richard B. Russell Federal
Building and Courthouse
75 Spring Street, S. W.
Atlanta GA 30303

QUARTERLY REPORT, May 1, 1980 - July 31, 1980
A Behavioral Approach to Productivity:
Specification and Reinforcement of Desired
Performance
Project Number 80 GA 08

Dear Kathy,

I am pleased to forward a progress report of the research being conducted in conjunction with the city of Savannah. During the first quarter:

a) the research site and personnel were identified,

b) an analysis of the work environment was made,

c) a system for measurement of employee performance was developed,

d) observers were trained, and

e) data collection was begun.

a) After discussions with the City Manager and Assistant Manager of Management Services, it was decided to conduct the research in the city's central wastewater treatment plant and to focus on the performance of plant operators. The operators' job consists of monitoring and maintaining high-volume, heavy-duty sewage treatment machinery. Examples of their duties include the monitoring of raw sewage pumps, the operation of heavy-duty dewatering presses, and the maintenance of optimal rabble rates inside the incinerator. Twelve operators are employed (range working at any given time is 10 to 12) who work 8-hour shifts around the clock 365 days a year. The average age of the operators is 31 years (range: 27 years to 41 years). Experience averages 25 months on the job (range: 1 month to 50 months).

b) An analysis of the work environment was made to determine what might be hindering performance. Basically, it was found that the unique nature of the operator's job, which primarily involves monitoring, makes it difficult to ensure that the job is done. Several characteristics set it apart from the typical production line job. First, there is no tangible product. Inspected equipment looks virtually the same as uninspected

equipment. As a result, it is difficult to determine whether the operators are, in fact, doing their jobs. Second, plant indices may be misleading. The plant may function properly whether it is inspected or not. Conversely, the plant may not function even if the operators are doing their job properly.

The lack of a sensitive, ongoing, and accurate index has significant implications. When it is difficult to determine when, how, and if persons are performing, favorable consequences are rarely provided. There is little recognition on a day-to-day basis. At the same time, it is difficult to rectify omissions. When it makes little difference whether one performs one way or another, it is difficult to motivate personnel.

In addition to the fact that the operator's job is invisible and difficult to monitor and motivate, it is relentless. That is, it must be done regularly, in some cases at least once each hour.

In summary, an analysis of the work environment revealed the lack of direct, frequent, and objective indicators of performance and a lack of proper motivation. The challenge becomes one of designing a system for a job, with few immediate or dramatic effects, that needs to be done week in and week out.

c) Three components of performance were identified:

1) System monitoring

2) Action taken

3) Plant cleanliness.

The measure of system monitoring assesses whether and how accurately the plant operators are monitoring daily operations of the plant. The second measure, action taken, assesses whether equipment identified as needing adjustment actually is adjusted correctly and promptly. The measure of plant cleanliness determines the extent to which plant operators are cleaning assigned areas within the plant.

Percentage agreement scores are computed, for system monitoring and action taken, based on comparisons made between the checklist completed by the plant operator and the information obtained by an independent inspection of plant equipment. An agreement means that the information recorded by the independent observer is the same as that recorded on the operator's checklist. For example, the independent observer noted that there was a problem and the operator also noted that there was a deficiency in the operation of a piece of equipment. Percentage scores are computed for plant cleanliness based on the number of clean areas divided by the total number of areas.

The observational code and data sheets are attached.

d) Three employees of the City of Savannah were identified as observers. They were trained until they obtained interrater reliability scores of 90% or better.

e) After an extensive training and fieldtesting period, data collection was begun on 30 June, 1980. Information is being collected daily by the trained observers. Each shift is observed on the average of once every three days.

A total of eight site visits were made by the principal investigator and the project manager, Johanna Williams. Plans for the next quarter include

the design and implementation of a reinforcement program in at least one of the performance areas. In summary, work is progressing as planned and no unusual problems have been encountered.

Sincerely,

Judi Komaki, Ph.D.

cc: A. A. Mendonza
J. Nuckel
R. Blackston

A-265

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

November 4, 1980

Kathleen Signacio
U.S. Office of Personnel Management
Intergovernmental Personnel Programs Division
Suite 904
Richard B. Russell Federal
Building and Courthouse
75 Spring Street, S.W.
Atlanta, Georgia 30303

QUARTERLY REPORT, August 1, 1980 - October 31, 1980
A Behavioral Approach to Productivity:
Specification and Reinforcement of Desired
Performance
Project Number 80 GA 08

Dear Kathy,

I am pleased to forward a progress report regarding the research being conducted on productivity in the public sector.

During the second quarter, the research continued in the City of Savannah's central wastewater treatment plant. In particular:

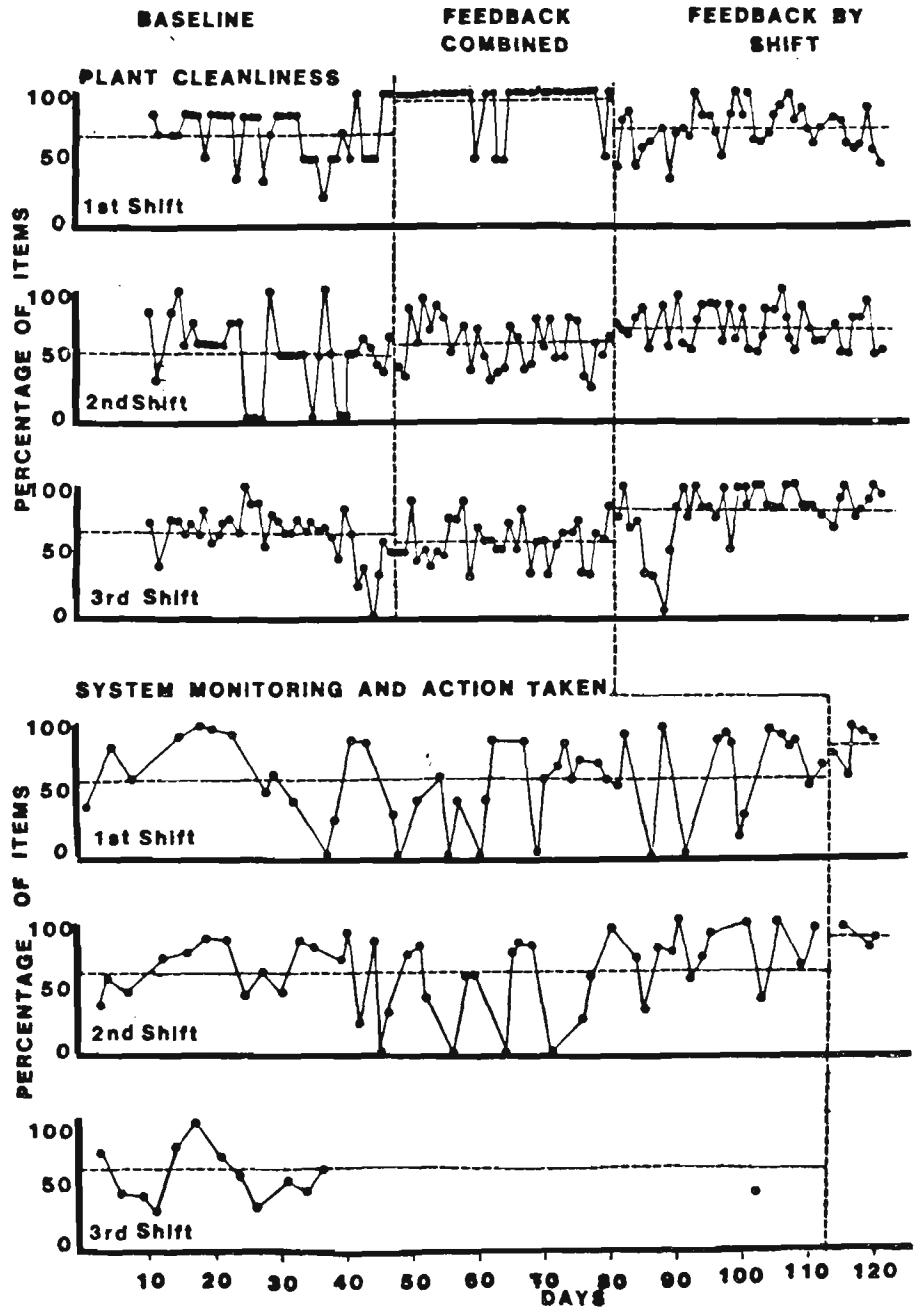
a) information on plant operator performance continued to be collected in the two primary areas of plant cleanliness and system monitoring;

b) a behavioral program was introduced to improve plant cleanliness;

c) ten weeks later a similar program was introduced to improve system monitoring.

a) City of Savannah employees continued to collect information about plant cleanliness (the extent to which operators are tidying their assigned areas) and system monitoring (whether, and how accurately, operators are inspecting and taking care of discrepancies). After six weeks, the observers requested a change in scheduling. As a result, third (night) shift was dropped. Data continue to be collected daily, however, on the average of once every other day in either first or second shift. The dropping of third shift meant the loss of information about system monitoring of the third shift operators. Because plant cleanliness could be assessed at any time, this change did not affect data collection for that area. Information could still be obtained about first, second, and third shift plant cleanliness performance.

b) The behavioral program on plant cleanliness was introduced after approximately five weeks of data had been collected, and it was found that only 60% of the assigned areas were meeting standard. The behavioral program consisted of training and reinforcement in the form of feedback. At an initial meeting the researchers, in conjunction with the superintendent and the supervisor, explained and posted the cleanliness standards for each cleaning station. Following the meeting, feedback on operator performance was provided. The observers posted the percentage on a graph once daily. Initially, feedback was presented in a combined fashion. That is, the operators posted the percentage of clean areas for the plant as a whole. The provision of feedback in a combined fashion had mixed results. There were improvements in first shift, but not in second and third, as Figure 1 indicates.



It was decided that the method by which the feedback was being presented was too general. A change was then made in which feedback was presented by shift rather than in a combined fashion. It was found that the more specific feedback, by shift, generated greater changes in employee performance than did the group feedback.

c) Based on the results for plant cleanliness, a similar program was designed and implemented in system monitoring. At an initial meeting, the superintendent and the supervisor, in conjunction with the researchers, explained what was expected and distributed revised monitoring checklists. The revised checklists detailed exactly what to inspect and what to do when there was a discrepancy. As in the immediately previous phase, feedback on operator performance was presented by shift. Results, thus far, look very promising.

A total of eight visits were made by the principal investigator and the project manager, Johanna Williams. Plans for the next, and last, quarter include the continuation of the program until the first of the year, the completion of the final report, a presentation to City of Savannah personnel, and recommendations for the development of an in-house capability to continue with a similar productivity program.

Sincerely,

Judi Komaki, Ph.D.

cc: A. A. Mendonza
M. Brown
J. Nuckel
R. Blackston

A-2655

FEDERAL CASH TRANSACTIONS REPORT

(See instructions on the back. If report is for more than one grant or assistance agreement, attach completed Standard Form 272-A.)

Approved by Office of Management and Budget, No. 80-R0182

1. Federal sponsoring agency and organizational element to which this report is submitted: U. S. Office of Personnel Management

2. RECIPIENT ORGANIZATION

Name: Georgia Tech Research Institute

Number and Street: Georgia Institute of Technology

City, State and ZIP Code: Atlanta, Georgia 30332

3. FEDERAL EMPLOYER IDENTIFICATION NO.: AH58-0603146

4. Federal grant or other identification number: 80-GA-08

5. Recipient's account number or identifying number: A-2655 & E122-208

6. Letter of credit number: N/A

7. Last payment voucher number: 0

Give total number for this period

8. Payment Vouchers credited to your account

9. Treasury checks received (whether or not deposited): 1

10. PERIOD COVERED BY THIS REPORT

FROM (month, day, year): 10/01/80

TO (month, day, year): 01/31/81

11. STATUS OF FEDERAL CASH (See specific instructions on the back)

a. Cash on hand beginning of reporting period	$ (11,326.12)
b. Letter of credit withdrawals	-0-
c. Treasury check payments	11,326.12
d. Total receipts (*Sum of lines b and c*)	11,326.12
e. Total cash available (*Sum of lines a and d*)	-0-
f. Gross disbursements	12,808.88
g. Federal share of program income	-0-
h. Net disbursements (*Line f minus line g*)	12,808.88
i. Adjustments of prior periods	-0-
j. Cash on hand end of period	$ (12,808.88)

12. THE AMOUNT SHOWN ON LINE 11j. ABOVE, REPRESENTS CASH REQUIREMENTS FOR THE ENSUING _____ Days

13. OTHER INFORMATION

a. Interest income	$ -0-
b. Advances to subgrantees or subcontractors	$ -0-

14. REMARKS (*Attach additional sheets of plain paper, if more space is required*)

CERTIFICATION

I certify to the best of my knowledge and belief that this report is true in all respects and that all disbursements have been made for the purpose and conditions of the grant or agreement

AUTHORIZED CERTIFYING OFFICIAL

SIGNATURE

DATE REPORT SUBMITTED: March 16, 1981

TYPED OR PRINTED NAME AND TITLE: B. H. Atcheson, Manager, Accounting and Budgets

TELEPHONE: (Area Code) 404 (Number) 894-3438 (Extension)

15. SPACE FOR AGENCY USE

POSITIVE REINFORCEMENT IN THE PUBLIC SECTOR:

A SUCCESSFUL DEMONSTRATION

Final Report

Judi Komaki and Johanna Swanson-Williams

Georgia Institute of Technology

In Collaboration With

The City of Savannah

Sponsored By

Office of Personnel Management, Southeast Region

Grant 80 GA 08

May 1, 1980 - January 31, 1981

Judi Komaki, Principal Investigator

Many thanks to

A. A. Mendonsa

T. Witsman

M. Brown

J. Nuckel

R. Blackston

B. Turner

S. Christy

D. Perry

M. Granzow

J. Knight

and all plant employees

for their sustained cooperation and support

Summary

Despite the American taxpayers' clamor for lower taxes and more services, significant shortcomings plague all productivity improvement efforts. In its productivity efforts, the public sector has emphasized those activities that occur before the employee arrives on the job, such as recruitment and selection. Little consideration is given to ways of ensuring that the work environments themselves are conducive to sustained productivity.

The present study, funded by the Office of Personnel Management in collaboration with the city of Savannah, attempts to provide a practical and effective model for ensuring that workers know what to do and are motivated to do it once they are on the job.

The study was set in the city of Savannah's wastewater treatment plant. An explicit appraisal system was devised which included the identification of desired performance for plant operators and enabled the collection of information about their level of performance. This information was then made available to the operators in the form of feedback, a reinforcement strategy which has been demonstrated to be effective in improving performance in a variety of business, industry, and government settings. At the same time supervisors and management were encouraged to recognize employees for jobs well done.

Result: City employees not only reacted favorably but they also substantially improved their performance from approximately 60% to 80% and 90%, as much as a 50% increase.

Thus, it appears that productivity improvements are even possible in the elusive and intangible area of public sector jobs, jobs which have traditionally been difficult to define specifically, appraise, and upgrade. Particularly noteworthy is the fact that feedback, when provided in such a way that pertinent employees can readily influence this information, is effective in the nonprofit public sector.

Recommendations

Plans should be made to ensure that the substantial improvements which have resulted thus far are maintained. In particular, it is suggested that on-site supervisory personnel be identified to implement the program described.

The tools are available: performance standards, an explicit appraisal system, and a documented motivational device. What is needed is to make sure that these tools are used.

Countless programs fail at this crucial implementation stage, however, despite the best intentions. The most common mistake is the assumption that supervisory personnel simply need to be trained and occasionally reminded of their duties in this regard. Unfortunately, this is not the case. Supervisors are plagued with jobs which do not lend themselves to the traditional methods of specification, measurement, and reinforcement. As with public sector personnel, there is a need to clarify exactly what supervisors are expected to do, to monitor their progress, and to provide positive rewards if they perform as desired.

In summary, it is suggested that the same principles which proved to be effective with on-line personnel be applied with supervisory personnel.

Table of Contents

INTRODUCTION

The American taxpayer continues to clamor for lower taxes and more services. Despite this uproar, significant shortcomings plague all efforts to effect productivity improvements among public sector employees.

Before now, attempts at improvement in the public sector emphasized the development and validation of recruitment, selection, and assignment methods within work organizations. Although these concerns continue to be salient, particularly as they relate to equal employment opportunities, they all concern what happens before the employee arrives on the job. Little attention is paid to what happens once the employee is hired and placed.

While there can be no question about the importance of hiring qualified, motivated job candidates, the on-the-job environment has an equally significant impact on employee performance. Unfortunately, little consideration is ever given to possible ways of ensuring that work environments are conducive to sustained productivity.

In government settings the vast majority of efforts focus on training. The assumption operating is that trained personnel will automatically transfer their newly learned skills or insights to the work place. Unfortunately, little evidence exists to support this assumption. Training programs in the public sector, as elsewhere, are rarely validated (Goldstein, 1980). Moreover, growing evidence suggests that training alone is not effective unless the work environment itself is supportive (Komaki, Heinzmann, & Lawson, 1980; Quilitch, 1975). Most work environments are not supportive, however, and public sector environments are hardly exceptions. In general, few positive consequences encourage sustained productivity of personnel who work on straight salary. What is needed is a practical and documented way to ensure that workers know what to do and are motivated to do it once they are on the job.

Recent demonstrations have shown that a relatively new approach to work motivation, the behavior analysis approach, has been successful in improving performance in a variety of different businesses and industries (refer to the recent review by Andrasik, Heinberg, & McNamara [in press]). In the behavioral approach, a) performance is first specified so that workers know exactly

what is expected, b) then workers are appraised frequently and fairly, and lastly, c) rewarding consequences are provided for desired performance. The rewards need not be financial and may take the form of information about performance, official recognition, or promotion to greater responsiblities.

A review of the literature, however, reveals few demonstrations of actual productivity improvements in the public sector. Although Schneier, Pernick, and Bryant (1979) obtained substantial improvements after introducing a behavior modification program in the payroll and travel units of a federal agency, it was still not clear that the behavioral approach per se was responsible since the study lacked controls.

The nature of public sector jobs makes it difficult to ensure a productive work force. Public sector jobs, which are typically service oriented, are elusive and intangible; thus performance in them is difficult to specify and appraise. Not surprisingly, few organizations directly assess the performance of their employees.

The lack of a sensitive and objective measure of productivity has significant implications for productivity efforts. When employees are not sure what is expected of them or how they are doing, they are not likely to upgrade their performance. Similarly, when supervisors do not have accurate and ongoing information about personnel performance levels, it is not only difficult to recognize good employees, but also treacherous to attempt to rectify performance discrepancies. Furthermore, when management cannot judge the level of performance, workers automatically assign it a lower priority than other, more measureable activities.

What the public sector sorely needs is a model for clarifying what personnel should do, a systematic measurement system which reflects what personnel actually do, and a documented strategy for motivating trained personnel to be as productive as possible.

An auspicious opportunity arose in this regard. First, Dr. Judi Komaki at Georgia Tech had successfully introduced the behavior analysis approach in a variety of problematic work areas (e.g., Komaki, Barwick, & Scott, 1978). Second, the Office of Personnel Management listed as one of its research priorities for 1980: Personnel management-related productivity improvement

projects designed to provide more effective or higher quality services at the same costs. Third, the City Manager of Savannah had seen firsthand the disappointing results of training courses and was ready to explore some new directions. Savannah, with a population of 141,000, a city work force of over 1,600, and a reputation for concern, action,and results in productivity improvements, was set to serve as a research site.

A BEHAVIORAL APPROACH TO PRODUCTIVITY IMPROVEMENT IN THE PUBLIC SECTOR

Setting

The focus was on the operators of the city's central wastewater treatment plant. Plant operators were selected because of the interest expressed in the project by management, and because of highly publicized problems the plant had with meeting discharge standards set by the state in conjunction with the United States Environmental Protection Agency.

Savannah's central treatment plant, constructed in 1974, has a design capacity of 20 million gallons of wastewater per day. It is staffed 24 hours a day, 365 days a year, with a shift supervisor and three operators. During each shift each operator is responsible for one treatment phase: a) wet cycle, b) dewatering, or c) incinerator.

The operators' primary job consists of monitoring the high-volume, heavy-duty sewage treatment machinery and recording the status of the equipment and any changes made in machine operation on specially designed checklists. Their duties include such activities as monitoring and maintaining raw sewage pumps during the wet cycle; assuring that pressure levels within the equipment conform to safety and efficiency levels during the dewatering process; and making sure that rabble rates inside the incinerator are optimal. Each operator is also assigned an area within the plant for light housekeeping, although a utilities maintenance crew is responsible for the bulk of the cleaning and maintenance of the buildings and grounds.

The plant employed twelve operators, most of whom were high school graduates, who earned approximately $5.00 an hour. The average age of the operators was 32 years (range: 23 years to 56 years). Experience averaged 25 months

on the job (range: 1 month to 50 months). The primary training was conducted on the job, although off-site training opportunities were provided.

Analysis of the Work Environment

The first step my colleague, Johanna Swanson-Williams, and I took was to analyze the work environment to see what hindered desired performance and maintained undesired performance. The job of sewage treatment plant operator is like other public sector employment in that the primary job, monitoring equipment, is elusive. Supervisors, for instance, would say operators should check the equipment to see if it is operational. When asked to be more specific about what the worker should look for, they sometimes repeated "to see if it is operational." Further inquiries revealed, as one would expect, that "operational" meant one thing to one person and something quite different to another.

Thus, while the operators understood the general work assignments, the standards for performance were not clear. Operators knew they were responsible for monitoring the equipment and for light clean-up duties; however, they did not know exactly what to look for when monitoring and how clean was satisfactorily clean.

Second, it was found that it was difficult to tell how well operators were performing because they produced no tangible products. Inspected equipment looked virtually the same as uninspected equipment. Despite the fact that the city of Savannah pioneered the use of accountable measurement systems for public sector employees, there was no objective or systematic indicator of operator performance. Supervisors did not directly oversee the activities which were carried out at different locations within the plant. No formal records were kept.

The primary means of evaluation were such plant indices as whether the plant was meeting discharge standards (e.g., quality of water). Unfortunately, plant indices were misleading as indications of an individual operator's performance since the plant could sometimes function properly whether the equipment had been inspected or not. Conversely, the plant could sometimes not function even if the operators had done their jobs properly. Equipment age and design, for example, often hampered plant operations. In

such a situation, it is difficult to specify and assess employee productivity accurately.

Because it was difficult to determine if, when, and how the operators were performing, favorable consequences were rarely provided. Little or nothing was said or done when personnel performed properly; no news from their supervisors was good news. Likewise, undesired performance resulted in few consequences. Supervisors were reluctant to attempt to rectify acknowledged and common problems, such as "dry labs" in which operators noted the status of the equipment prior to making their hourly rounds.

The lack of a sensitive measure of performance also minimized the relationship between performance and organizational incentives such as pay increases and bonuses. In fact, the primary way to go up the pay scale was to complete a prescribed number of certification courses.

In summary, an analysis of the work environment revealed a lack of standards for desired performance, a lack of objective and systematic indicators of performance, and a lack of motivation for doing jobs well. As a result of the analysis, it was decided to a) draw up standards for desired performance, b) design an explicit appraisal system, and c) ensure there were positive consequences for performance in the form of feedback and recognition.

Clarification of Performance Standards

To clarify exactly what personnel were expected to do, supervisory and management personnel were asked to rank order the tasks they thought to be most important. For each of these tasks, they were asked to note precisely what operators should do and when they should do it.

For the primary activity of system monitoring, the clarifications sometimes consisted of noting exactly what equipment should be monitored: for example, the operation of the ash slurry pump and its mercury setting. A common clarification involved defining what it meant for the equipment to be considered operational and what were danger signals: for example, in the wet cycle, the raw sewage pump was checked to be sure it was on, that it was making no excessive noise, and that the valve was closed; in the dewatering system, the equalizing tank pressure was monitored to be sure it was within ±

50 lbs. of the filter pressure after the first hour of the run; in the incinerator, the cooling air motor blower was checked to be sure it was on with no belts flapping, skipping or smoking. Once the standards were determined, the appropriate action to be taken was specified: for example, if the feed pumps were losing pressure, the operator was supposed to cut off the pump, and drain and clean the lube tank and strainer.

A similar clarification process was done for plant housekeeping. Supervisory personnel identified the areas that operators were responsible for light-cleaning: the floor, staircase, rails, steps, and table, in the first and second floor incinerator area. The most common clarification involved housekeeping standards: the floor should be free of debris, defined as pieces of wood, gloves, broken bags of lime, empty containers, and pipes, but not tools.

Based on the above clarifications, the authors drafted preliminary data sheets and observational codes that consisted of observational procedures and definitions. The four data sheets included those for monitoring of the three systems -- wet cycle, dewatering, and incinerator -- and housekeeping. Because of the nature of the monitoring task, it was decided that independent observers would collect information on the status of the equipment and then compare their recordings with those of the operators. Observational procedures were drawn up which took into account the equipment, its operating standard, and the conditions under which the operators should make adjustments.

To determine whether the definitions were clearly stated and the observational procedures feasible, interrater reliability was assessed. Two observers checked each piece of equipment and each housekeeping area. Both recorded <u>independently</u>. Afterwards they assessed interrater reliability using the percentage agreement method in which the number of agreements is divided by the total number of agreements plus disagreements and then multiplied by 100. Any disagreements were then discussed so that ambiguous definitions and unworkable procedures could be refined. The revisions of the data sheets and observational codes and the training of the observers continued until two persons consistently agreed on virtually all of the items.

Explicit Appraisal of Desired Performance

The two measures of System Monitoring and Housekeeping were the end result of the above revisions and were used to determine how well operators were performing. The measure of System Monitoring assessed whether and how accurately operators were checking, adjusting, and operating plant equipment. The measure of Housekeeping determined the extent to which operators were cleaning assigned areas in the plant.

Four management analysts employed by the city of Savannah served as observers during the study. Training sessions were held at the plant. All the observers were asked to obtain interrater reliability scores of 80% or better before formally collecting data. The observers were awarded compensatory time for observations made outside normal working hours. In addition, each observer was allowed to use a city vehicle or was reimbursed for travel expenses incurred in getting to the plant.

The observers received assignments that included the day, the shift, and the hour during the shift they should begin, as well as the order in which they should observe each of the three systems. Observations were scheduled daily. Hours within each shift, as well as the order in which the observers should check each system, were assigned randomly with replacement. Initially, each shift was visited an average of once every third day. After six weeks, the observers requested a change in scheduling. As a result, the third (night) shift was dropped. Data continued to be collected daily, however, on the average of once every other day in either first or second shift. The dropping of third shift meant the loss of information about System Monitoring of the third shift operators. Information could still be obtained about first, second, and third shift Housekeeping performance.

For System Monitoring, the independent observers made an inspection of plant equipment, noting whether it was operational and whether there were any problems. Following this inspection, the observer compared his or her notations with those on the checklist completed by the operator during the same hour. A percentage agreement score was computed, defined as the number of agreements divided by the number of agreements and disagreements. An agreement meant that the information recorded by the independent observer was the same as that recorded on the operator's checklist. For example, if the

operator noted on the checklist for the dewatering system that the pH at the filter was 8.5 during the second hour of the second shift on June 2nd, and the observer noted that it was 9.0 (within $\pm$ .5) during the same hour and day, this constituted an agreement. For items such as the one above, an acceptable range ($\pm$ 5) was noted to take into account cases in which the status might vary during the hour when operator and observer would check.

For action taken, the observer recorded on his or her inspection tour when action was needed: that is, when the equipment was not running, when the measurements were out of the desired range, or when there were other problems. In some cases, the observer noted whether appropriate adjustments had been made, such as on the blow scum ejectors. In other cases, the observer checked the operator's checklist to see whether he or she had made any adjustments. The action taken percentage score was calculated as the number of items on which action was taken or not needed divided by the total number of items and then multiplied by 100. The total System Monitoring score consisted of the system agreement score plus the action taken score divided by two.

For Housekeeping, independent observers made an inspection of all the housekeeping areas, noting whether the areas were cleaned satisfactorily. Percentage scores were calculated first on an individual operator basis as the number of clean areas divided by the total number of areas and multiplied by 100. Then individual operator scores were added together and divided by the number of operators assigned to each shift.

Interrater reliability was assessed 13 times for System Monitoring and 14 times for Housekeeping throughout the course of the study. Considering the complexity of the measurement system, the observers consistently obtained high percentages of agreement throughout, averaging 91% for System Monitoring and 88% for Housekeeping.

Baseline Assessment

During Baseline, beginning the end of June, observations were conducted to see how the operators normally performed on a day-to-day basis. It was found that the average score was approximately 60% for both System Monitoring and Housekeeping. That is, three-fifths of the time the operators accurately monitored the three systems and three out of every five housekeeping areas were taken care of each day.

Feedback Combined Across Shifts

During this phase, operators received feedback about their performance on a combined basis, that is, information about the plant as a whole was given. The observers posted the plant percentage score for the day on a graph for all to see following each observation. Feedback was selected because of its low cost, previously demonstrated effectiveness, and ready acceptance in the work environment.

To evaluate the effectiveness of the feedback, plans were to provide feedback for just one performance area, in this case, Housekeeping. Then when performance improved, feedback would be provided for System Monitoring, the second performance area. If performance improves during, and not before, the feedback, and if this result occurs each time the feedback is provided for another performance area, then the feedback is presumably responsible for improvements. The primary advantage of this multiple-baseline type of design is its power to reveal cause-effect relationships without requiring the arrangement of a suitable control group. This is a significant consideration since control groups are extremely difficult to arrange properly in work settings.

Management chose to begin with Housekeeping due to equipment changes being made in one of the three systems and an influx of newly hired, but not yet fully trained, operators. To kick off the combined feedback program in Housekeeping, the authors held a series of meetings with operators and supervisors of all three shifts in mid-August.

The authors first portrayed their analysis of the operators' work environment, acknowledging a) that it was sometimes not clear what the operators they were supposed to do, b) that no one could be sure how well they were doing, and c) that there was little recognition for a job well done. They then presented the standards for the Housekeeping areas (noted on the data sheets); described how the observers had been collecting information on their performance; asked the supervisors and operators to estimate the group's performance level; and compared their estimates with the actual performance level, which was shown on a large graph. Care was taken to point out the positive aspects, i.e., those areas kept consistently clean and those instances in which the actual level was higher than the estimated level.

To ensure that the housekeeping standards were understood, the operators and their respective supervisors practiced scoring each of their assigned areas within the plant. Performance improvements were encouraged: To aid the plant, to gain recognition for the group. Operators were told that the plant housekeeping would be posted each day on the unplotted portion of the graph, which would be posted in a conspicuous place, in this case, the control room.

Supervisors were encouraged to refer to the graph, a source of objective information about the housekeeping level, and to recognize improvements. The operations superintendent was asked to speak with each operator each week about his or her performance.

Problems with accountability. The results of the Combined Feedback were lackluster. Improvements were slight overall, from a preprogram mean of 60% to a postprogram mean of 69%. On a day-to-day basis, the slight increase in the overall performance level was difficult for operators and supervisors to discern on the graph, even though the cleanliness of select areas within the plant had improved.

Discussions with on-site personnel revealed that supervisory and management personnel were aware of the negligible improvements but rectification was difficult because the responsibility was diffuse, being shared by operators working on different shifts under different supervisors. No one person could influence the score. Supervisors on any one shift could not, because they were responsible for only one-third of the operators and their assigned housekeeping areas. Individual operators had even less influence on the total plant score.

As a result, it was decided to provide the feedback in such a way that an individual shift supervisor and the respective operators could have a noticeable effect on the information, be recognized for improvements, and held accountable for discrepancies. The decision was to provide feedback for each of the three shifts.

In preparation for the feedback by shift phase, the data were broken down for the three shifts. It was found that the results of the combined feedback had different effects on the three shifts. First shift made sub-

stantial improvements, second shift improved only slightly, and third shift actually declined, as shown in Table 1.

Table 1

Average Performance Level of Wastewater Treatment Operators By Shift Before and After Combined Feedback

		Before	After
Shift:	1st	67%	94%
	2nd	50%	57%
	3rd	64%	57%
Total		60%	69%

Feedback By Shift

During this phase, operators received feedback about their peformance on a shift-by-shift basis. The observers posted each shift's percentage score for the day on three graphs, one for each shift, instead of the plant's percentage score on a single graph.

To introduce the revisions, the authors again held a series of meetings with operators and supervisors of all three shifts in late September. The authors acknowledged that the previous program had definite flaws and presented the rationale for changing the specificity of the feedback. Other than the way in which the feedback was provided, however, all else remained the same: housekeeping standards, the daily appraisals by the independent observers, and the public posting of the information. To ensure that the standards were understood, operators and their respective supervisors then practiced scoring the housekeeping areas of operators on the shift.

Supervisors were again encouraged to refer to the graphs and to recognize operators for improvements. The operations superintendent was asked to speak to each supervisor each week about the housekeeping performance.

Performance improvements. The results were much improved. All three shifts substantially upgraded their level of performance over that of Baseline and over that of Feedback Combined, as shown in Figure 1 and Table 2. Operators consistently attained performance levels of 71% to 80% when feedback was presented by shift.

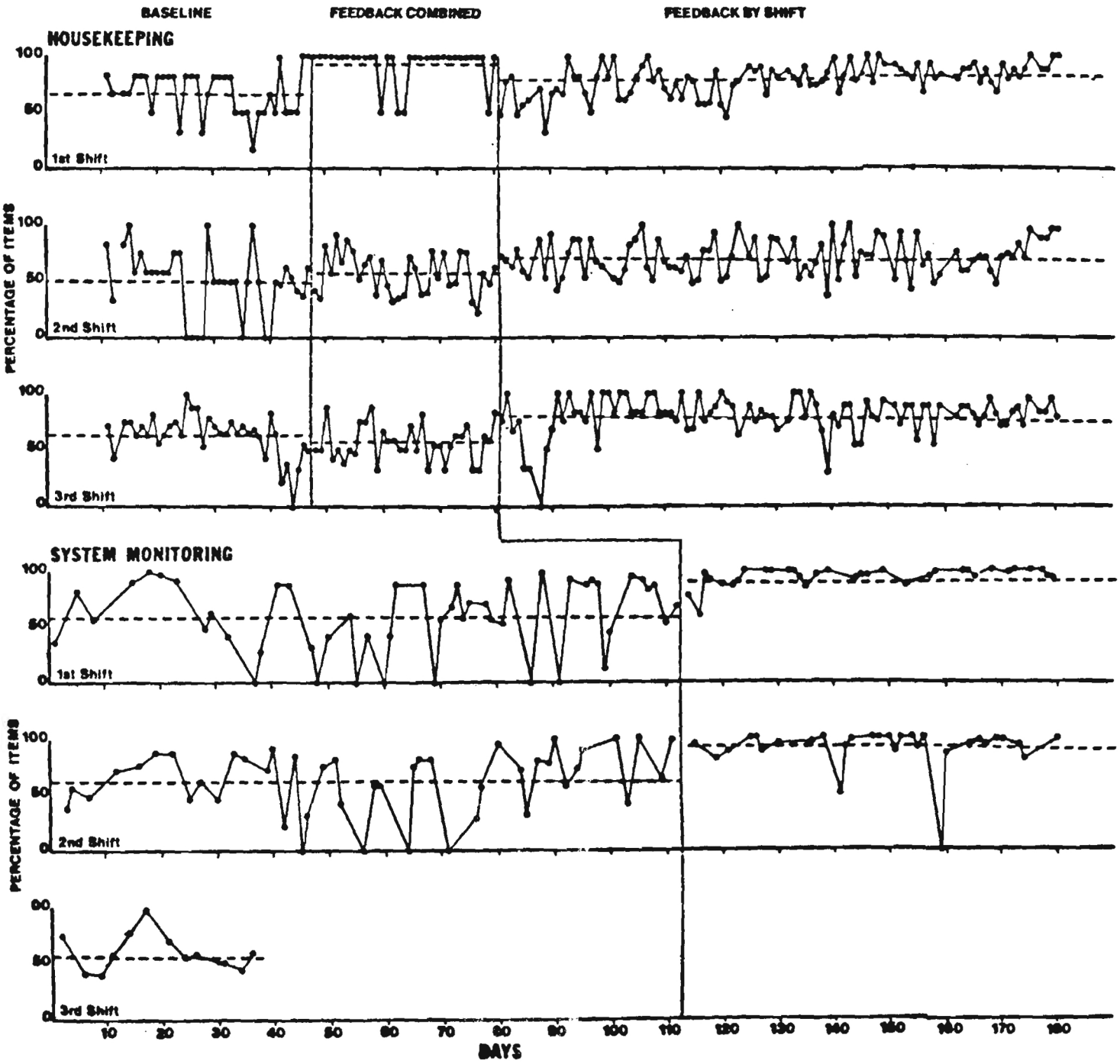


Figure 1
Performance of City Employees
On Two Feedback Programs

Table 2

Average Performance Level of Wastewater Treatment Operators
in Two Areas
During Three Experimental Phases

	Experimental Phases		
Performance Areas	Baseline	Feedback Combined	Feedback By Shift
Housekeeping			
Shift: 1st	67%	94%	79%
2nd	50%	57%	71%
3rd	64%	57%	80%
Total	60%	69%	77%
System Monitoring			
Shift: 1st	59%	-	92%
2nd	63%	-	90%
3rd	56%	-	-
Total	59%		91%

When improvements were evident in Housekeeping in late October, Feedback by Shift was introduced for the primary job of System Monitoring. The authors again held a series of meetings with operators and supervisors of all three shifts. Revised operator checklists were presented which listed what, how, and when operators should monitor the system. The authors then described how the observers had been collecting information on their performance; operators were told, for instance, when all three systems were down that information on System Monitoring was not collected. The authors then asked supervisors and operators to estimate the shift's performance level and compared their estimates with the actual performance level. Again, care was taken to note the positive aspects. Those items frequently monitored accurately were delineated and when appropriate it was noted when the actual performance level was higher than the estimated level. Operators were then told that a System Monitoring score, as well as a Housekeeping score, would be posted each day on the shift's graph. Both the supervisors and the operations superintendent were asked to consult the graphs and recognize instances of desired performance.

Further improvements. System Monitoring performance rose dramatically from less than two-thirds during Baseline (59% to 63%) to nine-tenths during Feedback by Shift (92% and 90%). Operators regularly inspected the equipment and kept accurate records of any adjustments they made. There were only two occasions in which a shift received a 0%, indicating that the checklists were virtually always completed and turned in. These improvements occurred in both first and second shift, as can be seen in Figure 1 and Table 2.

Renewed interest. Employee reactions to the system of specification, monitoring, and feedback on a shift-by-shift basis were quite positive. When the information was presented by shift, an informal competition arose among the shifts, with workers checking to see which shift had done best. When performance fell below 100%, employees typically asked which item(s) had been counted off. Eventually, the data sheets themselves were made available. Any mistakes which had been made in scoring individual items, computing shift scores, or posting the data on the graphs were then swiftly brought to the attention of management.

The availability of unbiased information about the shift performance facilitated positive interactions among the various levels of personnel. The shift supervisor for instance, could hold each employee accountable for a specific set of standards. Those employees meeting performance standards could then be recognized by management. At the same time, when discrepancies arose, supervisors could attempt to rectify them. The operations superintendent also benefited, since he now had a running account of operations, and thus, could better pinpoint and rectify problems. In addition, he could be more specific and positive when dealing with the supervisors.

IMPLICATIONS

The present demonstration is among the first of its kind, and it indicates that productivity improvements are, in fact, possible in the public sector. The improvements occurred in the performance of wastewater treatment operators who are typical of public sector employees in that the nature of their jobs is elusive and intangible, and therefore difficult to specify, monitor, and improve. Furthermore, the improvements occurred not only in a highly visible shift but also in the second and third shifts which are notoriously difficult to surveil.

The results of the present study illustrate the viability of a positive reinforcement approach in the public sector. When performance was specifically defined, regularly monitored, and positively reinforced, City employees not only reacted favorably to the programs but also substantially improved their productivity.

The incentive used in the present study, feedback, was not costly. In fact, the resulting improvement in performance was particularly impressive given the low cost of its cause. Of considerable interest was the discovery that feedback must be extremely specific if it is to result in performance improvements. The effectiveness of a nonmonetary incentive such as feedback is a particularly salient consideration to the nonprofit public sector.

In summary, the present study illustrates the importance of clarifying standards, systematically appraising performance, providing positive consequences, and making sure that information is presented in such a way that pertinent employees can readily influence and be held accountable for performance.