AN IDIOGRAPHIC ANALYSIS OF

PRODUCTION BEHAVIOR

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PRODUCTION BEHAVIOR

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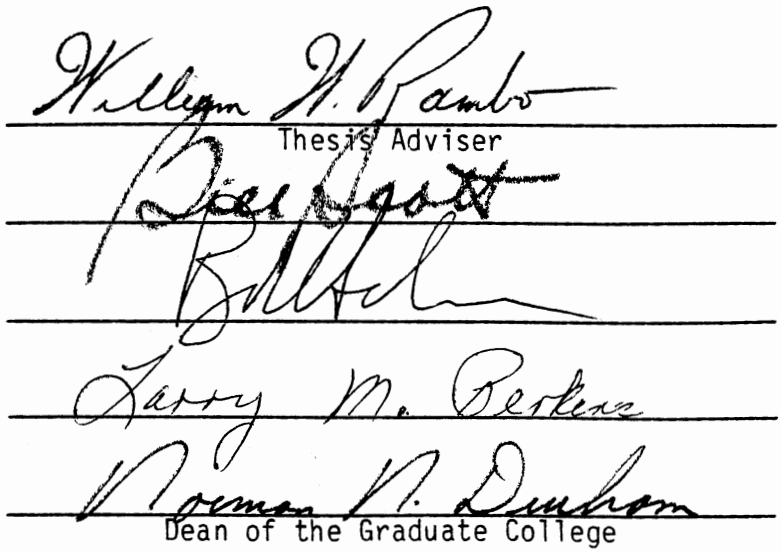

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CHAPTER I

INTRODUCTION

In psychology, many theoretical and applied issues require certain assumptions concerning the reliability of human performance. Furthermore, the assumption that behavior is highly reliable is fundamental to our ability to make generalizations beyond the experimental settings that constitute psychological research. That is, when performance reliability over time is low, generalizations about observed events will be restricted by time and other situational constraints. But high levels of consistency permit more meaningful generalizations to be made beyond the observed time frame within which observations are collected. Further, performance measures are often used as a criterion for validating tests, measuring effectiveness of procedures, setting performance standards, and evaluating one's contribution to an organization. The greater the stability of these behaviors, the more confidence one can have in the observed results and the ability to predict future behavior.

Human performance is often studied in carefully controlled laboratory settings where the experimental conditions are held relatively constant. This stable environment enhances the probabability that observed variability in subject behavior may be attributed to the phenomenon being examined. That is, since many of the extraneous

variables are held constant, the link between the predictor and the criterion is strengthened. However, there are drawbacks to laboratory research. These experiments are generally conducted over short periods of time and are rarely longitudinal in nature. Often these studies sample a limited aspect of behavior, for example, specific psychomotor skills as measured by reaction time or frequency. Further, many of them focus on changes in performance during learning or acquisition and seldom on behavior that is already established and well learned through previous practice. These conventional approaches to experimental design, although convenient and efficient, tend to create conditions which are very structured and unchanging but may not be valid representations of situations outside the laboratory.

Whereas laboratory studies permit tightly controlled research settings, field research offers the applied psychologist the opportunity to explore behavior in situations which cannot be duplicated in the laboratory. Furthermore, many aspects of life present individuals with fairly routine and redundant situations which, to some extent, emulate the laboratory. More specifically, work often provides an environment which is characterized by recurring, well-defined tasks being performed under relatively well-controlled conditions which are unchanging for long periods of time. In these situations, one learns to respond in a certain familiar manner and these habitual behaviors appear to be highly automatic and predictable. Functional maintenance behaviors are called upon which are "well developed sets of learned responses that are drawn on repeatedly to cope with the requirements of recurring tasks" (Rambo, Chomiak, & Price, 1983, p. 78). It is generally assumed that over long periods of time and under unchanging

conditions, performance is highly consistent from week to week and this may be attributed to the degree to which one relies on these maintenance behaviors to accomplish the task. This assumption of consistency is significant in that it is the basis for the generalizations the one makes concerning behavior, thus enabling the research to extrapolate beyond the time frame and circumstances studied.

Actually, there is very little empirical research in the area of performance consistency. Most reliability studies have concentrated on predictor variables and not on the performance criterion they are trying to predict (Ghiselli, 1956; Rambo, Chomiak, & Price, 1983). But recently a study was conducted which supported the assumption of high levels of performance consistency within stable working conditions and under an effective piece rate incentive system (Rambo, Chomiak, & Price, 1983). Evidence indicated that the production behavior of two different groups of employees was highly consistent, particularly between weeks that were contiguous in time. As the time between correlated observation periods increased, the magnitude of the relationship did decrease somewhat. However, this change was orderly and even as the time intervals between the production data reached 3.5 years, the levels of reliability, for both groups, were still moderately high. It should be noted though that the group which performed a more complex task did exhibit lower levels of consistency regardless of the interval of time separating the two production periods. Hence the results of this study suggest that when the setting and tasks remain unchanged and they require the use of maintenance behaviors, and where an effective incentive is in operation, one should expect production data to be highly reliable.

Thus, in situations where task conditions are stable and unchanging, it is generally assumed that high levels of performance consistency will be observed. However, a certain amount of variation does occur. Conventional statistical models incorporate two types of variance, one reflecting behavior changes which may be attributed to the phenomenon being studied and another referring to uncontrolled variation which is generated by randomization. This latter source of variance is assigned to the error term in the statistical model. Whenever there is no intervening change introduced into a system of ongoing performance, it is expected that performance consistency is limited by the size of the random error component. Any variation is attributed to spontaneous changes in the state of the reacting individual, and is from a statistical perspective, considered a principal source of uncontrolled variance. Since this source of behavioral variation is assumed to be random, this means that these fluctuations will occur in one direction (increase or decrease) as often as in the other and in no particular pattern. But perhaps these behavioral fluctuations over time which are associated with these maintenance behaviors are not random. Might there be a considerable degree of regularity in the variation; that is, a pattern to the change over time? A further question involves the range of individual differences in the magnitude of the consistency. Are there some individuals who are very stable in their performance, varying little over time, while others display a large range of behavior?

When the temporal variations in performance are considered random, the true level of performance can be represented by the group average of those observations. However, if variability in performance

is actually nonrandom, then aggregate data may be misleading regarding the true nature of performance in that it may "average out possible patterns." Group statistical analyses usually treat individual differences as a source of error and may be insensitive to certain kinds of systematic differences in moment to moment variation within an individual. For example, it is possible for group performance to increase after the implementation of a new process; but this change could be the result of marked improvement in just a few individuals while others remained unchanged in their performance or even decreased slightly. Group analyses would have been supportive of the change but it may have been important to know that only a few benefitted and a more effective and efficient method should be explored for greater improvement. An analysis of individual performance records would have revealed different patterns of response to the change.

There are several benefits of individual over group analyses (Sheridan, 1971). First, more information may be derived from individual analyses. Furthermore, in many circumstances one might be able to derive group functions from individual functions, but rarely can one move in the opposite direction. Second, individual outcomes are generally obscured in group averages. For instance, a "typical" learning curve for individuals may be identified, but the averaged group curve for the same data may not resemble any single individual's form. Thus, interpretation of the average data may not reflect the true nature of the situation. Third, generalizability may actually be enhanced if individuals could be assigned to meaningful subclasses based on their individual performance behaviors. That is, since individual behavior may vary greatly, it may be possible to identify

special relationships that are applicable only to certain subclasses of individuals, such as high performers. These particular principles or relationships may be consistent within individuals, but may become variable and be ignored when the subclasses are grouped into aggregate data.

Silverstein (1988) discussed what Allport dubbed idiographic or single subject designs (also known as "N of one" designs) versus nomothetic or group designs. He suggested, taking from Aristotle, that while one is attempting to form universal behavioral principles at a high degree of abstractness, strategies must be used "for designating uniqueness (rather than merely relegating it to error)" (p. 429). Thus, it appears that the individual may be an appropriate level at which to study consistency of performance.

In summary, very little research has been conducted on the temporal characteristics of well learned tasks, particularly in a relatively unchanging work environment. Further, it appears that it would be appropriate to investigate this phenomenon at the individual level of analysis and then attempt to define meaningful subgroups into which these individual subjects may be assigned.

Statement of the Problem

A basic requirement for the prediction of human performance is that performance must be reliable (Ronan and Prien, 1971). That is, reliability of behavior is fundamental to prediction which is, after all, one of the goals of psychology. According to Ronan and Prien (1971), "performance measurement becomes crucial, it must be reliable

if we are to work back to the human characteristics functioning as bases for performance" (p. 89).

In psychology, the assumption is made that performance is consistent and that observed variations are random to be charged to the error term. However, some have questioned this assumption (Rothe, 1958; Ghisell, 1956; Ronan & Prien, 1971). Ronan and Prien (1971) stated that what evidence there is suggests that human performance is not reliable, but very few studies have directly addressed performance reliability. Those which exist generally have been short-term laboratory studies that have focused on relatively simple tasks involving fine motor skills. In addition, when it comes to studying behavior variability, still fewer studies have examined well-learned behavior.

Furthermore, no one has followed behavior as it unfolds over long periods of time to describe its patterns, cycles, and other regularities. During much of the day an individual is exposed to repetitive tasks which demand similar responses from an established behavioral system. These are what have been referred to earlier as "maintenance behaviors." The issue then is, what do these behaviors look like over a long period of time. Are they completely unchanging from one time period to the next or is there some detectable variation? If the latter, is there some pattern to those changes or is this variability random? Further, are there other measures of performance which relate to the variability that is observed? This behavior simply has not been described nor have these questions been addressed before. However, the data for this study provided a unique opportunity to describe the week-to-week fluctuations in the well-learned behavior of individuals performing in a stable work setting.

The purpose of this study was to examine and describe variations in routinized behaviors over a long period of time in order to gain some knowledge of behavior reliability, the nature of its variability, and the extent to which this is random. The goal was to add to the limited knowledge regarding the fundamental issue of performance consistency which directly pertains to the prediction of behavior and the generalizability of results.

The present study attempted to describe work performance of individual employees within the format of an idiographic or single subject design in which the individual became the unit of analysis. The study was essentially exploratory in its approach. This research was unique because the data were collected in an applied setting which had built-in controlled conditions. It was a longitudinal field study in which the long-term output rates of experienced employees were examined under work conditions that were unchanging from week to week. More specifically, the study was concerned with the changing level of performance from one point in time to another. It was an attempt to describe patterns of performance stability and change over a long period of time. Moreover, the work environment and the process of work continued undisturbed by experimental manipulation in that this was a noninterventional effort that focused on archival production data.

This study was intended to analyze individual performance behavior as it occurred in a field setting. It attempted to describe, in detail, the different output patterns of individuals belonging to two groups of experienced workers who were faced with jobs which consisted of narrowly defined tasks which were unchallenging, routine, and un-

changing from week to week. These data were obtained from objective, unbiased, reliable company production records. They contained the monetary equivalent of the average, hourly output rates of employees paid on a piece rate incentive system. These figures were calculated and recorded on a weekly basis so that the data represented repeated measures on each employee. The subjects, data, and incentive system are discussed in detail in Chapter II.

In this study, post hoc hypotheses concerning human performance behavior were derived through observation and inductive generalization (Hays, 1981). More specifically, the data upon which this research was based consisted of the actual output rates of individual employees for 208 weeks or a four-year period. The hypotheses were empirically derived in that each subject's data were divided in half with the second two years (weeks 105-208) of data held back, in reserve, from the initial statistical analyses. The output behavior during the first 104 weeks were examined and the results of these observations formed the basis of inductive generalizations or hypotheses which were made. These hypotheses were then carried over and tested with the second two years of performance data. The data covering the second 104 weeks served as a replication study in the sense that the observations had been collected under the same conditions. These data then were scrutinized using the same analyses.

This study examined a fundamental issue about behavior. It was concerned with the nature of human performance and the consistency of well learned habits or maintenance behaviors. It attempted to address questions concerning the stability of performance over an extended time frame. That is, to what extent is output a consistent measure

over time? How valid is the assumption that it is stable? This is important since performance measures are often used as criterion variables and their reliability is vital. This is directly related to the generalizability of results beyond the time frame and circumstances of particular research. Further, to the degree that there are temporal changes, that is variability, to what extent are there discernible patterns in these changes? Are there cyclical or other regular patterns so that future performance may be predicted or is this variability within unchanging conditions, in fact, random? Once these patterns were examined, they were compared to determine if there were patterns shared by other employees. The identification of meaningful subgroups may enhance the generalizability of certain statements which otherwise would be rendered insignificant if applied to larger groups. Further, it may have important implications regarding the placement of workers in particular jobs which may depend on consistent performance.

Once subgroups could be identified, then other available characteristics such as the employee's assigned operation or level of consistency (e.g., standard deviation) were examined to assess any relationships they might have with performance level or each other. Further, the magnitude of individual differences in the level of performance consistency were explored. Questions such as whether consistent employees were more or less productive than those who displayed considerable week-to-week variation in output were addressed. The principle objective was to explore the ongoing process of work performance in a situation that was undisturbed by an experimental investigation which might disrupt the normal flow of work.

The major a priori hypothesis of this study was that the results of the first two years would be replicated with the observations collected in the second two years. What follows is a discussion of the general objectives of this research. Again, the analyses used to examine these areas of interest were performed on the first two years of output data separately and then repeated on the second two years to determine if the results were replicated during this second period.

Patterns of Performance

In order to examine the individual's work performance, each subject's long-term output was analyzed to determine its level of stability or reliability. Plots of the week-to-week output of each subject were investigated for patterns. For example, increases and decreases in output from week to week were examined in order to discern whether this variation in weekly production behavior was random or occurred in recurring patterns such as increasing performance every fourth week. The duration of these shifts or changes were described as well. That is, the length of time in weeks the shift lasted before resuming the individual's typical level was discussed.

Once individual patterns of output had been examined, they were compared to discern patterns which were shared by more than one subject. In other words, an attempt was made to identify general "styles of performance." These "shared patterns" are discussed in more detail in Chapter II. This was significant because, if these patterns are considerably different, then some general work-related statements made about the group as a whole may be meaningless. It may be that some general findings and statements concerning work performance about a

group as a whole may be more valid for certain subgroups than for others. That is, generalizability may be confined to subgroups. Further, these patterns may be an indication that different criterion reliability levels exist for subgroups and that a single measure of group performance reliability may not be appropriate. Finally, from a more practical perspective, employers wishing to affect worker performance may want to apply a variety of change strategies in order to account for the differences in the various subgroups. In particular, where performance consistency is important, an employer may want to install tighter controls; but this may actually have an adverse effect upon the performance of those in the group who already display a fairly consistent pattern. Thus, the manager may want to impose the controls differently, according to employee pattern.

Employees who share particular output patterns may have other measures of performance in common as well. That is, other aspects of performance may be related to one's general consistency or general pattern of performance. Therefore, within each of the identifiable patterns, the employees' performances over time were examined to see if they shared other measures. In other words, within these subclasses, special relationships with other performance indicators were tested. For instance, do the majority of employees in a certain category display random output over time?

Another measure which was addressed concerned the level of output. Is there any association between a given pattern and the general level of output? For example, are those who share a fairly consistent pattern also producing at a high rate? In addition, it may be that those who share a consistent pattern also show less variability, in

terms of standard deviations, than those workers who shared less consistent patterns of performance.

Distributions of output rates were examined in the context of those shared patterns. The purpose was to discern any evidence of "restriction of output" within particular patterns to see if it relates to the general consistency of output. According to Rothe (1946), this term is used to indicate "that workers are producing at a rate lower than the rate they are capable of maintaining over a long period of time without suffering any ill effects" (p. 322).

Bliss (1931), Bedford (as cited in Rothe, 1946), and Rothe (1946) have suggested that slower workers would display negatively skewed distributions and more variation about their own means while the frequency distributions for faster workers would be positively skewed with less variation in performance. Given this, it was hypothesized that skewed distributions might be associated with different patterns of performance. That is, perhaps certain categories would contain performers whose distributions were symmetrical, whereas the workers whose performance patterns belonged to another category might have negatively skewed distributions that were less peaked (negative kurtosis) and another category might have a predominance of positively skewed output distributions which were more peaked than normal. In summary, those with certain consistency patterns may also share other frequency distribution characteristics and these may be indicative of "restriction of output."

Finally, these patterns of performance were examined for any relationships with job tenure and with the actual operation performed. Although all of the employees in this study were experienced workers

who were well beyond the job learning stage, each subgroup of performance patterns was checked to determine if an association existed between one's pattern and seniority. Since all were experienced, no relationship was expected.

The pattern categories were also examined to see if particular job operations dominated any of the categories. If this was the case, then particular patterns of output performance might be task-related. Within the two general types of workers in this study (sewers and nonsewers), no such relationship was expected. Although it was expected that subjects from one of these two groups would dominate a particular category. More specifically, the nonsewers who have a less complex job than the sewers may dominate the more consistent pattern category while the sewers dominate a category which features more variability.

Finally, it was expected that the same employees who shared common patterns during the first two years would retain their membership in the same categories over the final two years of output. Further, it was expected that those relationships between measures of performance and pattern category which were found during the initial two years of data would be replicated during the second two years.

To summarize up to this point, the output performances of experienced employees were examined idiographically. Then a schema was developed to try to group these workers into meaningful subgroups. This schema consisted of shared patterns of output behavior over time and this was used to compare employees in terms of other measures of performance such as randomness, average output, and consistency. The purpose was to determine whether other aspects of performance behavior relate to different types of performance patterns.

Relationships Between Performance Variables

On a broader level, the relationships between several measures of performance were addressed to determine whether they relate to the general level and/or general consistency of output. The analyses were conducted on the sewing group, as a whole, and the entire nonsewing group. First, even though all of the subjects were highly experienced, well beyond the training period, a check of the relationship between seniority and amount of output was carried out for each of the two groups. No correlation was expected. Second, the relationship between output consistency and output level was investigated across the sewers and nonsewers. According to Rothe (1946), a negative association should exist. Third, the relationships between the randomness of performance over time and the level and consistency of output were checked. Finally, the level of performance and the skewness and kurtosis of the frequency distributions of output rates were examined. The purpose was to determine if some sort of restriction of output existed (Bedford, as cited in Rothe, 1946). That is, it was predicted that overall a positive correlation would exist between performance and positive results regarding the skewness and kurtosis of the distributions. Those who were faster would display positively skewed, peaked distributions, while slower ones would have more negatively skewed and flatter than normal distributions.

Summary

It should be noted that this study was not so much concerned with the actual sources or causes of performance variation, but rather the

description of the various patterns of this variance. Although it is acknowledged that individual behavior is influenced by such factors as needs, social interactions, and physical factors, these within subject variables were beyond this proposed study. The primary objective was to describe the regularity of patterns and consistency of rates observed in groups of workers whose jobs require that they repeatedly carry out the same narrow set of motions through each work day. That is, the ongoing work behavior of individuals in a stable environment in which the normal flow of work was routine and cyclical was described. This study was essentially exploratory in its approach and was accomplished within a noninterventional framework. The major hypotheses address the consistency of performance over time.

CHAPTER II

METHOD

Subjects

The subjects for this study were employees of a large textile company which manufactures men's and women's clothing. The particular plant in which they worked employed approximately 140 and produced garments such as men's T-shirts, briefs, and pajamas. Most of the employees are involved in "cut and sew" operations which are classified into two general groups: (a) sewing machine operations and (b) non-sewing machine operations such as inspecting, folding and packing, and bar-tacking labels to the finished product. The sewing operations fit the designation described by entry 786.682 in the Dictionary of Occupational Titles (U.S. Department of Labor, 1977). Definitions of the inspection and folding jobs and tacker operations may be found under headings 789.687 and 786.682, respectively. These two classifications constitute the groups to be used in this study. A brief description of each operation involved in this study may be found in Table 1.

These jobs were highly routinized and narrowly specialized, being organized into production lines, each of which was responsible for the completion of a particular garment. The T-shirt line, for instance, consisted of nine separate sewing operations (e.g., seam sleeve

Table 1

Description of the Job Operations

Operation	Description	Lines Where Utilized
Group One--Nonsewing Machine Operators (N = 16)		
AJS		T-Shirts
UL	Bar-Tack Label to Garment	T-Shirts
WIBB	Inspect, Fold, and Bag	T-Shirts, Athletic Shirts, Brief, Midways, Longies, Pajamas, Robes, Shave Coats
UUU	3-Bar Tacks	Athletic Shirts
Group Two--Sewing Machine Operators (N = 22)		
DSH	Seam Sleeve at Top of Shoulder	T-Shirts, Pajamas, Shave Coats
DN	Seam Neckband	T-Shirts
H_2	Sew Tape	T-Shirts
DSLV	Seam Sleeve Together	T-Shirts
DSLG	Seam Sleeve Into Garment	T-Shirts
JJB	Hem Bottom	T-Shirts, Pajamas, Robes, Shave Coats, Athletic Shirts
DR	V-Neck Seam	T-Shirts
ZA	2-Needle Armbinding to Shirt	Athletic Shirts
CZE	Apply Leg Band	Briefs, Midways, Longies
DP	Sew in Fly	Pajamas, Robes, Shave Coats

together or seam neckline) involved in the production of finished T-shirts. Thus, an operator on this line sewed the same seam, repeatedly, throughout the workday. For the subjects in this study, this meant that they would have been carrying out exactly the same work behavior for the four years during which the data were collected. In addition, employees had had at least 14 months prior experience on the job before data collection was begun. It should be noted that each person governed her own work pace; there was no conveyor that paced the speed of production.

The folding and packaging group was also arranged as a production line of employees engaged in narrowly defined, repetitive operations. However, in terms of skill demands, the sewing tasks required more complex manual skills. These jobs also experienced more frequent technical problems such as thread breakage, variation in thread and material quality, and machine failures.

Evidence indicated that the work tasks and production rates did not change during the four-year time frame of interest for this study. Interviews with the management and staff personnel, including the plant engineer responsible for time studies, disclosed that the basic tasks of both the sewing and nonsewing operations had not been modified either prior to or during the data collection time period. Further, the general output rates do not suggest any alterations. Thus, it was reasonable to assume that the subjects had been employed in a work environment in which their jobs had not been altered for a long period of time.

The nature of longitudinal studies as well as a set of additional criteria placed further restrictions on the sample. For example, all

of the subjects were women: 22 employed as sewing machine operators, and 16 in nonsewing tasks. Based on their seniority (rounded to the nearest month) which was calculated from the end of the one-month probationary period for new employees, all 38 operators were experienced. At the onset of the data collection period, company job experience for the sewers ranged from 14 months to 205 months (17.1 years), with a mean of 103 months (8.6 years). The nonsewers had seniority ranging from 39 months to 280 months (23.3 years). Their average was 119 months (9.9 years). Thus, the subjects were workers who were very experienced at their jobs and remained at these particular tasks for the duration of the study. Therefore, it was reasonable to assume that these tasks were well learned.

In order to be included in the study, the subjects must have been employed and on the job throughout the four-year duration of this study. Additionally, since job changes in this organization had profound effects on employee performance, none of the employees included as subjects had a job reassignment during the data collection. Finally, only employees who had missing data for no more than 12 consecutive weeks were included in the sample.

The Incentive System

Employees at the plant were paid under a piece rate plan with a guaranteed minimum weekly earning. This was an individual financial incentive system which was based on the Method Time Measurement (MTM) standard setting procedure. This method was introduced by Maynard, Stegemerten, and Schwab (1948). They defined MTM as:

> Procedure which analyzes any manual operation or method into the basic motions required to perform it and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made.
>
> MTM procedures were used to appraise how much time was required by the average individual to complete one cycle, or unit, of work with allowances for fatigue and delays. This then enabled the standards or piece rates of each operation to be set (p. 12).

Time studies were conducted when there was an indication that a rate was inappropriate. The standard for a job was calculated by totaling the predetermined time standards associated with the various human motions utilized in a task and adding a 20% personal fatigue and delay allowance. These standards make it possible to compare the relative efficiency of performance of all the employees. Thus, workers assigned to different operations received equal pay if they worked at the same rate. For example, perhaps a standard of two bundles per hour was established for sewing the sleeve at the top of the shoulder and the standard for hemming the bottom of a garment was set at three bundles per hour. If the employes performing these two operations reached exactly their standard, both workers would have received the same pay even though the number of bundles required was different.

These standards established an output rate or quota for each job. Those employees who produced above this level were paid on a straight piece rate basis. Those who worked below quota received a guaranteed minimum wage whose level depended on one's seniority date. The minimum wages applicable during the data collection may be seen in Table 2. After 30 days of employment, the garment workers were required to join the International Ladies' Garment Worker's Union and there was a

corresponding wage increase. Finally, there was a guaranteed minimum wage increase after six months.

Table 2

Guaranteed Minimum Wages

	1977	1978	1979	1980
Starting Wage	$2.30	$2.65	$2.90	$3.10
After 30 Days	$2.40	$2.70	$2.95	$3.15
After 6 Months	$2.70	$2.88	$3.09	$3.30

This incentive system was explained to employees during orientation and could be found in the Reference Book to Company Policy which each employee received upon entering the company. It may be noted that this particular company has been cited as "one of the better paid apparel companies".

There is some evidence supporting the contention that this piece rate system sustained high levels of motivation. According to interviews with management and employees, rather than restrictive production norms, moderate levels of competition for high earnings occurred among some of the operators. In addition, it was not uncommon for employees to work through rest breaks and to shorten lunch periods in order to increase output and thus earnings.

During the four years of interest to the study (1977-1980), three, across-the-board, 7% cost of living wage increases were given at the beginning of each year. In an absolute sense, these wage adjustments were not very large, amounting to approximately 20 cents per hour as reflected in the last row of Table 2. Since the increases applied to all employees, relative earnings were not disturbed and no observable change in production was evidenced.

Data Collection

The data used in this study were the employees' output rates as recorded in the plant's weekly production earnings report. These records were maintained by the management and were highly accurate. They could be verified by the operators who were diligently aware of their output rates. The study was retrospective in nature, covering a 208-week period. For each employee, these records include her identification number, operation, and seniority date. It also stated each subject's quarterly average. This was the average amount of money paid per hour to the employee during the previous three months, in other words, the average earned rate. For example, if, in the last quarter of 1978 an employee of more than six months produced an average of $1.50 per hour in output, she would not be meeting her job's standard. However, she would still be paid minimum wage and $2.88 would be recorded under quarterly average.

Most importantly for this study, these records reported, by week, the average hourly production multiplied by the piece rate established for each operation. These figures represented the monetary equivalent of the average per hour output rate of each employee based on their

operation's standard. In other words, these were records of the number of pieces produced by each employee, transformed into dollars and cents according to the rate set for each operation. The monetary figures which appeared in the records were a direct linear function of the units produced by the employees. This section did not necessarily indicate the wages paid. Thus, for the above example, $1.50 would be posted as the wage equivalent of the number of units actually produced and not the $2.88 which was the guaranteed minimum wage earned. A sample of the Weekly Production Earnings Report may be found in Appendix A.

The data spanned 208 weeks from the beginning of 1977 through 1980. Since these figures were weekly averages, absences of less than one week were not distinguishable. There were no data recorded for eight weeks because the plant was closed for summer vacation, but these missing data were replaced by the averaged output rate of the adjacent weeks.

Experimental Design

To recapitulate, the purpose of this replication study was (1) to examine the weekly work patterns of the individual in an attempt to describe the long-term reliability of performance in a routine work situation for two groups of employees, and (2) to replicate the results using a second set of performance data from these same subjects. An idiographic or single-subject design was used. The study was longitudinal in nature, eventually covering 208 weeks, with the data collected retrospectively. The study was noninterventional, meaning that no experimental manipulation was introduced during the

time period of interest. Instead, within the sewing and nonsewing groups, each individual subject's average hourly output rates, determined weekly over two two-year periods, were scrutinized as they occurred in a relatively unchanging natural work environment.

Furthermore, this study explored individual differences through several intra-group measures. To this end, the plots of individual performance behaviors were compared and common patterns were identified. In addition, the relationships between output variables, such as performance consistency and performance rate were examined to add to our knowledge about work.

Statistical Procedures

This effort was intended to investigate and describe the long-term consistency of individual work behavior. The hypotheses were empirically derived through inductive generalizations and tested in a cross-validation design. That is, each subject's 208 weeks of data were divided in half with the second two years omitted from the initial statistical analyses. The production output of the first 104 weeks was examined by exploratory methods which may have been somewhat unorthodox. The methods were selected to meet the objectives discussed in the Statement of the Problem. Briefly, they were: (1) to describe individual performance behavior and determine if any patterns are common to other individuals; and (2) to discern relationships between various output variables such as level of performance output and consistency of output from week to week.

The results allowed for the formulation of inductive hypotheses which were carried over and tested with the second 104 weeks of per-

formance data. It was hypothesized, a priori, that the work behavior patterns would be sustained or replicated and that the results of various exploratory analyses would be similar to those found on the first half.

The various analyses that were conducted are indicated in Table 3 and are discussed below. The data were examined using the analyses in the sequence given in Table 3 and then reported in the following order in Chapter III. Sewing machine operators--initial two years; nonsewing machine operators--initial two years; sewing machine operators--final two years; and nonsewing machine operators--final two years.

Intra-Individual Analyses

The first phase examined, in depth, the work behavior of each subject. At issue was the consistency of the individual's performance from week to week. Further, to the extent that it was variable, were there any discernable regularities?

Individual Plots of Performance

In order to address questions regarding the actual shape of individual performance rates, each employee's weekly output rates were plotted over time for each 104 week period. The plots of performance over the first 104 weeks were examined using several exploratory methods. A characteristic rate of performance was defined for each subject. The rate was defined as the subject's average output for the 104-week period plus or minus five percent. In order to further examine patterns in variation in weekly production behavior, a change in performance needed to be defined to indicate when a shift in produc-

Table 3

Statistical Analyses

Analysis	Purpose
I. Intra-Individual Analyses	
A. Performance Categories	Identify patterns of performance from individual plots
B. Randomness of Performance: Runs Test	Examine the randomness of the changes in output over time;
Chi-Square	Test the relationship between output patterns and randomness
C. Levels of Performance: Average Output Per Employee	Inspect individual mean output in the context of the performance categories
D. Consistency of Performance: Individual Standard Deviations	Investigate consistency of output and its connection to the performance categories
E. Distribution of Rates: Mode, Range, Skewness, and Kurtosis of the Distribution of Output Rates for Each Employee	Report various properties of the frequency distribution of each individual's output
F. Individual Employee Descriptors: Tenure, Job Category, and Operation	Examine their relationships with the patterns of performance
II. Group Analyses	
A. Seniority and Level of Performance Correlation	Discern any relationship between job tenure and average output
B. Level and Consistency of Performance Correlation	Examine the connection between employees' average output and variability
Box and Whisker Display of Mean Output, Range, and Standard Deviation	Visual display of each worker's descriptive output statistics

Table 3. Continued

Analysis	Purpose
C. Level and Randomness of Performance Correlation	Check the connection between the workers' average output rates and the randomness of the output over time
D. Consistency and Randomness of Performance Correlation	Determine the relationship between these two variables
E. Level and Distribution of Performance Correlation	Examine average output rates in relation to the distribution of these rates

tion output occurred in the plots. This change was designated by an aberrant output rate. This was a rate which differed considerably from the individual's usual level and was outside the rates defined as change when a runs test was subsequently used to evaluate performance consistency. Again, its exact monetary definition was dependent upon the individual's data. When it occurred, some form of performance adjustment may have been required by the individual. If this was true, then this pattern of adjustment surrounding the aberrant event could be described. The duration of the shift in performance around the aberrant rates could also be measured. That is, the length of time, in weeks, that it took to resume the characteristic rate could be determined as well as the time between significant deviations. Further, the patterns of behavior surrounding aberrant events of a positive deviation (a surge in performance) were compared to those that indicated a major decrease in performance to determine whether the patterns were the same.

It was believed that these plots might reveal cycles of performance, fluctuations, and repetition; therefore, any discernible patterns or lack thereof were described. For example, it was possible that some compensatory behavior might be indicated in that given the piecework incentive system, an employee could predict fairly accurately her take home pay and within these limits she could manipulate her work pace. Thus, it may be that if a subject displayed very low output one week, there may have been a tendency to make up for the corresponding low wages by producing at a higher level the following week. In other words, she may have a certain dollar amount of income set as a monthly earnings target. This target identified a pattern of con-

sumption, a standard of living; and since these employees were paid once a week, each has several opportunities to change the weekly work pace in order to keep within a reasonable distance of this monthly economic target.

Other possible patterns included: uniform consistency cycles, any nonrandom performace with definable shifts in output, or simply a random weekly output rate. Following replication methodology, after the individual plots of the first 104 weeks had been detailed, the focus shifted to the second 104 weeks to determine if the patterns of performance, established by the first two-year interval, repeated themselves within the following two-year period.

Patterns of Performance

Once the production behavior of the individual employees within the sewing and nonsewing groups were examined over the first two years, it was of interest to investigate whether there were patterns of output performance that were common to other members within each work group. That is, "styles of performance" may have existed that were shared by several employees. These patterns of output helped to group individuals in an attempt to discern any other performance-related similarities that they might share. For example, these individuals might have similar average output rates, standard deviations and/or distributions of rates. Further, there may be a link between the amount of randomness in their output over time and the "style" which the individuals demonstrated. One reason for attempting to identify those "styles" was to better understand whether individuals displayed unique output behaviors in unchanging work environments or

whether employees perform routine, habitual tasks at similar rates week after week.

These categories of performance were determined by examining the individual output patterns over time. They were scrutinized to determine if subjects shared patterns. These groupings focused on the occurrence of aberrant rates and the levels of output for the weeks just prior to and following the atypical rates.

In summary, these analyses attempted to discern, on an individual level, patterns of performance. Examination of the individual plots of output lead to the identification of styles of performance shared by other employees in this unchanging, stable work environment. These generic categories then became the basis for determining if these employees had other performance-related similarities, as well. In other words, it was believed that these styles might reveal that groups of employees not only share characteristic patterns of output but, for instance, they may be similar in level or consistency of performance. Different styles might be related to random performance from week to week while others may be associated with nonrandom output over time. Further, each style might be linked to distinct frequency distributions of output rates. All of this may reveal some basic properties of work performance and its consistency of time. These analyses and their purpose are summarized in Table 3. They were conducted on the data of the sewers and folders, separately and then duplicated on their data from the second two years.

Randomness of Performance

To dissect individual performances over time, the nonparametric

one-sample runs test (Siegal, 1956) was conducted on each half of each employee's data. This indicated whether the pattern of output changes (increases or decreases) constituted a random system or whether the pattern contained systematic components that could be described. The one-sample runs test was a technique developed to determine if a sample was random based on the order in which observations were made or the number of "runs" displayed within the data. "A run is defined as a succession of identical symbols which are followed and preceded by different symbols or by no symbols at all" (Siegal, 1956, p. 52). Too many or too few runs indicated that the observations were nonrandom. In this case, a run was equivalent to the number of consecutive weeks in which the individual's average per hour output rate was basically consistent or nonchanging within practical, intuitive limits. For example, if change was defined as any absolute change, a one-cent increase or decrease in the employee's average hourly rate would constitute a difference even though it could result in only a forty-cent alteration in the week's income and probably would be psychologically meaningless to the worker. Besides, defining change by one penny probably falls within a margin of measurement error. Furthermore, a penny difference would have increased the number of runs, thus leading to an inaccurate conclusion that the sample was random when the definition upon which it was based was too limited. Thus, what constituted a change in rate of performance needed to be large enough to be noticeable but not too great as to be insensitive to relevant alterations in rate.

Several possibilities were available that enabled one to define operationally a change in performance used in the runs test. One

option was to define change as a five-cent absolute difference, across all subjects. Another method was relative, defining change as a difference of more than 5% of the individual's previous week's output rate. A third possibility was to use one-half of each person's standard deviation as change. Still another definition could have been 5% of each subject's mean performance over 104 weeks. A fifth suggestion was to define change as that percentage of the individual's mean output for 104 weeks which would result in a $10.00 a week difference in pay. One last option was to use a standard score for each employee using the standard deviation divided by the corresponding mean output. The actual definition used was decided on once the data were examined. This is reported in Chapter III.

Individual Employee Descriptors

Finally, several descriptors were provided for each subject: her length of seniority with the company, assigned garment category, and performance operation. This information was subsequently used in various comparisons which were conducted in the context of the generic categories of output patterns. For instance, although all of the employees were experienced, it was of interest to see whether those with the most experience demonstrated a particular pattern of output, perhaps showing short transition periods, while those with fewer years might display a pattern of output peculiar to them.

Another issue of interest was whether workers from certain garment times (e.g., T-shirts, athletic shirts, etc.) or those who performed the same operation (e.g., sewing the sleeve seam, hemming, etc.) did so in a like manner, speedwise. If so, this might indicate

that there was something about the tasks themselves that contributed to these patterns of rates. That is, perhaps the behaviors involved in completing certain tasks fostered transition periods of defined lengths.

Group Analyses

Introduction

The employees in this study were assigned to various operations such as seam sleeve at top of shoulder, which consisted of similar jobs on different garment lines (e.g., T-shirts, pajamas, and athletic shirts) and these operations were basically grouped into two classifications: sewing and nonsewing. The Method Time Measurement established time standards (piece rates) for all of the operations in this plant (Chapter II--The Incentive System should be consulted for more information). This allowed a common scale to exist by which to compare the output of employees across operations. Further, it allowed for inter-group comparisons to be made.

It was of interest to determine, for each of the two groups, whether relationships existed between various performance measures. Many of the comparisons which are discussed below (such as the relationship between average output and consistency of the output) have been cited in past literature and support for these was sought.

Seniority and Level of Performance

Although it has already been reported that all of the subjects were experienced, a correlational analysis was conducted to test whether there was a relationship between seniority, at the onset of

the study, and mean output per two-year period. Rothe (1946) has shown that experience can influence inter-individual production rations; however, in this study all of the employees had far surpassed the six-month training period and no significant relationship was expected.

Level and Consistency of Performance

Several experimenters (Bedford, 1922; Bliss, 1931; Kunst, 1941; Rothe, 1946; Rothe, 1970) have suggested that there is a relationship between the rate and the consistency of performance with faster employees showing less variability in their performance. The current study generated data that were ideal to test various relationships between performance output and consistency for group data. The analyses were conducted over the same time periods which were used for the individual analyses: weeks 1 through 104 and weeks 105 through 208.

One direct method for examining this relationship was to define performance output as individual mean performance for a particular time period and consistency as the corresponding standard deviation and correlate these two variables. Relatively high negative correlations were expected, indicating that the higher performers tend to display less variability or were more consistent in their performance.

The mean, range, and standard deviation of each subject were displayed graphically, for the same time periods, using the Box-and-Whisker method (Tukey, 1977) and any relationships were described. For instance, it may have been that employees with higher mean performance rates were generally less variable in their output and displayed smaller standard deviations and/or perhaps smaller ranges. If so,

motivation for these workers may have been high, indicating that they were effective at their jobs and executed them efficiently which might account for the lower variability in the week-to-week output. Another potential outcome indicated by these graphs might have been that those employees with variant output could be identified as having jobs that were more complex than those whose performance was fairly consistent. This might lead one to believe that the more complex jobs give rise to more opportunities for diversity with each required task. If it was possible for employers to identify particular jobs which were associated with variable output, then they might be modified to enhance stability in performance. That is, if elements of the task which contribute to inconsistent output behavior were modified or eliminated, then one barrier to increased performance may have been removed. The Box and Whisker plots also provided a graphic comparison of these descriptors over the two time periods. It was expected that they would remain relatively similar. These graphc representations were supported by other analyses.

Level, Consistency, and Randomness of Peformance

For this series of analyses, the results of the individual runs test were utilized. The runs test indicated whether a sample series was random or not. This analysis provides results which were dichotomous (random or nonrandom). The results of the runs test were then used to conduct a point-biserial correlation between the random-nonrandom variable and the standard deviations of the output rates. Here it was expected that the nonrandom, patterned output performances were related to smaller standard deviations. That is, those who displayed

a pattern in their rates may have been more consistent in their performance over time.

The runs test was also used to inspect the relationship between average output rates and randomness (measured dichotomously) of the rates from week to week. It was expected that nonrandom, systematic output would be more characteristic of high performers while low performers would demonstrate random, less predictable behavior from one week to the next.

Level and Distribution of Performance

Further, the frequency distribution of the output rates for each employee were presented broken down by year and any irregularities were discussed. An irregularity was defined in several ways. For instance, general inspection of these frequency distributions may have indicated that they were not bell-shaped, that is, normally distributed, or it may have revealed breaks in the plots. In other words, there may have been clusters of output rates rather than a continuous series. Since the rates were not independent, chi-square analyses could not be performed. However, a measure of skewness and kurtosis was reported for each one. It has been suggested (Applewhite et al., 1965; Yoder in Rothe, 1946) that faster employees may display a frequency distribution of output rates that is positively skewed, while the distribution for slower workers would be negatively skewed, indicating a restriction of output or an ineffective incentive system. To test this, a Pearson product-moment correlation was performed between average output and degree of skewness.

Summary

All of these intra-individual and intra-group analyses were performed first on the data of the sewing machine operators which covered the initial two years. Then, the corresponding data from the nonsewing machine operators underwent the same scrutiny. A replication was finally conducted when the same procedures were performed of each group's data from the final two years. Table 3 summarizes these analyses and their purposes.

CHAPTER III

RESULTS

This study described performance in a "real world" circumstance, that of a work situation. This particular work place provided, much like a laboratory, a setting in which the tasks, equipment, facility, environment, and organization remained relatively unchanged throughout the time frame of the study. The major focus was idiographic in that the output rates of individual employees were described within the context of a "replication design." This design required that each subject's output record for the four-year period be divided into two 104-week time segments. Then analyses were performed on the data from the first 104-week period while the data from the second 104 weeks were held in reserve. After the analysis of the first 104-week period was completed, the same calculations were carried out on the output from weeks 105 to 208. In this manner one could determine the degree of consistency in the patterns of performance that had been observed during the first period of observation.

Each individual's weekly output records were analyzed separately. Typical and atypical performance periods were identified. The patterns formed by these periods were described and examined, and those employees who shared similar patterns were grouped together. Further analyses were performed within both the sewing and nonsewing groups to

discern any intra-group relationships between performance styles. For instance, one might expect to find a relationship between average output and variability of production. These results, obtained from the first 104-week period, provided hypotheses which then were tested on the data from the second two-year production period in the replication segment of the study.

More specifically, the data from the sewing machine operators were examined first. Then, any meaningful models or categories were tested for generalizability using the sample of nonsewing machine operators. Finally, a replication was conducted using the data of these two samples from the second two years. Thus, the results are presented in the following order: Sewers--Initial Two Years, Nonsewers--Initial Two Years, Sewers--Final Two Years, and finally, Nonsewers--Final Two Years.

Intra-Individual Analyses/Sewers-- Initial Two Years

Patterns of Performance

Over a 104-week period, the weekly average hourly output rates of each subject were determined. These rates were plotted and examined for patterns of performance that repeated themselves within and across subjects. The first step in this analysis involved identifying levels of output that were thought to be characteristic of each individual worker. These performance levels served as a set of standards against which aberrant output rates that were of a magnitude that was psychologically meaningful could be determined. The solution to the problem

of what constituted an aberrant rate was an arbitrary one since there were no absolute criteria for "typical response rates." Essentially, this analysis resulted in a definition of "typical output." Next, a criterion was adopted that served as a standard for a major change in output. Finally, a standard was constructed that was used to identify the transition between typical rates and aberrant rates. Thus, three types of output rate events were determined.

A range of output values defining "typical" performance levels was identified first. This was accomplished by calculating a range of values that bracketed each individual's average output (during the first 104-week period) by plus or minus 5% of that mean value. When the weekly average hourly output rate fell within this range, it was considered a "typical" event.

A second level of performance behavior was then defined. This category contained output rates which departed significantly from the subject's typical performance. It was assumed that these were events about which the subject was psychologically aware when they occurred. More specifically, these atypical performance levels were defined as rates which were $1\frac{1}{2}$ standard deviations or more above or below the individual's average rate. Defining these rates in this manner constituted the basis for identifying output levels considered "aberrant".

Finally, another set of rates was defined. These were output levels which fell outside the typical range of performance (the mean ±5%) but which were within the $1\frac{1}{2}$ standard deviations from her average performance level. These rates indicated a shift from "typical" performance to "aberrant" levels or vice versa, and were referred to as transitional rates.

In summary, three levels of output rates or events were defined for purposes of identifying patterns of performance. They were: typical levels (a band of performance defined as the subject's average output over 104 weeks ±5% of that rate), aberrant levels (any average hourly output rate which exceeded 1½ standard deviations from the subject's mean rate), and transitional levels (the output rates adjacent in time to the aberrant rates which also exceeded the typical rates).

Once these three types of output rate events were defined, patterns of performance could be identified for each subject. That is, patterns of typical, aberrant, and transitional events were determined. Then, an attempt was made to group subjects by patterns that were shared by two or more workers.

Once identified, an aberrant rate pointed to what was called a "localized periods of disturbance" in performance. These local disturbances consisted of an aberrant event and the transitional rates that occurred during time periods that were antecedent and consequent to the aberrant event. In other words, a local disturbance was an interrupted period during which atypical performance events occurred. This time interval contained an aberrant rate and the transitional rates surrounding it. The duration of each local disturbance was calculated by determining the number of weeks between the last week prior to an aberrant event in which the subject displayed a typical rate and the first week after the aberrant rate in which production again fell into the range of typical performance. These local disturbances formed different patterns. For example, some employees displayed aberrant rates which occurred in isolation with no or few preceding transition rates. For other workers, fairly long periods of

transition occurred between a week of typical performance and an aberrant rate and/or vice versa. It should be noted that not all transitional output events were included in this analysis because some of these rates occurred without an accompanying aberrant event. However, this was a very rare event.

Attempts to group subjects by shared patterns resulted in four types of patterns. These were based primarily on the duration of the local disturbance periods rather than on frequency of these periods where performance deviated from levels identified as being typical.

Figure 1 presents the four patterns of performance which emerged from the analysis. These are generic in that they summarize, in a general form, the output pattern, including local disturbances, that might be expected of a member of each particular group. Four symbols were used to represent the events that entered the patterns. The symbols were displayed on five different lines for each figure. The highest line represented aberrant rates that were above the typical rate (on the middle level) while the lowest line represented aberrant rates that were below the typical rate. Transition rates were displayed on the second and fourth lines depending on whether they fell above or below the typical rate.

The four types of patterns were designated as: "short cycle," "long cycle," "mixed cycle," and "variable cycle." Sometimes "disturbance duration" was substituted for "cycle" to denote the time period surrounding and including an aberrant rate in which the individual was performing at levels outside her typical range.

More specific descriptions of these patterns are given below because within each group there were variations in behavior over time.

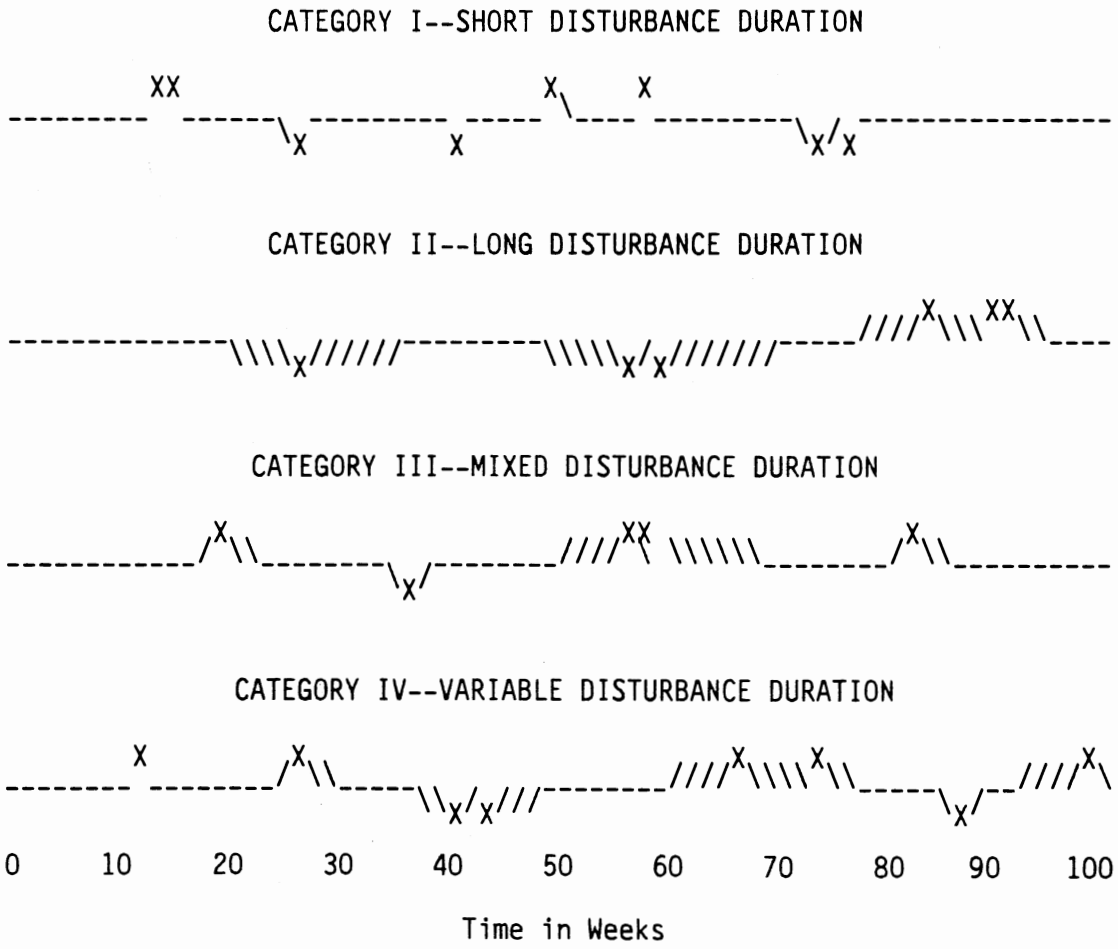

Figure 1. Generic Representations of Performance by Category

For instance, there were idiosyncrasies regarding the frequency of aberrant rates and when they occurred. Thus, in order to better understand the individual differences, these descriptions, by sewer subject, follow.

Short Cycle. One pattern which emerged was distinguishable by the relatively isolated, but fairly frequent occurrence of an aberrant rate with few or no accompanying transition rates. If adjacent transition rates existed, the total period of atypical performance rarely lasted more than three weeks, with two weeks being the norm. This first category will be referred to as "short disturbance duration" or short cycle. The subjects whose style of performance most resembled this description were: 2, 3, 20, and 27. It may be helpful to refer to the first graph in Figure 1 when reading this section.

Subject 2 displayed five high aberrant rates and four low ones. All of the low ones occurred within an eight-week period near the onset of the second year. Only one transition rate appeared and that was in connection with the low aberrant rates. Otherwise the aberrant rates occurred in isolation or in pairs and their timing was not predictable.

Subject 3 displayed a similar pattern with high aberrations outnumbering low ones six to three. Only two transition rates appeared in the 104 weeks.

Subject 20 shared the pattern as well, but there was a greater number of low aberrant rates (6) than high rates (2). It should be noted that in this case all of the aberrant rates occurred in the second year between weeks 70 and 96.

The final subject (27) to share this pattern displayed seven high and six low rates. These were spread throughout the 104-week period with no particular timing noticeable.

The workers who fell into Category I shared the unique feature of very short periods of atypical behavior. The data revealed nothing that could be identified as a precipitating event resulting in an aberrant rate. Recovery from these very sharp increases or decreases in production occurred rapidly and in many cases a typical rate was resumed the very next week. Further, there was no regularity in this pattern. That is, there was no rhythm or circularity to the occurrence of these local disturbances. Finally, it should be noted that there was variation among the four members of this category.

Long Cycle. Another identified pattern of performance was characterized by periods of localized disturbance in output which were long in duration. That is, an aberrant rate was preceded and/or followed by a number of weeks of transition rates. Whereas the short cycle patterns contained very brief transition periods and local disturbances, this pattern presented very long ones. However, in this type no systematic upward or downward trend appeared either prior to or following an aberrant point. The number of preceding and succeeding transition rates differed both within and between the subjects. Further, some of the local disturbances contained repeated occurrences of aberrant events, sometimes in a continuous series. The major commonality was that their total disturbance periods covered rather long periods of time. This was true of the time periods surrounding both the high and low aberrant output rates. This will be referred to as

Category II--"long disturbance period." Subjects 4, 9, 15, and 25 displayed output patterns that resembled this description and will be called "long cycle" performers. A representative description of this output pattern may be found in Figure 1. As with the workers in Category I, differences in performance were found among the "long cycle" performers. Therefore, a description of each individual's output behavior follows.

Ten high and six low aberrant rates were displayed by subject 4. For this worker all of the high rates occurred in the second year and during a single local disturbance in performance which lasted 22 weeks. The low aberrant rates were dispersed throughout the first 60 weeks with each local disturbance period containing a single low aberrant rate. In comparison to the short duration pattern previously described, local disturbances for subject 4 average nine weeks or more than two months.

Although subject 9 exhibited one local disturbance which lasted only 2 weeks, the other three transition periods lasted 11, 13, and 12 weeks, thus qualifying it for this category. It may be noted that the short disturbance occurred when the subject reached her maximum output which was nearly three standard deviations above her average rate. All five of the low aberrant rates occurred during a single disturbance period in the second year which lasted 13 weeks. Of the five high aberrations, three of them were contained in one local disturbance which also occurred in the second year. However, this disturbance lasted 12 weeks and was similar to a disturbance in the first year which contained only one high aberration and lasted 11 weeks.

The next subject in this category (15) displayed only one local disturbance period, but it lasted 27 weeks or more than half a year. All of the employee's ten aberrant rates, by definition, were low and took place during this one period in the first half of the second year. Even within this local disturbance, the aberrant rates occurred in no predictable pattern.

The final subject in this category (25) displayed eight low aberrant rates, five of which exceeded two standard deviations, followed by three unusually high rates. All of the low rates took place in series of two or three weeks and, except for one typical performance rate in week 28, they occurred within a continuous local disturbance which lasted 22 weeks. The unusually large rates began to appear at the end of the first year. Mirroring the employee's long, below average transition period, two of the high aberrant rates appeared in an almost continuous (week 77 fell in the typical range) sequence of atypical rates which lasted 30 weeks.

In summary, there was no evidence among the subjects in Category II of any predictable patterns in the transition rates themselves such as a gradual approach to or departure from an aberrant rate. Lastly, output records were examined for a consistent time interval between the weeks of aberrant rates or the onset of the transition periods and none emerged. Hence, as was the case with the short cycle group, these production records revealed idiosyncratic styles of performance that were not shared by any two members of this group.

Mixed Cycle. A third category of patterns which, to some extent, was a combination of the two already described was observed. This

generally consisted of several local disturbances which were short in duration and a single local disturbance which occurred over a relatively long period of time. (Subjects 6, 8, 13, 14, and 18 displayed this pattern of atypical output behavior.) Although the length of the shorter transition periods varied across subjects, from an average of 1 to 5 weeks, the lengths of these periods tended to vary little within a single individual. For example, the ranges for the lengths of these periods within the individuals of this category were 1, 0, 2, 1, and 1, respectively. This category will be referred to as "mixed disturbance duration" and a generic graph of the output may be found in Figure 1.

As with the first two categories, there was variation among the subjects in this group. For example, the first subject (6) displayed seven aberrant low rates and two high ones. The low quantities all occurred during the first year, while the high ones took place during the second year. Five of the low aberrations occurred during the single, extensive (13 weeks) transition period with four in a series and the last one being more than two standard deviations below the mean. Nothing about the data distinguished the onset of the prolonged transition.

The second individual in this category (8) exhibited 13 low aberrant rates and only 1 of high magnitude during a total of three disturbance periods. Two of these periods lasted 5 weeks while the longer period extended over a 10-week period. Again, nothing in particular indicated ahead of time the onset of the longer duration. In review, one realizes that all of the rates during that period were unusually low and included 7 weeks in which the output departed two

standard deviations below the typical rate. Further, if it were not for the occurrence of a typical rate in week 53, that period of very low rates would have increased 5 more weeks. Except for the fact that the shorter transition period contained the lone high aberration and the longer, the low ones, nothing else distinguished the two periods.

Although subject 13 displayed an output pattern that was similar to that of the previous subject, she displayed all 10 high (not low) aberrant rates during the long transition period of 12 weeks and the low ones were found in periods which lasted 1 to 3 weeks. Of the 10 aberrant rates, 9 exceeded two standard deviations above her mean output. A similar observation was made when reviewing the last subject's (8) records but concerned only low rates.

Employee 14 was placed in this category because the short transition periods lasted between 1 and 3 weeks while the long performance disturbance lasted 9 weeks. It should be noted that this period was more unusual than normal in that after four preceding transition rates, two high rates which exceeded two standard deviations occurred in succession, immediately followed by two aberrant low rates and a terminal transition rate. Altogether, six low and four high aberrant rates were exhibited.

The last subject in this category (18) displayed 4 low and 11 high aberrant rates. Examination of the data indicated that all but one of the high rates occurred during the long (12 weeks) transition period and eight of these were greater than two standard deviations above the subject's average output rate. The other aberrant rates existed in isolation or, in one case, during a 2-week period.

Thus far, the variations between descriptions of performance behaviors of the individuals are most noticeable with this group. This may reflect the lack of consistency in the pattern. That is, although short disturbances are dominant in this pattern, the existence of the one occurrence of a long disturbance may suggest irregularity in behavior which can manifest itself in a number of ways. Finally, not only did the disturbance durations differ with one being relatively long, but the onset of this lengthy cycle was not predictable.

Variable Cycle. The final category of output patterns was the model category accounting for the largest group of workers (i.e., more employees displayed this cycle than was found in any other category). These subjects, within the two-year period, displayed local disturbances which varied considerably in duration. That is, in terms of number of weeks, no consistent pattern of transition occurred. This group of employees was the most unpredictable regarding the length of time it would take before a typical rate of performance would be resumed. Category IV will be referred to as "variable transition duration." The subjects who fell in this category were numbers 1, 5, 7, 10, 11, 12, 16, 19, and 23. A graphical representation of their output may be found in Figure 1. Each of the subjects who fell in the category showed great variation in their output pattern and the graph was meant to convey this lack of predictability, especially in comparison to the other categories.

The first subject (1) exhibited 2 low and 11 high aberrant rates over the two-year period. The seven transition periods ranged from 1

to 7 weeks in duration. Aberrant rates occurred in a variety of manners including: as isolated incidents, in a series with transition rates, coupled with one or more similar aberrant rates or even in a series of transition rates of the opposite direction. Thus, not only was the duration of the local disturbance variable, little was similar in the organization of the rates.

Inspection of the output record for subject 5 also indicated no characteristic pattern or typical duration for the local disturbances. Six low and three high aberrant rates occurred throughout the 104-week period. These transition periods ranged from 1 to 4 weeks and 1 to 6 weeks for the low and high rates, respectively. No other particular feature was distinguished.

Subject 7 demonstrated similar variability in transition period duration. This employee registered six low and nine high aberrant rates during periods which lasted 1 to 7 weeks. One other observation was that if the onset of a transition period occurred within a few weeks of the previous transition period, then, generally, the two periods contained aberrations that were in the same direction, either both high or both low.

The next subject (10) had 12 weeks of aberrant performance with seven low and five high. The low aberrant rates occurred within three local disturbances which lasted 2, 4, and 12 weeks while the high ones were dispersed through three periods which covered 4, 5, and 8 weeks.

Subject 11 had five transition periods which contained a total of three low and four high aberrant rates. All three low performance periods only lasted 2 weeks, but the two high transition periods lasted 1 and 5 weeks. Otherwise, nothing of particular note occurred.

The sixth subject in this category (12) exhibited four low and nine high aberrations. The periods of local disturbance lasted between 1 and 7 weeks, with longer periods to recovery of typical performance generally occurring around the high aberrant rates.

Subject 16 was included in this category because her six transition periods ranged from 2 to 9 weeks in length, covering six low and five high aberrant rates. The longest transition contained four of the six low rates and all of them were greater than two standard deviations below the employee's average output rate. More specifically, the transition periods chronologically lasted 2, 9, 3, 4, and 6 weeks which excluded this subject from the third category.

Another employee (19) who was placed in this category displayed nine low and seven high aberrant rates in six local disturbances. These periods ranged from 2 to 10 weeks. This subject's performance record was notable in that on two occasions extremely large variability in the rates was displayed. In the first instance, low aberrant rates were intermingled with correspondingly low transition rates, but then were followed by two weeks of transition rates which were higher than the typical range of performance. The second occurrence showed two low aberrant rates which were preceded by three weeks of performance which fluctuated from below to above and then below the typical range. This case demonstrated a situation in which performance prediction would be extremely difficult.

The final subject in this category was number 23. This employee's performance contained one low and six high aberrant rates during five transition periods. Four of these periods lasted between 2 and 7 weeks and one lasted just over a year (53 weeks). From week 48 to

week 1, this subject's performance never fell in the "typical" range. During that time only three aberrant rates occurred but with 45 low and 5 high transition rates, one of which occurred in the middle of a series of low rates. Like the previous subject, performance prediction would have been extremely difficult.

Of the four categories, the variable cycle displayed the most variability in durations of disturbance periods. This also seemed to hold between the nine workers and the lengths fluctuated in no predictable manner. Forty-one percent of the sewers showed this kind of output from week to week. In contrast, 18% of the sewers displayed short cycle disturbances while 18% displayed long transition cycles and 23% indicated mixed cycles which consisted of short cycles with one long cycle which could occur at any time. Many of the sewers demonstrated rather unpredictable patterns.

In summary, three output rate events--typical, transition, and aberrant--were defined to facilitate the idiographic description of employee performance. This, in turn, indicated a system for classifying the work behavior over time according to the duration of local disturbances or atypical output rates surrounding aberrant events. These four categories were also used to examine the data obtained for the nonsewing employees (presentation begins on page 72) and also for classifying the subjects' performance behavior over the final two years, which is addressed later.

Randomnness of Performance

Based on the system that was developed to examine individual patterns of performance, the largest group of workers that was studied

shared unpredictable (with regard to duration) patterns of behavior. However, this did not directly address the randomness of the weekly output behavior. In other words, from one week to the next, did the individual employees display output behavior which was random or non-random? If it was random, then prediction of output on an individual basis would be practically impossible.

To test this question, a one-sample runs test (Siegal, 1956) was applied to each subject's weekly output rates over the first two-year period. Output from week to week was examined using a definition of change in performance as ±5% of the previous week's output. As discussed in Chapter II, this definition was not entirely arbitrary. The difference of 5% was based on the results of studies which have been conducted on the just noticeable difference in changes in pay.

A run was an uninterrupted series of like signs. In this case, a run was either a series of weeks of no (within 5%) change or a series of weeks of output that were different (more than 5%) from the previous week. If the sequence of output over the two years was nonrandom, it was indicated by too few or too many runs. It should be noted that the runs test does not clearly define the nonrandom alternatives, although a significant departure from randomness seems more likely to involve a clustering of like symbols, too few runs, than an extraordinary changing from one sign to the next. That is, weeks of change or weeks of no change tend to occur together when the behavior is nonrandom (Lehmann, 1975). Random behavior, on the other hand, was portrayed as an irregular pattern of change/no change with neither too few nor too many runs.

The results of the runs test for the sewers are shown in Table 4. For the group of sewers, regardless of category, there were 13 workers (59%) whose output was random and 9 (41%) whose output was nonrandom. In other words, based on the definition of change in performance used in this study, the majority of sewing machine operators displayed week-to-week performance levels which were random with neither too many nor too few runs. Thus, for the majority of sewers, a run of similar or a run of changing output levels could not be anticipated accurately. A t-test revealed no significant departure of these values from a chance distribution of subjects ($p = .50$) between random and nonrandom types.

Further, there appeared to be no relationship between whether an employee's performance from week to week was random or not and the time period of atypical output (see Table 5). That is, the duration of atypical behavior, as defined by the four categories is employed, and the number of runs had no bearing on each other. A chi-square analysis was not conducted because of the small cell sizes.

In summary, both the system for classifying patterns and the runs test analysis were concerned with the sequence or order of the output. From week to week the classification system examined the pattern of output while the runs test determined whether the level of output was random. The results indicated that for many of the workers the occurrence and duration of local disturbances was unpredictable and that for the majority performance from week to week was random. Thus, predicting individual performance may be a much more complicated, if not impossible, task.

Table 4

Performance Information by Category--

Sewers/Initial Two Years

Subject	Mean (Rank)	Standard Deviation (Rank)	Runs Test
Category I--Short Cycle			
1	4.70 (21)	.18 (3)	Nonrandom
3	3.62 (10)	.13 (1)	Random
20	4.25 (18)	.32 (15)	Nonrandom
27	4.27 (17)	.34 (16)	Random
Category II--Long Cycle			
4	3.25 (4)	.44 (20)	Nonrandom
9	3.54 (9)	.24 (6)	Nonrandom
15	3.48 (8)	.28 (12)	Random
25	3.41 (6)	.48 (21)	Random
Category III--Mixed Cycle			
6	4.29 (20)	.34 (17)	Nonrandom
8	4.09 (15)	.36 (19)	Random
13	3.75 (12)	.19 (4)	Random
14	2.93 (1)	.17 (2)	Nonrandom
18	4.71 (22)	.26 (9)	Nonrandom
Category IV--Variable Cycle			
1	3.63 (11)	.28 (13)	Random
5	4.26 (19)	.27 (11)	Nonrandom
7	3.06 (2)	.19 (5)	Nonrandom
10	3.33 (5)	.35 (18)	Random
11	3.18 (3)	.26 (8)	Nonrandom
12	3.90 (14)	.24 (7)	Random
16	3.45 (7)	.26 (10)	Random
19	4.17 (16)	.30 (14)	Random
23	3.80 (13)	.54 (22)	Nonrandom

Table 5

Distribution of Sewers by Category and Runs Test Results

Runs Test Results	Category I	II	III	IV
Random	3	2	3	5
Nonrandom	1	2	2	4

Table 6

Distribution of Sewers by Category and Average Performance--Initial Two Years

Average Performance	Category I	II	III	IV
High	3	0	3	4
Low	1	4	2	5

While the aforementioned analyses were concerned with the order of output on an individual basis, it was also important to examine individual aggregate data or descriptors such as level of performance (individual mean output) and consistency of performance (individual variability), and distribution of output. Relationships between these variables will be discussed later in the section entitled "Intra-Group Analyses."

Levels of Performance

The actual rate at which one produces week to week is a measure of employee effectiveness. Therefore, the two-year average level of performance for each individual was examined. In other words, the mean of each person's weekly average hourly output rate over the first two years was determined. The individual two-year averages were calculated for each of the four "local disturbance period" categories. These individual mean output rates are displayed, by category, in Table 4 along with their comparative group ranking (from lowest to highest) across all sewing machine workers. The sewing group two-year average was $3.77 per hour.

Three of the four subjects who displayed short disturbance periods (Category I) fell in, not only the top half but the top 25% of the group in average output. Table 6 shows, by category, the distribution of employees into high and low output based on the group's average output. All of the four subjects in Category II (long disturbance duration) were ranked in the lower half in average output and the range of the rankings was small, between fourth and ninth.

The two categories which contained subjects who had mixed or variable disturbance period durations showed much less congruency among the subjects regarding average performances. For instance, three of the five subjects who displayed mixed disturbance periods (Category III) averaged output rates which were in the top half of the sewers with the remaining two subjects ranking at the bottom. Further, the rankings ranged from the lowest performer to the highest. The nine subjects in Category IV (variable disturbance duration) had average output rates which represented the entire range of rankings as well. The category contained five subjects in the lower half of the rankings and four in the upper half. The rankings ranged from second lowest to fourth highest.

In conclusion, in all cases, those employees who performed at atypical levels for very short periods of time (Category I) performed at a higher average rate than those who displayed long periods of local disturbances in output (Category II). However, no similar statement could be made for those subjects in Categories III and IV. That is, it appeared that those workers whose aberrant levels occurred as relatively isolated and short-term events averaged more output than those workers whose performance level may drift into the atypical range and whose recovery from an aberrant rate took more time. The workers in Category II performed at personal transitional and atypical rates more often than those in Category I and their overall average levels were not as high.

It was predicted that these individual average output rates and their corresponding relative rankings would remain approximately the same over the second two years. This will be addressed in the results

section which covers the analyses of the sewers over the second two years.

Consistency of Performance

If fairly accurate prediction of performance is to occur, then the stability of output must be high. Furthermore, research results and their interpretation largely depend upon the reliability of a criterion (Ghiselli, 1963) which in many cases involves performance output. Therefore, individual variability in performance was studied using the subject's performance standard deviation. For future reference, it should be noted that the average standard deviation for the individuals within the sewing group, for the first two years, was .29.

In the first category (short disturbance duration) two of the employees displayed high consistency in performance with relatively small standard deviations (.13 and .18). On the other hand, the remaining two employees displayed larger variability (.32 and .34) ranking in the top third of the sewing group.

The range of variability measures for the subjects in Category II (long disturbance duration) was also great. Of the four subjects, two had standard deviations below the sewing group's average and two were above.

The five subjects in Category III (mixed disturbance duration) exhibited a wide range of variability, from the second lowest standard deviation to the fourth highest. Three of the workers displayed relatively high consistency but two showed much higher variability in their performance.

The fourth category (variable disturbance periods) contained nine individuals who ranked throughout the range of variability with six employees who had standard deviations below the sewing machine group's average standard deviation of .29. However, all but one individual displayed standard deviations within ten cents of this figure.

In summary, there appeared to be no relationship between the variability of an employee's performance and the duration of atypical output rates; that is, the local disturbance period (see Table 7). This may be interpreted to mean that the duration of the local disturbance had little to do with the magnitude of the aberrant performance rates. That is, the number of weeks of atypical behavior preceding and/or succeeding a week of aberrant output may not be estimated.

Table 7

Distribution of Sewers by Category and Consistency--Initial Two Years

Consistency	Category			
	I	II	III	IV
High	2	2	3	6
Low	2	2	2	3

Distribution of Rates

Whereas the pattern category system and the runs test focused on the level and sequence of output rates, an analysis of the frequency distribution of these rates for each worker ignored the order in which the rates occurred. Rather, a discussion of the important properties of each subject's aggregate data in terms of frequency distributions may have revealed interesting relationships between the distribution of rates and the duration of atypical performance. Later, these distributions will be discussed in relation to average performance level.

Table 8 shows the mode, range, skewness, and kurtosis of each worker's output, by category. Those figures in the skewness column which are greater than zero indicate distributions which are positively skewed and those which are less than zero indicate negatively skewed ones. Further, the higher the absolute value the more skewed the distribution. The kurtosis denotes how peaked the distribution is. Those with a positive kurtosis are referred to as leptokurtic and this means that it is more peaked than normal, whereas negative numbers indicate platykurtic distributions which are less peaked (flatter) than normal.

As can be seen in the table, positively and negatively skewed distributions were scattered over the four categories with 11 being positive and 11 being negative. In Category IV (variable cycle), six of the nine subjects displayed negatively skewed distributions. However, some of them were only slight (e.g., -.07, -.10, and -.14). Thus, it appeared that the skewness of the distribution of output rates was not related to the duration of local disturbances in perfor-

Table 8

Properties of Individual Rate Distributions by Category--Sewers/Initial Two Years

Subject	Mode	Range	Skewness	Kurtosis
Category I--Short Cycle				
2	4.69	1.20	+.49	+2.01
3	3.64	.66	+.10	+.13
20	4.55	2.27	-1.81	+6.62
27	4.07	2.42	+.08	+2.63
Category II--Long Cycle				
4	3.02	2.03	+.25	-.39
9	3.46	1.21	+.25	-.52
15	3.67	1.20	-.78	-.45
25	3.35	2.20	-.55	-.20
Category III--Mixed Cycle				
6	4.39	2.65	+1.71	+9.63
8	4.11	1.97	-1.34	+1.65
	4.37			
13	3.67	.91	+.95	+1.08
14	3.04	1.12	-.02	+1.40
18	4.72	1.61	+.76	+2.14
Category IV--Variable Cycle				
1	3.41	1.74	+.89	+1.32
5	4.47	1.63	-.77	+1.58
7	2.93	1.16	-.17	+.94
10	3.50	2.27	-.07	+1.37
11	3.07	1.86	+.73	+3.34
12	3.77	1.20	-.10	-.06
16	3.34	1.51	-.79	+1.52
	3.39			
	3.53			
	3.64			
19	4.44	1.42	-.14	-.34
23	3.16	2.85	+.57	+.50

mance. Perhaps, then, the presence of these outlying performance rates (i.e., the rates from the skewed tails) are not related to the occurrence of these rates and other atypical rates over time, from one week to another. In addition, since neither type of skewed distribution dominated any particular category, no evidence existed to suggest a relationship between a ceiling or floor effect and a pattern of output.

On the other hand, the kurtosis scores for the distributions of output for workers in three of the four categories were exclusively either all positive or all negative. Even in Category IV, 7 out of 9 of the workers had distributions which were leptokurtic. All of the distributions for subjects in the short duration Category I (short cycle) were more peaked than normal, as were those in Category III (variable cycle) and 77% of those in Category IV (mixed cycle). This may have indicated that the influence, frequencywise, of the occasional occurrence of a long local disturbance (in Category III or IV) was not very strong, particularly in comparison to the number of typical rates.

The four workers in Category II (long disturbance duration) had distributions that were less peaked than normal. This, perhaps, reflected the influence of the larger number of transition weeks that accompanied aberrant rates.

Individual Employee Descriptors

Once the individual production records were categorized by the duration of the atypical rates (disturbance periods), it was important to determine whether the employees within the categories had other

aspects of their work in common. The purpose of this part of the discussion was to convey any relationships found between how long the employee had worked for the company, the particular job she performed and her output pattern, or the lack thereof. For example, if all the subjects from the short cycle group performed the same operation, then one might argue that the duration of atypical rates was task-related rather than, say, related to the individual worker. Thus, information regarding the assigned operations and seniority is discussed in this section and listed in Table 9. It should be remembered that all of the subjects were experienced and well beyond the training period.

The employees assigned to sewing lines worked on T-shirts (n = 18), pajamas (n = 2), athletic shirts (n = 1), and briefs (n = 1). The subjects who worked on the T-shirt line performed one of seven operations. Only one subject was assigned to a similar operation on another line, thus eliminating the possibility of between-line comparisons.

The four subjects who displayed relatively short disturbance periods (Category I) worked on different operations. All were experienced and their length of seniority at the onset of the study ranging from nearly 5 years (58 months) to 17 years (204 months).

Three of the four subjects in Category II (long disturbance periods) worked on the T-shirt line but all of them performed different operations. The newest employee had over 2 years experience (26 months) while the others had been working for the organization for more than $9\frac{1}{2}$ years.

Category III (mixed duration) consisted of five subjects who displayed short periods of local disturbance and one relatively long

Table 9

Employee Descriptors by Category--Sewers

Subject	Category	Operation*	Seniority (Months)
Category I--Short Cycle			
2	T-Shirts	DSH	129
3	T-Shirts	DN	204
20	Athletic Shirts	2A	58
27	Pajamas	DP	69
Category II--Long Cycle			
4	T-Shirts	DN	26
9	T-Shirts	DSLG	201
15	T-Shirts	JJB	118
25	Briefs	C2E	205
Category III--Mixed Cycle			
6	T-Shirts	H2	68
8	T-Shirts	DSLV	55
13	T-Shirts	DSLG	58
14	T-Shirts	DSLG	29
18	T-Shirts	DSLG	14
Category IV--Variable Cycle			
1	T-Shirts	DSH	145
5	T-Shirts	H2	192
7	T-Shirts	H2	28
10	T-Shirts	DSLG	128
11	T-Shirts	DSLG	127
12	T-Shirts	DSLG	70
16	T-Shirts	JJB	92
19	T-Shirts	DR	187
23	Pajamas	JJB	55

*See Table 1 (p. 18) for a description of these operations.

period. All of these subjects worked on the T-shirt line with three of them performing the same operation. Compared to employees from the other categories, on the whole, these subjects had less seniority ranging from over 1 year (14 months) to over 5 years (68 months). Nevertheless, all of them were well beyond the six-month training period.

In the last group (variable duration) eight of the nine employees worked in the T-shirt line with three performing the same operation. Their tenure ranged from over 2 years (28 months) to 16 years (192 months) with an average seniority of 9½ years.

In summary, the majority (18) of the employees who were subjects in this study worked on the T-shirt line and seven of them were assigned to the same operation (DSLG). Employees from the T-shirt line could be found in all four categories and the DSLG operation was represented in Categories II, III, and IV. Thus, given that no particular operation was very well represented in any one category, it might be suggested that the duration of the local disturbances were related to the individual rather than task.

Length of seniority varied greatly but all far exceeded any definition of the learning period and were considered very experienced. Hence, at least beyond the learning stage, length of seniority had little relation with the length of time the workers performed outside their typical range of output.

Group Analyses/Sewers--
Initial Two Years

Once the individual records were examined, it was important to

determine whether these sewing machine operators, as a group, had aspects of their work which were related. For instance, often it has been believed that rate of performance and variability were related, yet little empirical evidence has been found to support this idea (Bedford, 1922; Rothe, 1946a; Rothe, 1970). Thus, comparisons were made regarding performance levels, variability, distribution of rates (skewness), randomness of output, and length of seniority. It must be noted that group average output rates were similar across operations.

Seniority and Level of Performance

Although all of the workers who were subjects in this study were experienced, a Pearson product-moment correlation was calculated in order to determine if there was a relationship between length of seniority and average rate of output, during the initial two years, across all sewing machine operators. As predicted, no significant relationship was found, $r = -.02$ and $t(20) = .07$, $p > .10$. Thus, granting that the workers were performing well-learned tasks, there was no relationship between job tenure and average performance rate.

Level and Consistency of Performance

As mentioned before, it has been a commonly held belief that a negative relationship exists between level of output and variability of output. This was tested by examining the individual mean output rates, during the first two years, and their corresponding standard deviations, across all sewing machine operators. A Box and Whisker display of each sewer's mean, standard deviation, and range of output, for the first two years, may be found in Figure 2.

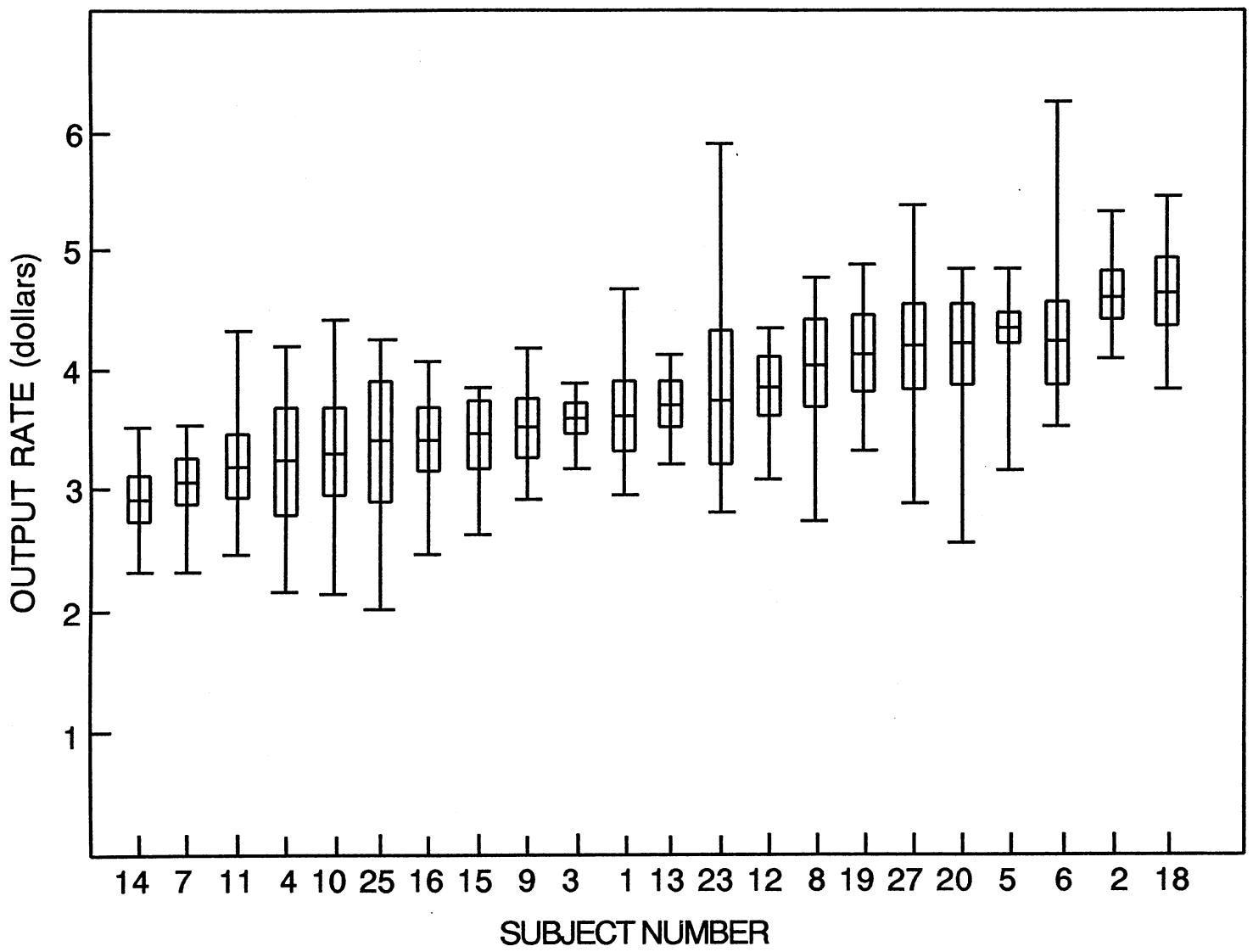

Figure 2. Box and Whisker Graph: Sewers/Initial Two Years

A Pearson product-moment correlation (r = .02) was determined for these workers and it was found to be not significant, $t(20)$ = .09, p > .10. Thus, this group did not support the hypothesis that there was a relationship between quantity and variability of output.

Level and Randomness of Performance

Along the same lines of the argument accompanying the last analysis, one might expect to find a relationship between average output and whether the week-to-week output was randomly ordered or not within the sewing group. In particular, those workers who performed at higher levels may have done so in a more systematic manner rather than randomly.

To test this, a point-biserial correlation coefficient was determined between the results of the runs test (random or nonrandom) and the average performance levels of the 22 sewers during the first two years. The correlation (r = .08) was slightly in the direction of prediction but it was not significant $t(20)$ = .36, p > .10.

Consistency and Randomness of Performance

Another relationship which was worth testing was that between consistency of performance, as measured by standard deviations, and randomness of output rates from week to week. It was expected that more consistent workers would perform in a less random manner. That is, those with smaller standard deviations would tend to display sequences of output that were nonrandom. A point-biserial correlation was performed between the results of the runs test (random or nonran-

dom) and the sewers' standard deviations. The coefficient (r = .003) was not significant, $t(20)$ = .01, p > .10.

Level and Distribution of Performance

Finally, it has been suggested (Yoder in Rothe, 1946a; Applewhite et al., 1965) that there may be a relationship between the average rate of performance and "restriction of output" measured by the skewness of the distribution of rates. More specifically, researchers have hypothesized that faster workers would display positively skewed distributions while slower ones would have negatively skewed data distributions.

To test this relationship, a Pearson product-moment correlation was conducted. The coefficient (r = .05) approached zero, indicating no relationship. In fact, the t-ratio was not significant, $t(20)$ = .26, p > .10. Thus, no support was found for this relationship between average rate and the distribution of the rates.

Intra-Individual Analysis/Nonsewers-- Initial Two Years

Patterns of Performance

The four patterns of "localized periods of disturbance" which were identified from the data of the sewing machine operators were used in an attempt to define the work behavior of the nonsewing employees (N = 16). These categories appeared to be useful with this second set of workers, thus enhancing the utility and generalizability

of the classifications. Refer to Figure 1 for the graphic display of these generic categories.

Short Cycle. The "short disturbance duration" represented the output patterns of six nonsewers: subjects 28, 31, 32, 33, 35, and 46. Whereas only 18% of the sewers displayed output rates which resembled this pattern, 37.5% of the nonsewers did so. Thus, a larger percentage of the workers who were employed in nonsewing tasks demonstrated only short periods of atypical performance.

Long Cycle. In contrast to the four sewers (18%) who demonstrated this kind of pattern, only two of the nonsewers (12.5%) produced a series of output rates which was indicative of Category II. However, their output patterns shared little else. Subject 40 had one disturbance which lasted 25 weeks, of which 24 weeks were below her typical rate. But subject 44 displayed two disturbances which lasted 51 and 26 weeks, respectively, and both periods contained some very high and very low aberrant rates.

Mixed Cycle. The main feature of this pattern is several short disturbances and one long transition period. While five (23%) of the sewers displayed this pattern, five nonsewers (31.25%) did also (30, 34, 37, 39, and 45). The short disturbances ranged from 1 to 4 weeks and the one long disturbance lasted between 13 to 16 weeks with an average duration of 14.2 weeks. These durations were similar to those found across the sewers (1 to 5 weeks and 9 to 13 weeks, respectively).

Variable Cycle. This category included those subjects whose two-year pattern contained local disturbances of considerably different durations. Only three (18.75%) of the nonsewers fell in this category. However, this category accounted for the largest number of sewers (9 or 41%). Subject 29 had four disturbances lasting from 3 to 11 weeks, but neither high nor low aberrant rates dominated. Subject 36 produced six disturbances lasting from 1 to 10 weeks. Finally, subject 38 had seven disturbances varying from 1 to 7 weeks, not unlike the output of the sewers from the same category.

In summary, the four categories easily applied to both the sewer and nonsewer groups of employees. However, some differences became evident in the distribution of these subjects across the categories. As can be seen in Table 10, the largest portion of sewers (41%) were found in Category IV because their output pattern over time displayed great variability in terms of the occurrence and duration of local disturbances. On the other hand, only 18.75% of the nonsewers exhibited this pattern, which actually is a category for those subjects whose output revealed no pattern. However, the largest number of nonsewers (6) in any one category were in the first one; 37.5% of the nonsewers revealed short disturbances in their typical performance and another 31.25% (5) of them fell into Category III (mixed cycle). This suggested that an aberrant rate usually occurred in near isolation with few, if any, preceding transition rates and quick recoveries back to their typical rates. In contrast to the percentage of nonsewers who displayed short cycles, only 12.5% of them showed a pattern in which aberrant rates were surrounded temporarily by long transition periods.

Table 10

Distribution of Sewers and Non-sewers Across Categories

Category	Sewers	Nonsewers
I	4/18%	6/37.5%
II	4/18%	2/12.5%
III	5/23%	5/31.25%
IV	9/41%	3/18.75%
	22/100%	16/100%

Randomness of Performance

The runs test was applied to the nonsewer data to determine whether each employee's output level from week to week was random. For the 16 employees, 37.5% (6) resulted in random output, while 62.5% (10) displayed a nonrandom output series. This is in contrast to 59% of the sewers who had a random series and 41% who had a nonrandom one. The individual employee results of the runs test for the nonsewers is displayed by category in Table 11. The distribution of the results may be found in Table 12.

Although sample size was small, a relationship seemed to exist between any distinguishable pattern and the nonrandomness of the series (see Table 11) especially in comparison to the sewer group (see Table 5). There appeared to be a tendency for those subjects who

Table 11

Performance Information by Category--

Nonsewers/Initial Two Years

Subject	Mean (Rank)	Standard Deviation (Rank)	Runs Test
Category I--Short Cycle			
28	3.24 (5)	.18 (4)	Random
31	4.54 (12)	.13 (1)	Nonrandom
32	4.59 (14)	.19 (5)	Nonrandom
33	4.56 (13)	.13 (2)	Random
35	6.65 (16)	.51 (12)	Nonrandom
46	4.78 (15)	.25 (7)	Nonrandom
Category II--Long Cycle			
40	3.12 (4)	1.02 (16)	Nonrandom
44	2.68 (1)	.40 (10)	Nonrandom
Category III--Mixed Cycle			
30	4.03 (8)	.24 (6)	Nonrandom
34	4.23 (10)	.55 (14)	Nonrandom
37	4.01 (6)	.59 (15)	Nonrandom
39	2.84 (3)	.27 (8)	Random
45	4.02 (7)	.51 (13)	Nonrandom
Category IV--Variable Cycle			
29	4.35 (11)	.45 (11)	Random
36	2.78 (2)	.17 (3)	Random
38	4.07 (9)	.28 (9)	Random

Table 12

Distribution of Nonsewers by Category and Runs Test Results

Runs Test Results	Category I	II	III	IV
Random	2	0	1	3
Nonrandom	4	2	4	0

Table 13

Distribution of Nonsewers By Category and Average Performance--Initial Two Years

Average Performance	Category I	II	III	IV
High	5	0	1	2
			$1=\bar{X}$	
Low	1	2	3	1

emphasized either short cycles (Category I), long ones (Category II), or one long one in conjunction with short cycles (Category III) to do so in a nonrandom manner. However, the results of the runs test indicated that the three subjects whose patterns showed considerable variability regarding the duration of atypical rates (Category IV) all had random patterns. Recognizing the sample size, one may still discern that this is considerably different than the results found with the sewing sample which indicated no relationship between the employees' output patterns and their randomness or nonrandomness.

Levels of Performance

Each nonsewer's average performance rate for the first two years was calculated and ranked from lowest to highest. These may be found in Table 11; Table 13 displays the distribution of the individual employee averages by category using the group's average rate to determine high or low performance.

In Category I (short cycle), five of the six nonsewers performed above the group average and actually they were the top nonsewing performers. But the two employees from Category II (long cycle) produced at comparatively low levels (the lowest and fourth from the lowest). In contrast, the distributions for Categories III and IV (mixed and variable) were far less one-sided. These outcomes were similar to those of the sewers during this time period.

Consistency of Performance

Performance consistency gives some insight into reliability boundaries. Each nonsewer's output standard deviation was calculated,

ranked, and compared to the average standard deviation for the group. Table 14 shows the breakdown of employees by category and consistency which was dichotomized using the group average. Those whose standard deviations fell below this group average were considered to have demonstrated high consistency, and low consistency was the label given to those whose standard deviation was more than the group's average deviation.

The distribution for the nonsewers was similar to their distribution based on average performance rates and somewhat different from the parallel distribution for the sewers where none of the categories was dominated by either high or low consistency employees. Rather, five of those in Category I showed high consistency while one did not, and both of the nonsewers in Category II displayed low consistency or high standard deviations. Further, Categories III and IV had employees performing at both levels.

Table 14

Distribution of Nonsewers by Category and Consistency--Initial Two Years

Consistency	Category I	II	III	IV
High	5	0	2	2
Low	1	2	3	1

Distribution Rates

The frequency distribution of output rates for each nonsewer was examined. Table 15 displays the mode, range, skewness, and kurtosis for each by category. The majority (10) of the workers had negatively skewed distributions, although skewness in some was very slight. Category I was divided with two positively skewed, two negatively skewed, and two near zero distributions. Both of those in Category II were negatively skewed and it may be noted that these employees ranked lowest and fourth lowest in average output, supporting the idea that negatively skewed distributions might be evidence of a ceiling effect. However, this was the only category for which any kind of statement could be made because neither type of distribution dominated.

The peakedness of these output distributions, by category, was similar to the results for the sewers. All of the distributions in Categories I and II and two of the three in Category IV were more peaked than normal (leptokurtic), while those in Category II were less peaked than normal. Apparently, the larger number of transition rates that typify this category succeed in flattening the distributions.

Individual Employee Descriptors

The length of seniority and the actual job operation of each nonsewing employee were inspected to discern any relationships they might have with the emitted patterns of performance. In contrast to the sewing group, in which no one operation dominated a category, a few observations could be made about the nonsewing group.

Table 15

Properties of Individual Rate Distributions by Category--Nonsewers/Initial Two Years

Subject	Mode	Range	Skewness	Kurtosis
Category I--Short Cycle				
28	3.28	1.28	-1.64	+6.80
31	4.57	.66	+.01	+.44
32	4.64	1.71	+1.82	+13.45
33	4.64	1.10	-.07	+4.75
35	6.59	4.93	-.65	+10.54
46	4.71	1.91	+2.35	+12.34
Category II--Long Cycle				
40	3.49	3.64	-1.21	-.06
44	2.96	1.78	-.64	-.46
Category III--Mixed Cycle				
30	3.80	1.31	-.40	+.78
34	4.00	4.45	-2.41	+15.21
37	3.93	3.46	-.88	+2.12
39	3.08	1.51	+.46	+.71
45	3.94	4.48	+2.42	+14.28
Category IV--Variable Cycle				
29	4.30	2.89	-.82	+2.43
	4.46			
	4.65			
	4.67			
	4.68			
36	2.73	.93	.63	+.59
38	4.01	1.36	-.14	-.15
	4.22			

These employees worked either with athletic shirts (n = 10) or T-shirts (n = 5) with one on pajamas (see Table 16). The majority of them (10) were folders, while the others performed various bar-tacking operations. Only one employee of the six in Category I (short cycle) performed the folding operation, but both of the women in Category II (long cycle), four of the five in Cagegory III (mixed cycle), and all three from Category IV (variable cycle) were charged with inspecting, folding, and bagging the garment. Perhaps there is something about the judgment process that comes with the quality control inspection that contributed to the long, mixed, and/or variable durations of atypical behavior. In contrast to the predominance of folders in Categories II, III, and IV, five of the six workers whose performance fell under Category I (short cycle) were employed in various bar-tacking operations. Further, it should be noted that four of these five were among the top five performers in the nonsewers' group and all of them displayed relatively little variability in their output.

Seniority ranged from 39 months ($3\frac{1}{4}$ years) to 280 months (over 23 years). Thus, once again, the employees were very experienced. Further, no discernible relationship seemed to exist between one's job tenure and the individual's pattern of performance as defined by the four categories.

Group Analyses/Nonsewers--
Initial Two Years

Aggregate data from the 16 nonsewing employees were examined for any relationships between job tenure, rate of performance, consistency of performance, randomness of output, and the distribution of output

Table 16

Employee Descriptors by Category--Nonsewers

Subject	Category	Operation*	Seniority (Months)
Category I--Short Cycle			
28	Athletic Shirts	UUU	39
31	T-Shirts	UL	150
32	T-Shirts	AJS	137
33	T-Shirts	AJS	137
35	Athletic Shirts	WIBB	182
46	T-Shirts	UL	280
Category II--Long Cycle			
40	Athletic Shirts	WIBB	54
44	Athletic Shirts	WIBB	47
Category III--Mixed Cycle			
30	T-Shirts	UL	171
34	Athletic Shirts	WIBB	221
37	Athletic Shirts	WIBB	65
39	Athletic Shirts	WIBB	61
45	Pajamas	WIBB	68
Category IV--Variable Cycle			
29	Athletic Shirts	WIBB	67
36	Athletic Shirts	WIBB	165
38	Athletic Shirts	WIBB	64

*See Table 1 (p. 18) for a description of these operations.

rates. Although no significant results were found for the sewers, some were found for this group.

Seniority and Level of Performance

Once again, all of the nonsewers were experienced at their operation; however, a positive correlation, $r(14) = .52$, $p < .05$ was found between their length of seniority, as a group, and their average output rate. So it appears that even though these were well learned tasks (the least senior employee had worked almost 4 years), increased tenure was somehow related to the ability to perform at higher rates. This is in contrast to the nonsignificant relationship for the sewing group.

Level and Consistency of Performance

No support was found for an inverse relationship between rate of performance and variability. Here these two variables were defined as average output over the first two years and one's performance standard deviation, respectively. Figure 3 displays each subject's mean, standard deviation, and range of output. The results were near zero ($r(14) = -.04$, $p > .10$). This was similar to the finding for the sewers' data.

Level and Randomness of Performance

A point-biserial correlation revealed a relationship between the average output rates and the results of the runs test. There was a tendency for those who performed at higher rates to do so in a nonrandom manner. Although the relationship was in the originally predicted

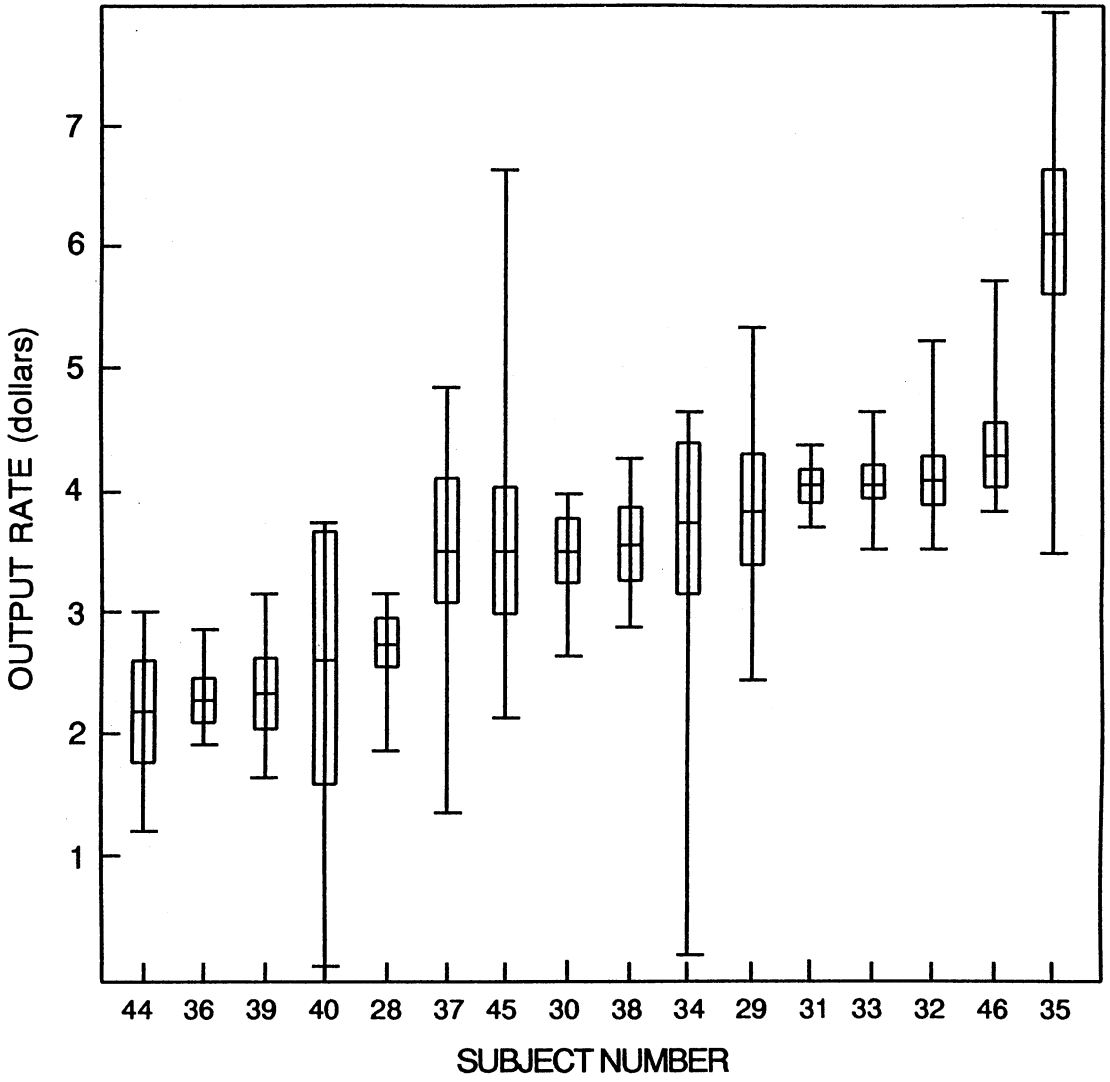

Figure 3. Box and Whisker Graph: Nonsewers/Initial Two Years

direction, the correlation was not significant ($r(14) = .32$, $p > .10$). This corresponded with the result for the sewing group.

Consistency and Randomness of Performance

A weak relationship was found between the variability in performance, as measured by the standard deviation, and the nonrandomness (runs test results) of the rates from week to week. A point-biserial correlation indicated that variability in performance differentiated between random and nonrandom output rates but not at a significant level ($r(14) = .41$, $p > .10$). This correlation was near zero for the sewing group.

Level and Distribution of Performance

The final correlation examined was that between average rate of output and the skewness of the frequency distribution of these rates. No significant relationship was found ($r(14) = .11$, $p > .10$).

Initial Two Years Reviewed--Sewers and Nonsewers

To summarize, whereas 41% of the sewers displayed output rates over time which lacked pattern and were allocated to Category IV (variable cycle), the largest proportion of nonsewers (37.5%) showed short transition cycles. Another 31.25% of the nonsewers demonstrated the short cycle dominated Category III (mixed cycle) pattern. Further, on the whole, the sewers produced more random output than the nonsewers, but Category IV was dominated by random output by nonsewers. Table 17 shows a comparison of the two groups.

Table 17

Summary of Predominant Results for Sewers and Nonsewers by Category--Initial Two Years

		Sewers N = 22	Nonsewers N = 16
Intra-Individual			
Patterns of Performance			
Short Cycle	I	18% (4)	37.50% (6)
Long Cycle	II	18% (4)	12.50% (2)
Mixed Cycle	III	23% (5)	31.25% (5)
Variable Cycle	IV	41% (10)	18.75% (3)
Randomness of Performance			
Runs Test		59% Random	37.5% Random
By Category		No Relationship	I, II, & III--Predominately Nonrandom; IV--Random
Level of Performance			
By Category	I	High Mean	High Mean
	II	Low Mean	Low Mean
	III	No Relationship	No Relationship
	IV	No Relationship	No Relationship
Consistency of Performance			
By Category	I	No Relationship	High Consistency
	II	No Relationship	Low Consistency
	III	No Relationship	No Relationship
	IV	No Relationship	No Relationship
Distribution of Rates			
By Category			
Skewness		No Relationship	I, III, & IV--No Relationship; II--Negatively Skewed
Kurtosis	I	Peaked	Peaked
	II	Flat	Flat
	III	Peaked	Peaked
	IV	Peaked	Peaked

Table 17. Continued

	Sewers N = 22	Nonsewers N = 16
Descriptors		
By Category		
Tenure	No Relationship	No Relationship
Job Category	No Relationship	I & III--No Relationship II & IV--Athletic Shirts
Job Operation	No Relationship	I--Bar-Tackers II, III, & IV--Folders
Group Correlations		
Seniority & Mean Output	-.02	+.52*
Mean Output & Standard Deviation	+.02	-.04
Mean Output & Randomness	+.08	+.32 P.D.
Standard Deviation & Randomness	+.003	+.41 P.D.
Mean Output & Skewness	+.05	+.11

*$p < .05$. P.D.--Predicted Direction.

Within these pattern categories, both groups of workers showed similar results regarding average output. The higher performers dominated Category I while low performers wwere found in Category II. On the other hand, no meaningful relationship was found regarding consistency of output except that highly consistent nonsewers tended to be found in Category I and the low consistency nonsewers prevailed in Category II.

No relationship appeared to exist among the two groups with regard to distribution skewness except that both the nonsewers in Category II had negative results. In contrast, both groups shared similar results concerning kurtosis. Categories I, III, and IV were dominated by distributions which were more peaked than normal and Category II had flatter ones.

For both groups the range of employee seniority was represented in all four categories. Similar results were found with regard to the garment line on which the employees worked and the actual operation performed. The exception was that bar-tackers seemed to have short cycle transitions.

Finally, an examination of the relationships between various measures of performance within the sewing and nonsewing groups, as a whole, was conducted. Only one significant correlation was found and that was between seniority and average output for the nonsewing group.

The Replication

Introduction

A replication was performed with the data from these two groups

of subjects which covered the following two-year period. It was expected that the results of the various analyses would be duplicated with these samples. More specifically, it was proposed that the individual output patterns which the subjects displayed during the first two years would persist and thus the same people would continue to share these patterns. Further, it was predicted that within these performance pattern subgroups, similar results would be found regarding the randomness of the rates and the dominance of particular levels and consistency of output. In addition, it was believed that the nature of the individual distributions of their rates would be comparable. Finally, the relationships between various performance measures (e.g., the correlation between average output and standard deviations, etc.) on the sewers and nonsewers were expected to be similar to that found with the initial data.

Intra-Individual Analyses/Sewers--
Final Two Years

Patterns of Performance

The new performance data for each sewer were examined to determine patterns. As stated before, it was expected that each employee's original pattern would be replicated. This was true for 27.3% of the sewers whereas 72.7% demonstrated rates which indicated a change in their performance pattern. A comparison of category membership may be found in Table 18. As can be seen, a large increase in membership occurred in the short cycle category with the majority of the new members having previously displayed variable cycles. In contrast,

Table 18

Distribution of Sewers by Performance Category: A Comparison of Initial Two Years to Final Two Years

Initial Two Years Members	Final Two Years Old Members	Final Two Years New Members
Category I--Short Cycle		
2	2	5 (IV)*
3	3	6 (III)
20		7 (IV)
27		9 (II)
		10 (I)
		12 (IV)
		15 (II)
		16 (IV)
		18 (III)
n = 4	n = 11	
Category II--Long Cycle		
4		13 (III)
9		19 (IV)
15		
25		
n = 4	n = 2	
Category III--Mixed Cycle		
6		1 (IV)
8	8	20 (I)
13		
14	14	
18		
n = 5	n = 4	
Category IV--Variable Cycle		
1		4 (II)
5		25 (II)
7		27 (I)
10		
11	11	
12		
16		
19		
23	23	
n = 9	n = 5	

*Original category.

fewer employees showed a Category IV pattern (Variable Cycle). In general, it appeared that short transition cycles dominated the performance of the majority of the sewers during the final two years. Membership in the four patterns of performance are discussed below.

Short Cycle. The "short disturbance duration" characterized the output pattern of half of the sewers. This was a 32% increase in the number of subjects who displayed this pattern during the final two years over the first two. Further, only two of the four original members remained in this category.

Long Cycle. Only 9% (n = 2) of the sewers fell in Category II, exhibiting only long disturbances. This was down from four employees initially. It should be noted that neither of these two employees was originally categorized thusly.

Mixed Cycle. Only two of the five sewers who originally demonstrated this pattern continued to do so. One of the new members to share this pattern came from Category I and, therefore, continued the dominant short cycle pattern except for the introduction of one long transition period. The other new employee to this category had shown a variable cycle previously and now a more defined pattern could be discerned.

Variable Cycle. Membership in this category dropped from 41% to 23% with only two of the nine original members continuing to display this pattern. On the other hand, three employees showed this pattern who had not done so previously.

Randomness of Performance

The randomness of the rates over time was explored within the context of these performance categories. The results are displayed in Table 19 and the distribution by category are presented in Table 20. Overall, 55% of the employees performed nonrandomly while 45% did so randomly.

Nothing conclusive could be said concerning a particular runs test result and its dominance in any one category. One exception was that the two employees in Category II had output that was random and three of the four in Category III had nonrandom output.

Level of Performance

Mean performance levels were determined for each individual over her final two-year period. These are given in Table 19 along with relative rank. No particular relationship seemed to exist between average performance and one's performance pattern (see Table 21).

Consistency of Performance

Variability in performance was established for each sewer in terms of standard deviation which is displayed in Table 19. Table 22 exhibits the distribution of employees by category based on their consistency level in comparison to the group average standard deviation. Generally speaking, those in Categories I and III (short cycles dominated) showed high consistency while the two employees in Category II performed with relatively low consistency.

Table 19

Performance Information by Category--

Sewers/Final Two Years

Subject	Mean (Rank)	Standard Deviation (Rank)	Runs Test
Category I--Short Cycle			
2	4.74 (21)	.17 (3)*‡	Nonrandom
3	3.52 (5)	.12 (1)‡	Random
5	4.20 (15)	.18 (5)	Random
6	4.30 (19)	.16 (2)‡	Nonrandom
7	3.47 (4)	.26 (11)	Random
9	3.84 (10)	.28 (12)‡	Nonrandom
10	3.64 (8)	.24 (9)‡	Random
12	4.32 (20)	.20 (6)	Nonrandom
15	3.82 (9)	.48 (20)	Nonrandom
16	3.91 (13)	.54 (21)‡	Random
18	5.38 (22)	.17 (3)*‡	Nonrandom
Category II--Long Cycle			
13	3.92 (11)	.39 (18)*‡	Random
19	4.08 (14)	1.07 (22)‡	Random
Category III--Mixed Cycle			
1	3.59 (6)	.39 (18)*	Nonrandom
8	4.27 (17)	.23 (8)‡	Random
14	3.01 (1)	.29 (13)*‡	Nonrandom
20	4.25 (16)	.25 (10)‡	Nonrandom
Category IV--Variable			
4	3.61 (7)	.32 (15)	Random
11	3.22 (2)	.22 (7)	Random
23	3.95 (12)	.29 (13)*‡	Nonrandom
25	3.46 (3)	.34 (17)	Nonrandom
27	4.29 (18)	.32 (15)	Nonrandom

*Ties.

‡Results same as initial two years.

Table 20

Distribution of Sewers by Category and Runs Test Results--Final Two Years

Runs Test Results	Category I	II	III	IV
Random	5	2	1	2
Nonrandom	6	0	3	3

Table 21

Distribution of Sewers by Category and Average Performance--Final Two Years

Average Performance	Category I	II	III	IV
High	5	1	2	1 $1=\bar{X}$
Low	6	1	2	3

Table 22

Distribution of Sewers by Category and Consistency--Final Two Years

Consistency	Category I	II	III	IV
High	9	0	3	2
Low	2	2	1	3

Distribution of Rates

Individual frequency distribution information was formulated and is displayed by category in Table 23. Eighteen of the 22 sewers showed varying degrees of negatively skewed distributions ranging from -.07 to -5.47. Two of the five subjects in Category IV showed negatively skewed distributions while the other two of the positively skewed distributions were in Category I.

Leptokurtic distributions prevailed throughout the categories. Only three of the subjects had distributions which were flatter than normal.

Individual Employee Descriptors

No relationship appeared to exist between seniority and category. Each one was represented by employees of varying lengths of employment. In addition, although the majority of sewers worked on T-shirts,

Table 23

Properties of Individual Rate Distributions

by Category--Sewers/Final Two Years

Subject	Mode	Range	Skew-ness	Kurtosis
Category I--Short Cycle				
2	4.72/4.82	1.01	-0.84	+1.98
3	3.49	0.85	+0.14	+2.50
5	4.20	1.18	-0.07	+2.01
6	4.36	1.05	-0.75	+2.47
7	3.50/3.52/3.56/3.62/3.68	1.73	-1.96	+6.89
9	3.89	2.57	-5.47	+39.45
10	3.58	1.80	-0.14	+4.51
12	4.47	1.22	-1.82	+5.46
15	3.67	4.47	+2.78	+19.49
16	4.11	5.73	-0.61	+19.58
18	5.30/5.49	1.03	-1.06	+2.82
Category II--Long Cycle				
13	4.07	2.20	-2.01	+4.15
19	4.66	3.11	-0.84	-1.11
Category III--Mixed Cycle				
1	3.44/3.62	2.87	-1.86	+7.87
8	4.24/4.31/4.33/4.37/4.42	1.08	-0.50	-0.10
14	3.03/3.10	2.46	-4.51	+26.21
20	4.36	1.39	-0.36	+0.14
Category IV--Variable Cycle				
4	3.49	1.84	+0.47	+1.06
11	3.31	1.09	-0.21	-0.27
23	3.90	1.90	+1.08	+3.90
25	3.55/3.62	1.70	-0.57	+0.07
27	4.26/4.31/4.32/4.45	2.43	-1.85	+8.33

no particular operation dominated any one performance category. These data are displayed in Table 24.

Group Analyses/Sewers--
Final Two Years

Seniority and Level of Performance

A nonsignificant correlation, r (20) = -.22, p > .10, was found between seniority and average output for the sewers as a group. This was similar to the result from the first two years.

Level and Consistency of Performance

No relationship was found between these two variables (r (20) = -.11, p > .10). This was consistent with the results for both the sewers and nonsewers during the first two years. Figure 4 is a Box and Whisker display of the mean, standard deviation, and output range for each sewer.

Level and Randomness of Performance

Once again, no significant relationship was found with a point-biserial correlation (r (20) = .29, p > .10). This duplicated previous results between average output and the randomness of the rates.

Consistency and Randomness of Performance

Another nonsignificant relationship existed between the variability and the randomness of performance (r (20) = -.20, p > .10) for this group. This was similar to the results for the first time period.

Table 24

Employee Descriptors by Category--

Sewers/Final Two Years

Subject	Category	Operation*	Seniority (Months)
Category I--Short Cycle			
2	T-Shirts	DSN	129
3	T-Shirts	DN	204
5	T-Shirts	HZ	192
6	T-Shirts	HZ	68
7	T-Shirts	HZ	28
9	T-Shirts	DSLG	201
10	T-Shirts	DSLG	128
12	T-Shirts	DSLG	70
15	T-Shirts	JJB	
16	T-Shirts	JJB	
18	T-Shirts	DSLG	
Category II--Long Cycle			
13	T-Shirts	DSLG	58
19	T-Shirts	DR	187
Category III--Mixed Cycle			
1	T-Shirts	DSH	145
8	T-Shirts	DSLV	55
14	T-Shirts	DSLG	29
20	Athletic Shirts	2A	58
Category IV--Variable Cycle			
4	T-Shirts	DN	26
11	T-Shirts	DSLG	127
23	Pajamas	JJB	55
25	Briefs	CZE	205
27	Pajamas	DP	69

*See Table 1 (p. 18) for a description of these operations.

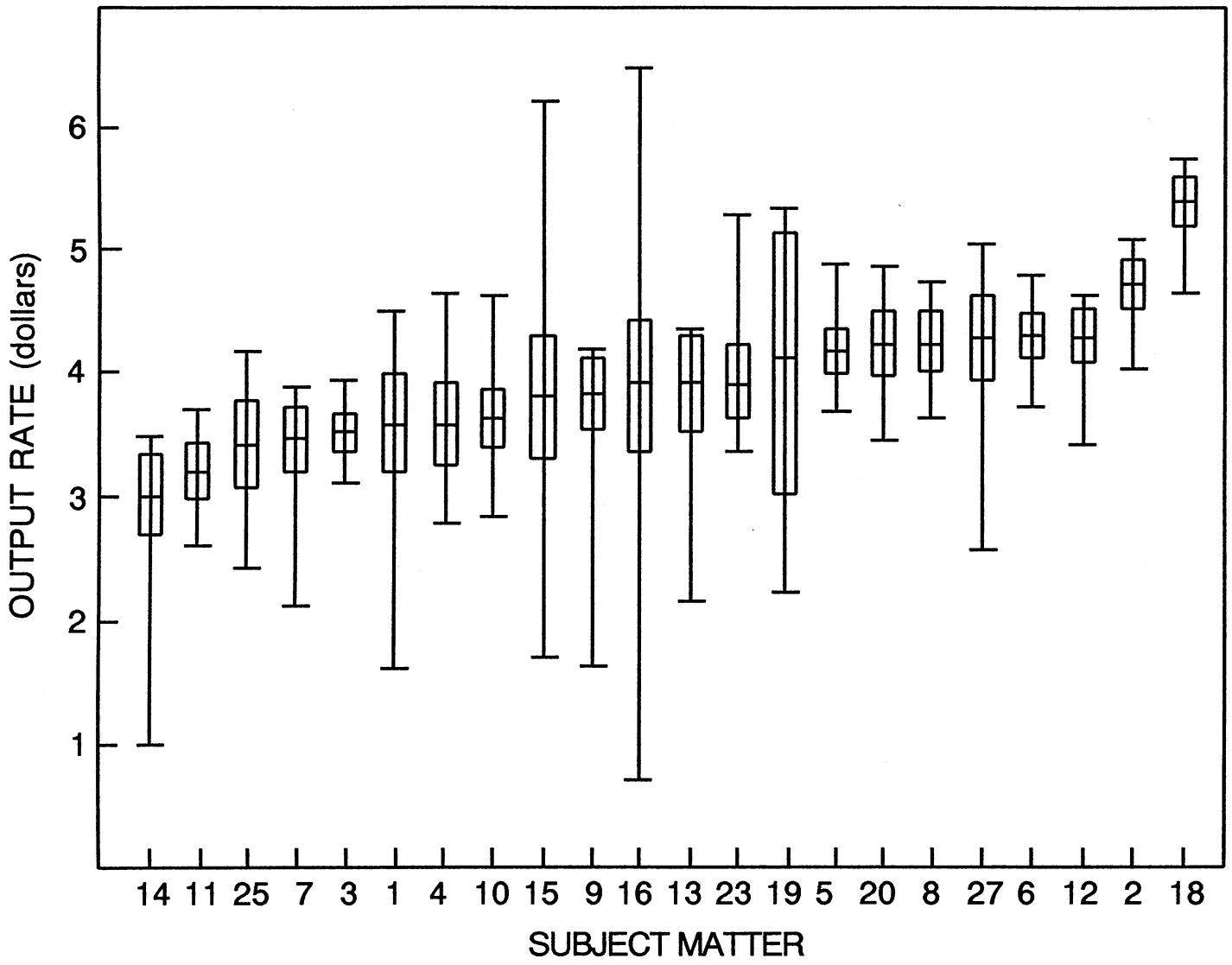

Figure 4. Box and Whisker Graph: Sewers/Final Two Years

Level and Distribution of Performance

Finally, no relationship was found between average output and the skewness of the frequency distribution (r (20) = .12, p > .10). This too replicated previous results of the study.

In summary, no relationship was found between job tenure and output level, and none had been expected. Further, no significant correlational results were found between various performance measures for the sewing group when past researchers such as Applewhite et al. (1965), Bedford (1922), Bliss (1931), Rothe (1970), and Yoder (in Rothe, 1946) have suggested that there might be some. However, the results found with the data from the final two years were similar to the results of the initial two years, suggesting some consistency over time in the relationships between these performance measures, at least, for the sewer group.

Intra-Individual Analyses/Nonsewers--
Final Two Years

Patterns of Performance

In the nonsewing group, 37.5% displayed a performance pattern which was similar to their initial one. This was in comparison to 27.3% of the sewers who has similar patterns during both time periods. Categories I and III were the ones to gain in terms of membership. One important observation was that none of the nonsewers showed long transition periods and thus none was allocated to Category II. Table 25 shows the pattern assignments for each employee along with the gains and losses for the various categories.

Table 25

Distribution of Nonsewers by Performance Category: A Comparison of Initial Two Years to Final Two Years

Initial Two Years Members	Final Two Years Old Members	Final Two Years New Members
Category I--Short Cycle		
28		30 (III)*
31	31	40 (II)
32	32	37 (III)
33	33	34 (III)
35		
46	46	
n = 6	n = 8	
Category II--Long Cycle		
40	--	--
44	--	--
n = 2	n = 0	
Category III--Mixed Cycle		
30		28 (I)
34		35 (I)
37		36 (IV)
39		38 (IV)
45	45	44 (II)
n = 5	n = 6	
Category IV--Variable Cycle		
29	29	39 (III)
36		
38		
n = 3	n = 2	

*Original category.

Table 26 indicates the similarities and differences in the distributions of these two groups of workers. Both had 50% of their respective employees displaying short transition cycles. Only two subjects overall showed long cycles and the remainder either had mixed or variable cycles with a smaller percentage of nonsewers than sewers falling into Category IV.

Table 26

Distribution of Sewers and Nonsewers Across Categories

Category	Sewers	Nonsewers
I	11/50%	8/50%
II	2/9%	0/0%
III	4/18%	6/37.5%
IV	5/23%	2/12.5%

Short Cycle. Fifty percent of the nonsewers (8) performed with short transition periods. Of the six who were originally in this category, two-thirds of them repeated their pattern. This was the largest percentage of employees to do so.

Long Cycle. None of the nonsewers showed this pattern. One of the original long cycle workers showed a short cycle pattern in the replication while the second exhibited a mixed cycle.

Mixed Cycle. This short cycle dominant category garnered the second largest number of nonsewers (6) during this time frame. However, only one was a repeat and the others came from each of the other categories.

Variable Cycle. Only two nonsewers demonstrated this varied pattern. Of these, only one was an original member of the category.

Randomness of Performance

Nonrandom patterns were presented by 56% of the nonsewers while 44% showed random output. Tables 27 and 28 indicate this. In Category I, half of the subjects had random output and half had nonrandom. Further, while nonrandom output dominated Category III, random performance was indicative of Category IV. On the whole, 56% of the nonsewers showed consistent results across the initial and final two years. Six continued a nonrandom pattern while three remained within random status. These employees' results are indicated in Table 27.

Levels of Performance

High performers tended to demonstrate Category I patterns (6 of 9 nonsewers) while four of the seven low performers were found in Category III. In addition, these four employees constituted two-thirds of the membership in that category. Table 29 exhibits this information.

Table 27

Performance Information by Category--

Nonsewers/Final Two Years

Subject	Mean (Rank)	Standard Deviation (Rank)	Runs Test
Category I--Short Cycle			
30	4.19 (7)	.17 (6)	Nonrandom
31	4.55 (8)*	.14 (3)	Nonrandom
32	4.59 (10)	.10 (1)	Random
33	4.60 (11)	.11 (2)	Random
34	4.88 (14)	.45 (13)	Random
37	5.00 (15)	.76 (16)	Random
40	3.01 (3)	.21 (7)	Nonrandom
46	4.55 (8)*	.16 (4)*	Nonrandom
Category II--Long Cycle			
---	---	---	---
Category III--Mixed Cycle			
28	3.26 (4)	.30 (8)	Nonrandom
35	7.15 (16)	.40 (11)	Nonrandom
36	2.73 (1)*	.16 (4)*	Nonrandom
38	4.84 (13)	.40 (11)	Nonrandom
44	2.73 (1)*	.61 (15)	Nonrandom
45	4.08 (6)	.46 (14)	Random
Category IV--Variable Cycle			
29	4.65 (12)	.40 (11)	Random
39	3.30 (5)	.37 (9)	Random

*Ties.

Table 28

Distribution of Nonsewers by Category and Runs Test Results

Runs Test Results	Category I	II	III	IV
Random	4	0	1	2
Nonrandom	4	0	5	0

Table 29

Distribution of Nonsewers by Category and Average Performance--Final Two Years

Performance	Category I	II	III	IV
High	6	0	2	1
Low	2	0	4	1

Consistency of Performance

The distribution of nonsewers among the pattern categories based on variability was almost identical to that of performance level (see Table 30). The more consistent performers tended to show short transition periods while three-fourths of the low consistency performers demonstrated mixed or variable patterns.

Table 30

Distribution of Nonsewers by Category and Consistency--Final Two Years

Consistency	Category I	II	III	IV
High	6	0	2	0
Low	2	0	4	2

Distribution of Rates

Nine of the 16 nonsewers had negatively skewed distributions: four of eight in Category I, four of six in Category III, and one of two in Category IV. Thus, Category III is the only one in which this type of distribution showed any relationship with a performance pattern: four negatively and two positively skewed distributions. Table

31 shows these results. With one exception, all of the nonsewers indicated distributions which were more peaked than normal. This was true across all categories.

Individual Employee Descriptors

Again, the range of employee tenure was represented in each of the categories. It should be remembered that the newest employee had 3¼ years of experience at the onset of the study. Table 32 may be referred to for this information.

The garment on which most (10) of the nonsewers worked was the athletic shirt. Five of the six employees in Category III, both of those in Category IV, and three of the seven in Category I did this. All four of the T-shirt workers were found in Category I. All of those on the athletic shirt line worked as folders, with one exception, so the distribution of particular job operations across performance categories was similar.

Group Analyses/Nonsewers--
Final Two Years

Seniority and Level of Performance

The relationship between these two variables for the group of 16 nonsewers was found to be nonsignificant (r (14) = .41, p > .10). Thus, no relationship appeared to exist between the amount of time one has performed those operations and their average output rates.

Table 31

Properties of Individual Rate Distributions

by Category--Nonsewers/Final Two Years

Subject	Mode	Range	Skew-ness	Kurtosis
Category I--Short Cycle				
30	5.35	1.36	-2.99	+16.43
31	5.28	1.22	+0.82	+8.01
32	5.30	0.54	-0.85	+0.94
33	5.34	0.61	+0.10	+1.14
34	5.69	3.65	-0.81	+6.99
37	5.54/5.46/5.53/5.94/ 6.08/6.11/6.76	7.18	-1.31	+10.58
40	3.27	0.99	+0.15	-0.39
46	5.20/5.23/5.26/5.66	1.30	+0.19	+5.66
Category II--Long Cycle				
--				
--				
Category III--Mixed Cycle				
28	3.90	2.80	-2.22	+12.56
35	8.23	2.92	-2.29	+8.97
36	3.19	1.34	-0.55	+5.11
38	5.60/5.89/6.02	2.08	-0.13	+0.72
44	3.35	5.73	+0.83	+15.57
45	4.91	2.78	+1.74	+4.94
Category IV--Variable Cycle				
29	4.86	2.76	+1.44	+5.01
39	3.95	1.99	-0.67	+0.91

Table 32

Employee Descriptors by Category--

Nonsewers/Final Two Years

Subject	Category	Operation*	Seniority (Months)
Category I--Short Cycle			
30	T-Shirts	UL	171
31	T-Shirts	UL	150
32	T-Shirts	AJS	137
33	T-Shirts	AJS	137
34	Athletic Shirts	WIBB	221
37	Athletic Shirts	WIBB	65
40	Athletic Shirts	WIBB	54
46	T-Shirts	UL	280
Category II--Long Cycle			
--			
--			
Category III--Mixed Cycle			
28	Athletic Shirts	UUU	39
35	Athletic Shirts	WIBB	182
36	Athletic Shirts	WIBB	165
38	Athletic Shirts	WIBB	64
44	Athletic Shirts	WIBB	47
45	Pajamas	WIBB	68
Category IV--Variable Cycle			
29	Athletic Shirts	WIBB	67
39	Athletic Shirts	WIBB	61

*See Table 1 (p. 18) for a description of these operations.

Level and Consistency of Performance

The Box and Whisker graph presented in Figure 5 shows the average performance, standard deviation, and range of output for each of the nonsewers during this time period. No relationship was found between average output and consistency of these rates (r (14) = .12, p > .10).

Level and Randomness of Performance

There appeared to be no connection between average output and whether or not the run is random as measured by a point-biserial correlation (r (14) = -.15, p > .19). This corresponded to the results obtained with the other data sets.

Consistency and Randomness of Performance

Another nonsignificant relationship was found between the consistency of output, as measured by standard deviation, and the randomness of the rates over time (r (14) = .26, p > .10). This too was similar to the results from the other samples in this study.

Level and Distribution of Performance

Finally, average output did not seem related to the skewness of the output frequency distributions (r (14) = -.24, p > .10). Thus, no indication of a restriction of output appeared (Bliss, 1931; Rothe, 1946).

Final Two Years Reviewed--Sewers and Nonsewers

To recapitulate, 50% (11) of the sewers and 50% (8) of the non-

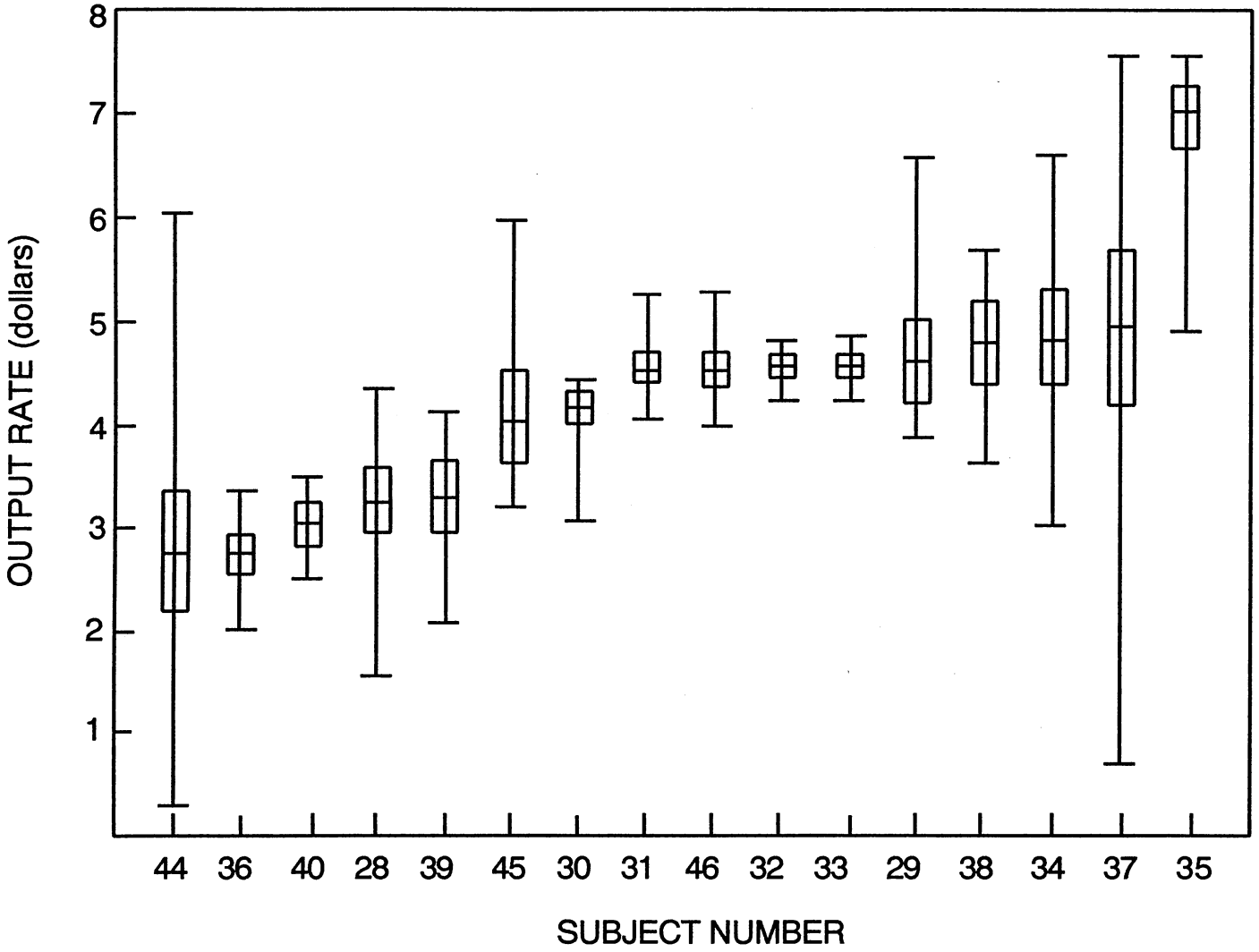

Figure 5. Box and Whisker Graph: Nonsewers/Final Two Years

sewers showed a short transition cycle (Category I) performance pattern. However, whereas the next largest group of sewers (23%) displayed the variable cycle (Category IV), only 12.5% (2) of the nonsewers did so. Instead, 37.5% (6) of the nonsewers indicated a mixed cycle (Category III) which featured short cycles with one longer transition period. Table 33 presents these data.

In each of the two groups, 45% had random changes in output while 55% showed nonrandom output. Neither runs test result dominated any of the performance patterns for the sewers. However, five of the six nonsewers in Category III showed nonrandom changes, and the two in Category IV had random results.

No relationship existed between average output level and the performance pattern for the sewers. However, three-fourths of the nonsewers had high averages in Category I while four of the six in Category III had averages below the group average.

The majority of the sewers and nonsewers in Category I and three of the four sewers in Category III showed relatively high consistency in their output. In contrast, the two sewers in Category II, four of the six nonsewers in Category III, and the two in Category IV performed with low consistency.

A large number of sewers and nonsewers had frequency distributions which were negatively skewed. This type of distribution dominated Categories I, II, and III for the sewers and Category III for the nonsewers. Further, except for one category, most of the distributions for both groups were leptokurtic.

No further relationships seemed to exist, except that most of the folders (7 of the 10) showed mixed and variable cycle types of pat-

Table 33

Summary of Predominant Results for Sewers and Nonsewers by Category--Final Two Years

		Sewers N = 22	Nonsewers N = 16
Intra-Individual			
Patterns of Performance			
Short Cycle	I	50% (11)	50% (8)
Long Cycle	II	9% (2)	0% (0)
Mixed Cycle	III	18% (4)	37.5% (6)
Variable Cycle	IV	23% (5)	12.5% (2)
Randomness of Performance			
Runs Test		45% Random	44% Random
By Category		No Relationship	I No Relationship III Nonrandom IV Random
Level of Performance			
By Category		I No Relationship II No Relationship III No Relationship IV No Relationship	High Mean -- Low Mean No Relationship
Consistency of Performance			
By Category		I High Consistency II Low Consistency III High Consistency IV No Relationship	High Consistency -- Low Consistency Low Consistency
Distribution of Rates			
By Category			
Skewness		I Negatively Skewed II Negatively Skewed III Negatively Skewed IV No Relationship	No Relationship -- Negatively Skewed No Relationship
Kurtosis		I Peaked II No Relationship III Peaked IV Peaked	Peaked -- Peaked Peaked

Table 33. Continued.

	Sewers N = 22	Nonsewers N = 16
Descriptors		
By Category		
Tenure	No Relationship	No Relationship
Job Category	No Relationship	I--No Relationship III & IV--Athletic Shirts
Job Operation	No Relationship	I--No Relationship III & IV--Folders
Group Correlations		
Seniority and Mean Output	-.22	+.41
Mean Output and Standard Deviation	-.11	+.12
Mean Output and Randomness	+.29	+.15
Standard Deviation and Randomness	-.20	+.26
Mean Output and Skewness	+.12	-.24

terns. No significant correlations were found between the various performance measures (e.g., mean output and consistency or randomness).

CHAPTER IV

DISCUSSION

It is generally assumed that well-learned habits or "maintenance behaviors" are displayed in a reliable manner over a long period of time. This is particularly so when the situation is fairly stable, routine, and unchanging. A further common assumption is that the variations which do occur are random. This is important since performance is often used as a criterion for validation purposes and is directly related to the confidence one has in its stability.

The present study examined the temporal consistency of output rates at the idiographic level in a situation where the working conditions were stable and an effective incentive was in place. The tasks were well-learned and only their complexity differed, that is, the nonsewing tasks were somewhat simpler than the sewing ones. This was a significant opportunity to observe and investigate routine behaviors as they occur in a real world situation.

The focus was on changes in performance, patterns of change. Further, other measures of performance, such as average output, were related to these patterns and a replication study was conducted in order to determine whether the results obtained during the first two years would be duplicated with another sample of their output behavior.

The primary issue was the consistency of the output rates over time. Since an effective piece rate incentive was in effect and the operators were very aware of their earnings, predictable patterns might have emerged. For instance, a week of "psychologically" low output may have been followed by a response of high output the next week, or every fourth week might have shwon as increase. However, the data revealed no consistency in patterns of output fluctuation in spite of the fact that previous research had revealed substantial consistency in the level of productivity observed from one week to the next.

The study attempted to develop categories of behavior which were descriptive of the changes in magnitude and duration of change observed in production data. Based on the behavior of the sewing group, this effort resulted in four categories which also were found to be applicable to the nonsewing group. One interesting finding was that, percentagewise, more than twice as many nonsewers as sewers showed patterns of change that were short in duration (Cateory I). They also demonstrated short cycle dominant output (Categories I and III) at a much greater rate than the sewers. Although no relationship was found between various sewing operations and performance change, the simpler, more routine tasks performed by the nonsewing group seemed to be linked with shorter durations of change disturbances. This may suggest that changes in behavior over time is, at least in part, task-related.

The randomness of changes in output over time was another issue that was explored. From one point of view, performance is assumed to be consistent and it is believed that the appearance of variability

(change) in behavior is a random occurrence. "Spontaneous" changes in the individual are usually the suggested cause of these differences. However, this may not be an appropriate attribution.

The majority (59%) of sewers displayed random behavioral changes but with no particular link to any performance category. In contrast, the majority of nonsewers (62.5%) had nonrandom output and these individuals tended to be found in those performance categories which had some type of "pattern" in the change behaviors (Categories I, II, and III). Again, this may indicate that change in habitual behavior is not only related to or influenced by the individual but also to the complexity of the task performed.

To elaborate, the sewing operations may be considered more complex in that the psychomotor skills are necessarily finer and the work is more susceptible to unpredictable variations in materials such as changes in the quality of fabric and thread. Further, these jobs were directly tied to the constraints of machinery. This is in contrast to the nonsewing operations which are simpler, more routine, and more dependent on the capabilities of the worker. These nonsewing tasks also may be more prone to a rhythm that is dictated by the individual. So, although the operations remained virtually unchanged and an effective wage incentive was in place for both groups, these variables may have influenced the observed output differences between the two work groups.

It has been suggested that there may be a relationship between mean level of performance and pattern of performance. This was somewhat supported by the data from both types of workers: sewers and nonsewers. Generally, those who were high performers tended to dis-

play short disturbance cycles while the slower workers had long disturbance cycles. Further, no apparent relationship was found between output level and the mixed or variable cycles. This suggests that the faster workers tend to return to their "usual" level of performance more quickly than the slower individuals, regardless of task. This may occur for several reasons. The wage incentive system may encourage a quick return when output drops because of the direct financial loss and since they are already operating at a fast pace, aberrant increases may not be sustained for long periods because of problems with endurance and physical fatigue. Along these lines, one might anticipate that the magnitude of performance change, as measured by the standard deviation of output rates, is linked to the duration of change behavior. However, this was only true for the nonsewers where those with small standard deviations often displayed short disturbance cycles and the long disturbance cycle category consisted of two employees, both of whom had large deviations. A more direct relationship between these two variables may exist for the nonsewers since their tasks are less complex and less susceptible to external influences not within the control of the worker.

In addition, several properties of the frequency distribution such as skewness and kurtosis were examined to see if there was a relationship with certain patterns of performance and change. Researchers have suggested that, depending on the sign, skewness may be indicative of a restriction of output or a lack of motivation and this may be related to performance pattern. However, there was no support for this idea since each performance category contained employees whose distributions varied in terms of degree and direction of skew-

ness. The one exception was the long disturbance cycle (Category II) for the nonsewers. The employees had negatively skewed distributions and they were among the slowest workers. However, this category only contained two people; therefore, any interpretation drawn from these results must be considered as being tentative. In terms of the peakedness, Category II for both groups had leptokurtic or flatter than normal distributions. The shape probably was indicative of the numerous transition rates that were typical of the long disturbance cycle category.

Analyses were conducted to determine if length of tenure, the garment line worked, or the assignment to a specific sewing or nonsewing operation had any relationship to the various patterns of productivity. None was found for the sewers, but an examination of the nonsewing operations found that the bar tackers dominated the short cycle category. Further, these were among the fastest, least variable employees in the group. The operation may be construed as a simple, straightforward one which may support the task-related influence on performance behavior.

Past researchers such as Bedford (1922) and Rothe (1946a & 1970) have suggested that relationships exist between various measures of performance, such as average output and variability. However, this study found no support for this during the first two years. Unexpectedly, a positive correlation was found between seniority and average output for the nonsewers, suggesting that as time went on, they became faster. Since these were experienced employees to begin with, one might predict that they had mastered the task already and their output level had reached a plateau. However, it may be that after having

mastered this relatively unskilled task, the employees created a "quantity" challenge to keep themselves involved in the job. Furthermore, one cannot rule out the possibility of competition among workers contributing to this relationship.

It was hypothesized that the performance patterns found in the first two years would be sustained in the replication study which examined the data from the second two-year period. Further, it was expected that the results of the initial exploratory analyses would be duplicated. For instance, employees who demonstrated random output initially would continue this behavior during the replication facet.

In contrast, however, during the second two years almost 3/4 of the sewers showed output patterns which differed from their initial one. There was a general move away from long disturbances in output. Specifically, many of these occurred when variable patterns transformed into short cycle patterns. This resulted in a jump from 18% to 50% of the sewers having this pattern. This general trend was observed in the nonsewers' group as well. This change was somewhat surprising since these again were experienced employees and one would have thought that their "pattern" would have been rather fixed. In fact, only about 1/4 of the sewers remained in their original pattern categories.

A possible explanation is that changes occurred in the working conditions which impacted on all workers in the sewing group and might underlie this lack of consistency in the two periods. For instance, these changes could include differences in the quality of cloth or thread and the sewing operations would be more susceptible to these occurrences than the nonsewing ones.

It should be noted that none of the nonsewers had long disturbance patterns during the replication and about 10% more of them than sewers remained in their original categories. Although the figures were not significant, this may again point to a general task-related influence on performance with more "stability" being demonstrated by those who performed the less complicated tasks.

The same percentage (55%) of sewers and nonsewers showed nonrandom output with approximately 58% of each group repeating their runs test results. Given the general hypothesis regarding duplication of results, one might have expected at least this rate.

Whereas a predicted relationship was found between performance pattern and level of performance in the initial study, the replication showed no such relationship for the sewers. The only finding which was repeated was that those nonsewers who performed at high rates did so with short disturbance cycles. Further, the only consistent result concerning the variability of performance and category was that those nonsewers in Category I also tended to perform at highly consistent levels. This is one of the few predicted relationships which actually was supported by the data.

Very little can be said about the distribution of rates and their relationship to performance categories over the two time periods. One exception was that the peaked distributions predominated Categories I, III, and IV for both groups. This might indicate that the magnitude of the transition rates was not that large, negatively or positively. Thus, the tails of the distributions around the mean remained relatively restricted.

As expected, again no relationship was found between the various individual descriptors and performance category for the sewers. For the nonsewers the significant change occurred in the initial high incidence of bar tackers in Category I and their absence from this category in the replication. However, this can be explained by the movement of workers from other operations into Category I.

Finally, no significant correlations were found among the various performance variables. It should be noted though that a strong, but nonsignificant, correlation was found again between seniority and average level of output. This continued the trend started in the initial two years and suggests that the use of speed as a challenge may be at work.

In general, the results of this study did not support the assumption that the patterns of fluctuation observed in production behavior is consistent over time, at least not at the individual level and by the methods used in this study. That is, output cycles were not nearly as reliable in a test-retest situation as one might have thought. Output may have depended upon habitual behaviors but these varied in magnitude. Further, the changes in these responses did not appear to be very predictable.

Although this study did not investigate possible sources of these behavioral differences over time and reasons for the changes which occurred, it is interesting to speculate on their origins. One way to examine unplanned change in performance is to look at strategies for planned change which very often are directed at four interdependent targets (Levitt, 1965): structure, technology, tasks, and people. One approach to change is to transform the structure. For example, a

modification in organizational design or the development of work teams could influence a subsequent change in performance. Another method to effect change is through technological improvements which could include new equipment, facilities, or workflow. Further, modifications in the actual tasks, such as through redesign or job enrichment can cause changes in behavior. Finally, changes or modifications in the actual workers can result in performance changes. This may be an attempt to modify attitudes, or values, and thus future behavior. Improvements in skills through training, development, and modeling may affect performance as well.

Unplanned changes in performance may also be traced to these same four variables. However, in the present study at least two of the usual components remained stable: structure and technology. Throughout the study they remained constant. Examining the task and people components may be more fruitful in this case.

Although the subjects performed one of two basic, routine tasks--sewing or nonsewing operations--neither changed over the course of the study. But the former operations required more fine motor skills and was a little more complex. The data did reveal some differences between the performance records of these two groups with the nonsewers generally displaying a slightly more consistent pattern in their output. Further, at least one analysis indicated that the output from the bar-tacking operation differed somewhat from the inspect, fold, and bag operation. Thus, the reliability of behavior may be task-related with the simpler, routine tasks being performed in a more consistent manner with few transition rates. However, task complexity can only explain some of the difference in performance reliability,

because even among those employees who performed the same tasks there were individual differences in the magnitude and reliability of behavior over time.

When structure, technology, and tasks are held constant, the workers themselves become a possible source of change in performance. In this study there was no evidence of retraining, development, or other organizationally implemented changes involving these experienced workers. After eliminating these sources which could influence performance variability, one is left with the impression that the observed variability in the performance of a habitual response must then be due to individual differences which may be outside the control of the organization.

Generalizing from an organizational setting, this might suggest that when one is faced with a routine, redundant situation, "maintenance behaviors" are relied upon in order to respond with habitual behaviors and variations may stem from the individual. Further, this root of nonconsistent behavior may not be subject to regulation by outside sources, e.g., an effective incentive system.

"The reliability of job performance is also influenced by both the stability and the general level of worker motivation. Changes in performance are expected to accompany changes in a worker's motivation to produce..." (Rambo, Chomiak, & Price, 1983, p. 79). So another approach to thinking about the origins of performance change may be to look at the definition of performance which comes from the Handbook of Industrial/Organizational Psychology (1976). It states: "Performance = f (aptitude level x skill level x understanding the task x choice to expend effort x choice of degree of effort to expend x choice to per-

sist x facilitating and inhibiting conditions not under the control of the individual" (p. 65).

Taken one at a time, some of these variables may be eliminated as sources of the change which was observed in the employee's behaviors. It would appear that the aptitude level, skill level, and task comprehension of these experienced employees remained relatively constant throughout the study. Further, most likely the inhibiting constraints (such as fabric quality) were relatively stable and the impact of those that did occur was not significant in this study in that the level of analysis (average hourly output determined weekly) and the time frame (two two-year periods) would have minimized much of their effect. This leaves the variables: choice to expend, choice of degree of effort to expend, and choice to persist. The determinants of these three types of choice are labeled motivation. "Motivation is a set of independent/dependent variable relationships that explain the direction, amplitude, and persistence of an individual's behavior, holding constant the effects of aptitude, skill, and understanding of the task, and the constraints operating in the environment" (Campbell & Pritchard in Dunnette, 1976, p. 65).

These variable relationships may be outside the control of institutional powers since an effective incentive system was in effect and yet there were individual differences. These week-to-week fluctuations in behavior must then be related to influences that are person-specific. This may include factors that the individual is exposed to outside the job that might carry over to affect output in a fashion that appears to be unsystematic.

In summary, this study examined a fundamental issue about behavior. Habitual behavior on an individual level was less consistent than might have been expected. Further, although some patterns of output were identified and categorized, membership in these categories was not very stable. The results of the replication did not duplicate the original study to the extent hypothesized either. This might suggest that it is important to recognize individual differences. "The study of individual differences itself is not applied psychology, but it is the presupposition without which applied psychology would have remained a phantom" (Munsterberg, 1913, p. 10).

REFERENCES

Applewhite, P. B., Paulhe, G. P., & Thompson, D. A. (1965). Frequency distribution shape and work output. Perceptual and Motor Skills, 20, 407-408.

Bedford, T. (1922). The ideal work curve. Journal of Industrial Hygiene, 4, 235-245.

Bliss, E. F., Jr. (1931). Earnings of machine tenders and of bench workers. Personnel Journal, 10, 102-107.

Ghiselli, E. E. (1956). Dimensional problems of criteria. Journal of Applied Psychology, 40 (1), 1-4.

Hays, W. L. (1981). Statistics (3rd ed.). New York: Holt, Rinehart, & Winston.

Kunst, E. J. (1941). Variations in work performance under normal industrial conditions. Psychological Bulletin, 38, 530.

Lehmann, E. L. (1975). Nonparametrics: Statistical methods based on ranks. New York: McGraw-Hill.

Levitt, H. (1965). Applied organizational changes in industry: Structural, technological and humanistic approaches. In J. G. March (Ed.), Handbook of Organizations. Chicago: Rand McNally.

Maynard, H. B., Stegemerten, G. J., & Schwab, J. L. (1948). Methods-time measurement (1st ed.). New York: McGraw-Hill.

Munsterberg, H. (1913). Psychology and individual efficiency. New York: Houghton Mifflin Co.

Rambo, W. W., Chomiak, A. M., & Price, J. M. (1983). Consistency of performance under stable conditions of work. Journal of Applied Psychology, 68 (1), 78-87.

Ronan, W. W., & Prien, E. P. (1971). Perspectives on the measurement of human performance. New York: Appleton-Century-Crofts.

Rothe, H. F. (1946). Output rates among better wrappers: II. Frequency distribution shape and work output. Perceptual and Motor Skills, 20, 407-408.

Rothe, H. F., & Nye, C. T. (1958). Output rates among coil winders. JAP, 42 (3), 182-186.

Rothe, H. F. (1970). Output rates among welders: Productivity and consistency following removal of a financial incentive system. Journal of Applied Psychology, 54 (6), 549-551.

Sheridan, C. L. (1971). Fundamentals of experimental psychology. New York: Holt, Rinehart, and Winston.

Siegal, S. (1956). Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill.

Silverstein, A. (1988). An Aristotelian resolution of the idiographic vs. nomothetic tension. American Psychologist, 43 (6), 425-430.

Tukey, J. W. (1977). Exploratory data analysis. Reading, MA: Addison-Wesley.

U.S. Department of Labor (1977). Dictionary of occupational titles (4th ed.). Washington, DC: Government Printing Office.

APPENDIX

SAMPLE OF WEEKLY PRODUCTION EARNINGS REPORT

WEEKLY PRODUCTION EARNINGS REPORT

MPL	EMPLOYEE NAME	SENIORITY	OPN	QTR AV	7	6	5	4	3	2	1	52	51	50	49	48	47
							T-SHIRTS										
		11-17-75	DN	3.03	2.84	3.23	2.60	2.75	2.55	2.63	2.47	2.44	2.67	2.46	2.50	2.51	2.79
		01-26-76	DN	4.83										4.76		4.41	4.82
		03-10-76	DN	3.60	3.29	3.71	3.21	3.44	3.54	3.14	2.97	3.01	3.69	3.67	3.69	3.67	3.48
		05-11-76	DN	2.89	2.10				2.04	.98	1.53	1.17	1.37	1.97	1.18	1.70	
	OPERATION AVG		DN	3.56	2.97	3.55	3.19	3.21	2.88	2.53	2.66	2.43	2.80	3.24	2.67	3.10	3.58
		03-08-76	H2	2.89	2.00	1.55	2.12	1.45						2.00		2.54	2.34
		12-14-76	H2	2.89						.92		.74	.72	.78			
	OPERATION AVG		H2	2.89	2.00	1.55	2.12	1.45		.92		.74	.72	1.39		2.54	2.34
		07-29-77	OP	3.91	4.28	4.08	4.04	3.63	3.70	3.55	3.99	3.66	3.44	3.58	3.45	3.96	3.99
		03-22-71	DSLV	4.41	4.48	4.30	4.24		3.91	4.01	4.08	3.84	3.86	3.60	4.06	4.42	4.26
		08-26-74	DSLV	4.15	3.89	3.67	3.72		4.00	3.73	3.30	3.11	3.76	3.36	3.44	3.76	4.00
	OPERATION AVG		DSLV	4.28	4.19	3.99	3.98		3.96	3.87	3.69	3.48	3.81	3.48	3.75	4.09	4.13
		09-30-75	DSLG	4.93	5.05	5.16	5.19	4.81	4.65	4.59	4.74	4.45	4.57	4.66	4.72	4.59	4.65
		10-27-75	DSLG	5.02	4.86	5.17	5.22	5.16	5.65	4.61	4.54	4.16	4.98	4.90	4.57	5.06	4.56
		05-10-76	DSLG	2.89	2.75	2.68	2.98	1.70	2.44	2.41	2.35		2.75	2.64	2.42	2.07	2.18
		05-25-76	DSLG	4.10	4.14	4.12	4.43	4.87	4.04	3.70	3.77	2.88	3.43	3.67	3.99	3.78	3.98
		07-26-76	DSLG	3.26	3.20	3.28	3.11	3.10	2.81	2.91	2.99	2.78	2.99	2.98	3.10	3.05	3.01
	OPERATION AVG		DSLG	4.04	4.00	4.20	4.19	3.93	3.92	3.64	3.68	3.57	3.74	3.77	3.76	3.71	3.68
		01-14-66	JJB	2.97	2.82	3.11	3.17	3.22	3.26	3.27		2.38	2.87	2.91	2.86	3.00	2.74
		03-08-76	JJB	2.89	2.54	2.51	2.50	2.36	2.33	2.38	2.43	2.15	2.57	2.73	2.61	2.30	2.39
		08-11-76	JJB	3.63	3.59	3.80	3.59	2.76	3.54	3.23	3.20	2.75	3.17	3.30	3.12	3.17	3.33
		02-21-77	JJB	3.20	2.88	3.08	3.15	3.27	2.81	2.79	3.01	2.53	3.05	2.96	2.86	2.65	3.03
		03-11-77	JJB	3.22	3.04	3.19	3.35	3.08	2.97	2.95	3.44	2.62	2.95	3.33	3.19	3.07	1.94
	OPERATION AVG		JJB	3.18	2.97	3.14	3.15	2.94	2.98	2.92	3.02	2.49	2.92	3.05	2.93	2.84	2.69
		05-22-61	DR	4.29	4.35	4.36	4.82	4.49	3.89	3.78		3.40	3.71	3.92	4.44	3.89	4.10
							ATHLETIC SHIRTS										
		07-15-64	ZA	4.07	4.18	4.06	4.28	4.26	3.80	3.68		3.74	3.72	3.91	3.79	3.62	3.76
		01-13-72	ZA	4.75	4.43	4.32	4.53	4.24	4.18	4.27	4.21	4.16	4.46	4.53	4.06	4.24	4.45
		08-02-73	ZA	4.42	4.43	4.52	5.08		4.31	4.18	4.12	4.35	4.24	3.43	3.73	4.34	4.35
		10-04-73	ZA	4.82	4.77	4.70	4.74	4.74	4.48	4.48	4.18	4.32	4.47	4.60	4.39	4.48	4.47
	OPERATION AVG		ZA	4.52	4.45	4.40	4.66	4.41	4.19	4.15	4.17	4.14	4.22	4.12	3.99	4.17	4.26
		08-05-75	ZNL	2.89	2.90	3.05	2.98	2.87	2.82	2.66	2.83	2.85	2.78	2.67	2.84	2.34	2.35
		07-20-76	ZNL	3.06	3.42	3.34	3.11	3.01	3.01	2.67	3.02	2.94	2.96	3.04	2.96	2.78	2.93

VITA

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Doctor of Philosophy

Thesis: AN IDIOGRAPHIC ANALYSIS OF PRODUCTION BEHAVIOR

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