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A DESIGN AND IMPLEMENTATION PLAN FOR A KEYPUNCH UNIT MANAGEMENT SYSTEM INCORPORATING A VARIABLE INCENTIVE WAGE RATE BASED ON INDIVIDUAL PRODUCTIVITY

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Monterey, California

December 1972

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A Design and Implementation Plan for a Keypunch Unit Management System Incorporating a Variable Incentive Wage Rate Based on Individual Productivity

by

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Submitted in partial fulfillment of the
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ACKNOWLEDGEMENT

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I. INTRODUCTION

If each unit of keypunch labor and machinery were more productive, it would then be possible to maintain the current level of output with fewer units of input. Fewer units of input, assuming wages are constant, would result in lower total cost. In terms of microeconomics, the additional output generated by an additional unit of input, say labor, is known as the marginal physical product of labor. Likewise, the cost of producing another unit of output is defined as marginal cost. If the marginal physical product of labor increases due to increases in productivity, the marginal cost is reduced since,

$$\text{Marginal Cost} = \frac{\text{Price Per Unit of Labor}}{\text{Marginal Physical Product of Labor}}.$$

Changes in marginal physical product of labor may be accompanied by an increase in the price per unit of labor as the worker makes a claim on the cost reduction he has made possible. If the increase in price per unit of labor is proportionately less than the increase in the marginal physical product of labor, some cost reduction will be realized. At this point the producer is faced with two alternatives. He can either increase output while maintaining the same total cost or he can produce the same output at a lower total cost. In this thesis the assumption will be that the data processing manager is faced with a fixed workload and will select to produce the same output at a lower total cost.

The goal of this thesis is to demonstrate a method to lower total keypunch costs through increases in the marginal physical product of labor and machinery. This goal will be achieved through improvements in machine performance, workspace environmental changes (lighting, color, etc.), information for employee performance counselling, and an incentive pay plan that financially rewards productive employees. A premise of this thesis is that the benefits resulting from these changes will more than offset the cost of their implementation and use. The chapters that follow will discuss each of the above recommended changes in relation to productivity, discuss implementation where applicable, and, for labor and machinery, project anticipated costs.

Chapter II contains a discussion of the dollar magnitude of keypunch in relation to the overall data processing operation, the range in keypunch installation size, and outlines the data processing organization and job tasks upon which this thesis is based.

Chapter III offers a discussion of the physical environment of the workspace. All facets of the workspace are treated in general as stimulus inputs to the senses of the keypunch operator. This combined stimulus input is discussed in the context of arousal theory. Additionally, the effect of the physical workspace on the worker's motivation to work is discussed in the context of Herzberg's motivation-hygiene theory. Chapter III concludes with specific findings in regard to color, lighting, noise, and music.

Chapter IV consists of a literature review of worker psychology and motivation. It provides a discussion of the worker as an individual and as a member of a work group. Using an excellent survey of available research by Opsahl and Dunnette (1966), the strength of money as a motivator is discussed as a necessary prelude to implementation of an incentive plan. Granting time off from work as an alternative to a financial reward is also discussed. In conclusion, Chapter IV outlines what others have done to encourage increases in worker productivity. This discussion includes most recognized formal plans, a look at a keypunch incentive plan in use at the Navy's Ships Parts Control Center, Mechanicsburg, Pennsylvania, and a summary of a few recent private industry attempts to boost productivity through "job enrichment."

Chapter V contains survey questionnaires designed to measure supervisor and employee "attitude" or "morale" before and after implementation of the recommendations of this thesis. The results of these questionnaires will be offered, in addition to actual labor and machinery reductions, as an indication of the degree to which the goal of this thesis has been achieved.

Chapter VI contains the proposed incentive pay plan. The plan includes a definition of all terms, a discussion of the implementation procedures, input requirements, report formats, time model and employee productivity calculations, and information useful in employee counselling. An optional subsystem of the proposed incentive plan which is designed to provide all necessary keypunch production data input to the Management Utilization and Control Standards Program, or MUACS, is also discussed.

Chapter VII contains a discussion of four keyboard data entry systems: (1) card punch and card verifier, (2) buffered card punch/verifier, (3) key-to-non-compatible and key-to-compatible computer tape, and (4) key-to-disk or drum. The card punch/card verifers and buffered punch/verifiers are treated as minor evolutionary steps since inception of the first machines in the 1890's. Key-to-tape has also been used for many years and its characteristics well documented.[1] Key-to-disk or drum, however, is new and relatively unknown. The main purpose of Chapter VII is to investigate and report on the current level of knowledge and experience regarding key-to-disk or drum systems in order to provide assistance and direction in future selection/procurement actions. The first section of

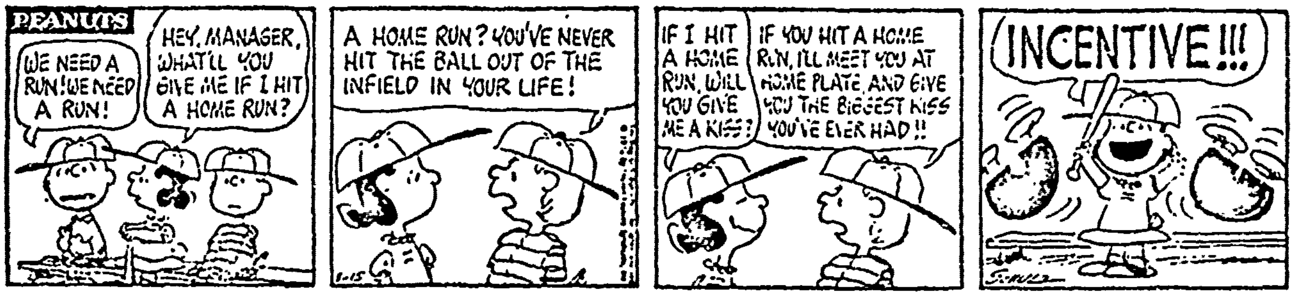
[1]See EDP ANALYZER, Vol. 9, No. 9, September 1971 and DATAMATION, June 1970.

Chapter VII provides a detailed listing of general and specific hardware and software requirements to use in comparisons of different machines. The second section of Chapter VII reviews what actions the Navy has taken to install, test, and use key-to-disk or drum equipment. This review includes a condensation of the test of Key Edit Hardware at the Naval Supply Center, Newport, Rhode Island. The last section reviews the experiences of several civilian firms in installing and converting to key-to-disk or drum hardware.

Chapter VIII contains a discussion of the costs of the four different hardware configurations in comparison with their output potential. In addition, Chapter VIII attempts to project the cost of the proposed incentive plan in terms of the probability of an individual operator exceeding the average productivity level of the installation and receiving an incentive reward.

Chapter IX, the conclusion, contains a summary of the thesis recommendations and a discussion of the Civil Service regulations that provide the environment in which the thesis will be required to function. The conclusion is followed by an Appendix that contains the system flowchart, record and file formats, and the necessary computer programs,

Pay plans where employees receive variable wages based on productivity are by their very nature susceptible to cheating and complaints of favoritism. The data processing manager installing this or any wage incentives system should consider these problems since they will most likely require his close attention. Additionally, data processing management should be wary of giving rise to employee expectations that exceed management's willingness to provide. Charles Schulz has perhaps said this best when:



but,

II. BACKGROUND INFORMATION

The exact number of keypunches and verifiers in use in the United States is unknown, primarily because IBM does not disclose the number of their devices in use. Estimates range from a little over one-half million to one million machines.[2] Of the total dollar shipments of data entry equipment in 1969, Stender (1970) reports that 62% were key-punch type machines, with 46% of these being conventional keypunches, 14% data entry units (keyboard type), and 2% paper tape, a sub-species that will not be considered in this thesis. Concerning the size of installations, Stender (1970) estimates that 30,000 installations have one to five machines, 10,000 installations have six to twelve machines, 6,500 installations have 13 to 50 machines, and 1,700 installations have over 51 machines. A 1970 analysis of budget data by the Diebold Research Program estimates that at least 18% of direct data processing costs are due to data entry operations and that costs are rising at a rate of 5% per year. Personnel costs account for 80% to 90% of the data entry costs.[3]

The keypunch operator is normally organizationally surmounted by many levels of management, each requiring

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[2] EDP ANALYZER, Vol. 9, No. 9, September 1971, p. 7.

[3] Ibid.

information on her performance.[4] The following is a brief outline of the data processing organization and job tasks upon which this thesis is based. Since this thesis will neither analyze alternative organization structures of data processing departments nor analyze the influence of data processing on the total organization's performance, no implication should be made that the following represents the optimal organization or assignment of job tasks.

The Keypunch Operator's prime function is to operate a machine which creates or verifies input records for submission to a mechanized process. The machines may consist of card punching and verifying machines, standard or buffered, or data entry units that utilize disk, drum, or magnetic tape storage.

The Keypunch Unit Supervisor directs the activities of the operators by preparing economic batch sizes, equitably distributing the workload, performing the administrative functions related to labor distribution, reporting employee non-productive time, and, most important, counselling each operator on her performance. The supervisor also performs the management analysis function at the individual job level to maintain the accuracy of the proposed incentive pay system.

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[4]In this thesis the keypunch operator is referred to as "she" since most keypunch operators are female. No intention is implied to restrict women to keypunching or to classify the work in terms of sex.

The supervisor is assisted in this effort by periodic production reports that will be discussed in detail in Chapter VI.

The Head of the Operations Branch is concerned with maximizing the effectiveness of the keypunch unit in the production of technically accurate input records subject to personnel ceiling point, hardware, and budget constraints. The branch head monitors the productivity of the keypunch operation via periodic production reports, and together with the Keypunch Unit Supervisor, will make recommendations on the type of hardware and the proper personnel/machine mix that should be utilized by the installation.

The Director of Data Processing is responsible for managing the data processing installation, maintaining good working relationships with the other departments of the command, and ensuring that achieving data processing's goals occurs simultaneously with achieving the command's goals. The Director's primary goal is to maximize the effectiveness of the installation subject to the budget constraints dictated by higher authority. For keypunch operations, production effectiveness indicators in personnel performance and hardware utilization as described in Chapter VI provide the necessary measurements.

III. THE WORKSPACE

The keypunch operator works in a surrounding physical environment that provides a stimulating input to the various senses of touch, sight, hearing, and smell. When coupled with stimuli from non-physical sources such as anxiety, emotional strain, the resultant arousal level may create a stimulus overload that results in degrading job performance.

Wallace (1971) reports that as a person's arousal or alertness level increases his level of performance increases, but by successively smaller amounts until a maximum is reached. Beyond this point increases in arousal will cause decreases in performance. It is in this area that a stimulus overload exists.

Broadbent (1958) has proposed a single-channel hypothesis as a model to describe human information processing. Halcomb, McFarland, and Denny (1971) discuss this in the context of human time-sharing in vigilance studies. If these studies can be extended to say that the human mind functions along the lines of a single-server, single-channel, real-time computer, the concept of an area of stimulus overload is not only logical, but may someday be measurable as it is measurable today in computers through simulation of real-time applications and queuing formulas.[5]

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[5]for a discussion of simulation of real-time applications and queuing theory see Martin, J., Design of Real-Time Computer Systems, Prentice-Hall, 1967.

In a different approach from the effect of workspace stimuli on a worker's arousal level, Herzberg, Mausner, and Snyderman (1967) have analyzed the effect the physical workspace has on the worker's motivation to work. They found that when feelings of unhappiness where expressed, the feelings were associated not with the work itself but with the conditions surrounding the work. These conditions were interpreted by the worker to be unfair and disruptive, and as such created an unhealthy psychological work environment. Herzberg, Mausner, and Snyderman (1967) refer to the factors that create this unhealthy environment as factors of hygiene. In regard to the physical workspace, the presence of harmful factors of hygiene serves to bring about negative job attitudes, but removal of these harmful factors will only serve to remove the impediments to positive job attitudes, not cause positive job attitudes.

The findings of Herzberg, Mausner, and Snyderman (1967) that the workspace environment functions only as a dissatisfier is in agreement with the distractive nature of a stimulus overload in arousal theory. One difference between the two is the differentiation between the effects of good and bad working conditions. In arousal theory, since no distinction is made between good or bad working conditions, either could provide an overload stimulus input to the keypunch operator's senses that may result in a reduction in her performance. In motivation-hygiene theory, however, bad working conditions reduce motivation while good working conditions play a neutral role.

The approach of this thesis is that if the environment of the workspace is unpleasant in the eyes of the keypunch operator or so stimulating that it dominates her attention, then action should be taken to remove the factors causing the reduction. This removal action may not in itself foster a positive work attitude, but it will inhibit the negative effect the factors may have on the proposals of this thesis.

The following discussion is offered to provide assistance in determining what actions can be taken to improve the physical workspace.

A. COLOR AND LIGHTING[6]

Color can provide a strong stimulus input. Yellows and oranges are considered warm colors that are stimulating. Cool colors such as green, blue, and grey are relaxing. Pure colors are more distracting than subdued tones.

In the workspace, it has been found beneficial for workers to have a cool expanse of wall at least twenty feet away on which to rest their eyes. If the climate is hot, cool walls make it feel cooler while ivory or buff tones give an illusion of warmth.

Lighting should be within a forty to sixty foot-candle range and there are meters available to test installed

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[6]Cutting, R. A., M.D., "Fatigue," The American Peoples Encyclopedia, Grolier Inc., 1963, p. 8-349.

lighting to see if this illumination is being provided. As important is the requirement that the light not be glaring, moving, or flickering.

B. NOISE AND MUSIC

The amount of distraction due to noise is dependent upon the nature of the noise and the worker's attitude towards it. Some people become accustomed to noises that constantly irritate other people. High and low frequency noises and sudden noises above 45 decibels are particularly disturbing.[7] Sound absorbing materials should be used in such situations to deaden the noise. Carpeting the floor will deaden most noises in keypunch, cut down on floor maintenance, and raise the appearance of the installation. If employee participation is permitted in the selection process, carpeting can be useful in raising employee morale.

Music is an unusual paradox. According to Poock and Wiener (1966), rarely have so many people felt so strongly for any entity that does so little towards improving productivity. Commercial music system contractors may promise all the benefits normally associated with music such as improved morale, production, absentee rate, turnover rate, etc. However, Poock and Wiener's studies into the actual effects of music do not support these claims. They report that while most workers desire music on the job, about 10% are

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[7] Ibid., p. 8-350.

annoyed by it, and in some cases music has even been observed to lower the quality of work.

Surface (1951) measured the metabolic rate of subjects performing a steady task under various noise and music situations. A decrease in metabolic rate under the music situation would have indicated the job was easier with the music or that music could be used to increase productivity with no increase in effort expended. The results showed no change in metabolic rate. His conclusion was that while statistical studies have shown an increase in productivity in some factories, these production increases were not achieved without an increase in effort expended.

Smith (1947) studied the effect of music on keypunch operators during breaks and lunch but not during work. An opinion poll of the operators showed 75% wanted the time increased, 90% felt happier on music days, and 50% felt the music had helped their work output. The actual results found no difference in number of cards punched, in the error rate, or in the absentee rate.

IV. THE WORKER

A premise of this thesis is that while the keypunch operator is not viewed as an extension of her machine, her performance in the workspace and her reaction to an incentive plan can be predicted. To assist in this prediction, the worker will be discussed as an individual and as a member of a work group in the context of Atkinson's theories on motivation to achieve success and motivation to avoid failure. The strength of financial rewards to motivate employees to increase productivity will be discussed via the work of Opsahl and Dunnette. A discussion will be presented on time off from work as an alternative to financial reward as an incentive. In conclusion, a review will be offered of what others have done to increase employee productivity. This review includes formal plans, the incentive pay plan currently in use in the keypunch installation at the Navy's Ships Parts Control Center, Mechanicsburg, Pennsylvania, and a few examples of the approach some private industries are currently taking.

A. THE INDIVIDUAL

Contingency Management deals with behavior modification through controlling reinforcements and offers techniques useful to data processing management. According to Malott (1971), Contingency Management first attempts to define its operation through five rules. The first rule is to be consistent. The second rule is to restrict the application to a small area in order to permit the concentration of administrative efforts and to allow workers to concentrate their behavior, learning fewer things, but learning them to a high level of competence. The third rule is to establish functional behavior which Malott (1971) defines as behavior that will continue as a result of reinforcements received from the worker's peer group, work relationships, etc., after the controls are removed. The fourth rule is to consider prerequisite behavior and not attempt to establish a particular behavior pattern before all preliminary behavior patterns have been developed. The last rule is to provide immediate consequences for behavior where after each response, feedback is provided to strengthen correct responses and weaken incorrect responses.

Malott (1971) defines a contigency as the relationship between a behavior and its consequence. There are four different contigencies:

Positive Reinforcement - a reward presented after the behavior is emitted,

Negative Reinforcement - an aversive event removed after the behavior is emitted,

Avoidance - the presentation of an aversive event is delayed or prevented as a consequence of the desired behavior, and

Punishment - an aversive event is presented after the behavior is emitted.

Reinforcers can fall into two categories according to Malott (1971). Primary reinforcers are basic, unlearned reinforcers such as food and water. Secondary reinforcers are learned reinforcers such as money and social approval.

While this thesis does utilize a questionnaire to evaluate employee attitudes before and after implementation, no cyclic, routine methods are provided for analyzing employee behavior. Therefore, the following discussion is offered in an attempt to forecast employee reaction to the implementation of this thesis and assist data processing management in determining which of the prior contigencies and secondary reinforcements should be applied. The normal worker and the marginal worker will be treated separately with the acknowledgement that a large grey area exists between these two groups where management must select the tools to best fit the varying conditions.

1. <u>The Normal Worker</u>

Teevan (1969) states that the normal worker will approach the job with both negative and positive motivations. Some work to gain whatever rewards are available while others work only because if they didn't work, they would fail. He emphasizes that when considering an incentive plan it is important to be aware of the differences between employees who are basically motivated to achieve success and those who are basically motivated to avoid failure because: "If one does not recognize what these latter persons are trying to do, their behavior sometimes makes little sense."[8]

Atkinson, as reported by King (1970), states that one factor of total motivation (TM) is the motivation to achieve success (MS) minus the motivation to avoid failure (MF). King (1970) reports that if a worker measures low in both these traits he most likely falls into the category of the marginal worker, that an operator who measures in the moderate zone will probably be a good average worker, and that an operator who measures high in either extreme can be a disruptive influence that will require close management observation.

According to King (1970), the worker who has a tendency towards a higher motivation to achieve success will thrive on an incentive plan, providing the worker perceives a balance in the plan between his concept of the benefits to be gained (incentive value of success) and his personal estimate of the chances of success (probability of success). Atkinson, as reported by Wallace (1971), states that the incentive value of success and the probability of success can take on values from zero to one and that as the balance between the incentive value of success (IS) and the probability of success (PS) move away from the midrange values about 0.5 in an $IS = 1 - PS$ relationship, the total motivation

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[8]Teevan, R. C., Fear of Failure and General Achievement Behavior, Buchnell University, 1969, p. 1.

of the worker begins to decline. If the incentive value of success and probability of success enter the range outside of 0.1 to 0.9, the worker becomes totally unmotivated to perform. This can be seen in his conceptualized formula of total motivation where:

$$TM = (MS - MF)\ (PS)\ (IS)$$

where:

TM = total motivation,
MS = motivation to achieve success,
MF = motivation to avoid failure,
PS = perceived probability of success,
IS = incentive value of success.

Thus, even though there may be tremendous value in performing difficult tasks (high IS), the motivation to perform these tasks, even by a person motivated to achieve success, will be quite low because of the level of difficulty expressed in the probability of success (low PS). Likewise, such a person does not want to waste his time on easy tasks of little value. A conclusion that might be drawn is that the person who measures high in motivation to achieve success may be initially happy as a keypunch operator but will soon be eager to move on to more rewarding jobs if she perceives the value of success low and the probability of success high. An incentive plan may offer sufficient benefits in recognition, money, and time off to keep her on the job, but, most likely, this operator will push for training on the other data processing machines or as a supervisor, and, if not forth-coming from the installation, will seek employment elsewhere.

Teevan's (1969) studies indicate that the degree to which a person is motivated to avoid failure appears to depend upon how he was treated by those responsible for his upbringing. Studies in early parental behavior have revealed that children of parents that emphasized early achievement tend to score in the higher or lower ranges of measures of fear of failure while children of parents that did not emphasize early development tend to be in the mid-range. The major determanent in whether a person scores high or low in measures of fear of failure appears to be the approach taken by his parents in emphasizing early achievement.

In surveys of both parents and their college-age children by Teevan (1969), a pattern has emerged. In cases of parents that reacted neutrally when the child came up to expectations but punished when he did not, the child tended to score high in fear of failure. Where parents reacted neutrally when their child did not come up to expectations the child tended to score low in measures of fear of failure. Where a combination of punishment and reward were utilized there was no pronounced tendency in the child. Additionally, parents of a lower occupational or educational level who stressed achievement seem to foster higher fear of failure tendencies.

Teevan's work indicates the worker who measures high in fear of failure should be of interest to data processing management because he can demonstrate characteristics that can be violently detrimental to an incentive plan based on performance. Teevan found that these workers prefer situations which do not lead to easy comparisons between themselves and others, a factor to remember when thinking of methods to promulgate performance results. If forced into achievement tasks they may yield outstanding results because they work so hard to avoid failure, but if they do fail, this will be remembered and used to reinforce future desires to avoid such tasks. They tend to volunteer for tasks that are either very easy (where success is assured) or for tasks that are impossible (where the penalties of failure are slight). Thematic apperception test stories by people who measured high in fear of failure displayed central characters that were more pawns than controllers of their environment.[9] Being externally oriented to the reactions of the group around them, such workers tend to conform to the standards of those whom they feel control the immediate rewards of their world, regardless of whether these standards are culturally acceptable. The standard setters may be data processing management, other workers, or people external to the workplace. Such workers tend to be hostile towards authority and lack the desire or ability to be good leaders.

[9]A Thematic Apperception Test is a psychological tool where a subject is given a picture and asked to tell a story about what he sees. The psychologist then analyzes the story by comparing it to various lists of key words.

2. <u>The Marginal Worker</u>

Porter (1970) defines a marginal worker as an employee who historically demonstrates inconsistent attendance at the work place, has failed to meet the established standards of the organization and/or has failed to achieve an adequate level of performance. Motivating this type of employee can present a complex problem to management.

First, Porter (1970) contends, do not assume the marginal worker lacks the intelligence to perform the task. He is likely to be very aware of people and events, and highly sensitive to the slightest cues concerning the impact of his behavior on others. His attitude upon entering the workspace is masked by self-protection defenses that may appear hostile and alienate management. This attitude is generated in the main by his expectation that he will not be treated fairly in relation to other employees and can be especially true if he is also a minority group member.

Expectancy theory, as set forth by Vroom and Campbell and reported by Arvey and Dunnette (1970), distinguishes two types of expectancy of an individual about a task - Expectancy I: belief about whether or not the expenditure of effort will result in effective performance, and Expectancy II: belief about whether being an effective performer will lead to valued rewards. The emphasis is clearly on personal probability estimates where the worker's beliefs regarding whether his effort will result in effective performance has a motivational effect on his performance. Porter and Lawler (1968) support this relationship in their findings that the value of a reward and the perceived effort-reward probability combine to influence effort (and, in combination with ability and role perception, to influence performance). Arvey and Dunnette (1970) have found that in regard to the marginal worker and expectancy theory, Expectancy I may be far more important in influencing job performance. If true, restructuring reward systems may be less useful in motivating this type of worker than explaining to him exactly how his job behavior relates to his becoming an effective performer.

In the context of an incentive plan for the marginal worker, Porter (1970) states that the methods of administering the incentive rewards are more important and should receive more attention than the types of rewards. Fringe benefits, in his opinion, are of little importance to the marginal worker since they are distant in time from his current behavior and they are seldom contingent upon the quantity or quality of performance. Profit sharing plans only induce employees to stay with a company, not work harder. The point Porter (1970) stresses is that the timeliness of the reward is important. An incentive plan for normal workers will not be sufficiently responsive for the marginal worker. Other rewards of a simple nature must be developed so that the incentive can be a reward of recognition.

Porter (1970) believes the incentive should be used with the marginal worker in a fashion approaching the operant conditioning technique of shaping behavior by selectively reinforcing already existing responses in the marginal worker's repertory by applying positive or negative reinforcements as consequences of the behavior emitted. Shaping consists of reinforcing closer and closer approximations of the desired behavior. The reinforcement, according to Porter (1970), may be given on the basis of a schedule of reinforcement. A schedule of reinforcement, according to Reese (1966), is a statement of the contingencies on which reinforcement depends where the contingencies are specified in terms of the number of responses emitted and/or in terms of the passage of time. If the reinforcements used are rewards of recognition, Porter (1970) warns that recognition from management may be accompanied by undercutting from the worker's peers if they feel the reward is unwarranted and the worker may feel insulted if he also feels such recognition is unwarranted. Once the shaping has been completed and the initial behavior pattern has been established, the normal incentive plan should serve as a follow-on to reinforce the marginal worker's efforts over time.

B. THE GROUP

From 1927 to 1932 a series of experiments were conducted at the Hawthorne Chicago Works of the Western Electric Company that were based on the assumption that worker productivity and complaints could be explained in terms of physical working conditions. Wassenaar and Oestreich (1972) report that it is difficult to overestimate the comprehensive nature of the Hawthorne experiments and offer as an example one part of the study which involved an analysis of 86,000 comments made by interviewees on 80 topics during approximately 10,000 interviews.

The experiments at Hawthorne were typical of a school of thought led by Frederick Taylor known as Scientific Management. Proponents of Scientific Management, according to Wallace (1971), believed that efficiency could be increased through careful selection and training of the worker and that the worker would put forth extra effort on the job in order to maximize his economic gain. An opposing school of thought at the time delt with Classical Organization Theory. The Classicist believed the structure of the organization was most important. Centralized or decentralized, tall or flat, and optimal sub-unit size were the critical elements. Wallace (1971) reports that, like the Scientific Manager, the Classicists gave little attention to the worker as a person.

The results of Hawthorne raised serious questions that could not be answered by either group. For example, Wassenaar and Oestreich (1972) report that three experiments were conducted to determine the effect of illumination on productivity. Two groups were established. One group experienced no illumination changes while the other group was subjected to changes in illumination varying between three and ten foot-candles. The results were that: "both groups showed a slow but steady increase in productivity. Only after the illumination of the experimental group was decreased to that of moonlight did the group's output decrease."[10] Other experiments concluded with similar results. Clearly some heretofore unknown powerful factors were operating to cause the increases in productivity.

Wassenaar and Oestreich (1972) conclude that the Hawthorne experiments taught the importance of the informal group in on-the-job worker performance. They state these groups form spontaneously, that group members frequently develop substantial unity and cohesiveness of thought and action, and that the group can exert highly effective pressures to enforce and maintain group norms and goals.

Studies performed since Hawthorne, as reported by Forward (1969), have shown that group achievement motivation is not solely a function of the individual motives which members bring into the group situation. Rather, as Zander (1970) states, the group as a functioning body has its own achievement motives that can either supplement or contradict the effect of the personal motives of the members.

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[10] Wassenaar, D. J. and Oestreich, H. H., The Hawthorne Studies: A Summary and Critical Evaluation, Lansford Publishing Company, 1972, p. 2.

Wallace (1971) reports that because of Hawthorne, a new doctrine arose dealing with human relations, but that the Human Relations school became the other extreme - people without organizations. A later school dealing in human potentialities has since argued that the Human Relations school only gives the worker the impression he is important and what is really needed is more emphasis on meaningful worker participation.

Each of the above schools of thought emphasize elements important to a data processing installation. Employee selection and development, the effect of the organization on the employee and the employee's effect on the organization are important. Group size is a factor in the extent individual motives can interact with and either supplement or contradict group motives. Wallace (1971) has found that small work groups have less need for dominant leadership and experience less attitude change as conditions change while Rothe (1960) has found that small groups take higher pride in success and produce about 6% more than large work groups regardless of the pay system.

Zander (1970) has found that while individual motives and group motives are independent, they display identical characteristics. Like individuals, groups can be motivated to achieve success or motivated to avoid failure. The motivational direction of one group may be quite different from another even though both have members in common.

Motivation to achieve success has been observed to be more likely aroused in a strong group than a weak one, in a successful group than in a failing one, in core members than in peripheral members, and in groups where success is perceived to be the normative group response.

There may be considerable difference from one group to another on whether the members emphasize their desire for group success or personal achievement. Studies by Zander (1970) have shown a tendency for more mature, more competent males to have interests in group achievement and for younger, less capable females to polarize about desires for personal success. Realizing this, data processing management should ask what can be done so that the keypunch operators can achieve their own goals best while directing their efforts towards organizational objectives.

The extent of member desire for group success is measurable in group output, and in some cases, member self-regard is affected by the degree of group performance. In the Hawthorne studies, Wassenaar and Oestreich (1972) state that the customs and values established by the group were more important to individual members than working conditions or cash benefits. However, one factor that did show a continuous relationship with improved output, according to Sutermeister (1963), was the mental attitude of the workers. His hypothesized cause of this attitude change was that the workers were responding favorably to the increased attention they were receiving.

The effects of group motivation are important to an incentive plan because if the group decides to reject the plan by condeming the rate busters, little will be gained. If small groups of equivalent competence can be formed, group motivation may be hightened through competition and the publication of general group achievement levels. Whatever the situation, apparently it is not sufficient that most individuals express an interest in an incentive plan; the group as one body must also support the plan.

C. THE STRENGTH OF MONEY AS A MOTIVATOR

Opsahl and Dunnette (1966) define an incentive as: "an object or external condition, perceived as capable of satisfying an aroused motive, that tends to elicit action to obtain the object or condition."[11] Financial rewards are commonly used as the incentive object, but they report that in spite of the many incentive plans that have been implemented during this century and the huge sums of money that have been spent, very little is known about how money interacts with the behavior of the worker. In their report they have listed five major hypotheses concerning the role of money in affecting worker on the job behavior. These hypotheses are:

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[11] English, H. B. and English, C. A., A Comprehensive Dictionary of Psychological and Psychoanalytical Terms, McKay, 1958.

1. <u>Money as a Generalized Conditioned Reinforcer</u>

Many support the hypothesis that money acts as a generalized conditioned reinforcer because of its repeated parings with various primary reinforcers.[12] Generalized because it applies to many reactions. Conditioned because it has no initial intrinsic value of its own but must be repeatedly associated with or paired with items of value in order to eventually envoke a response when present alone. Most of the knowledge about the strength of such reinforcers, Opsahl and Dunnettee (1966) conclude, has unfortunately been derived from studies with animals and the results involving money have been limited and inconclusive.

2. <u>Money as a Conditioned Incentive</u>

If a child performs some act that pleases its mother, she may reward it with a cookie and thereby reduce a primary drive - hunger. If the child liked the cookie, the expectation of a second cookie may provide the incentive to perform the act again. Once this primary incentive is established, it may be repeatedly paired with money until money also becomes an incentive by conditioning. This hypothesis is very similar to the hypothesis of conditioned reinforcement just discussed. The main difference being that here money is treated as an object capable of affecting drive reduction.

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[12]Opsahl and Dunnettee (1966) reference Holland, Skinner, Kelleher, Goleub.

3. Money as an Anxiety Reducer

When a child sees a parent experiencing a painful stimulus, such as the mother burning her hand on the stove, the child notices the emotional expression exhibited. Later when similar emotional expressions are displayed in pairings with a lack of money, the child feels anxiety related to the prior painful experiences. As an adult this person finds money to be an effective anxiety reducer. Opsahl and Dunnettee (1966) conclude, however, that there is no firm evidence to either support or disclaim this theory.

4. Money as a "Hygiene Factor"

Opsahl and Dunnettee (1966) refer to Herzberg, Mausner and Snyderman in a hypothesis that money can only be used to avoid dissatisfaction ("Disease") and not to promote increased motivation ("Health"). Again, they state little evidence is available to support this hypothesis.

5. Money as a Tool to Gain Desired Outcomes

Vroom has offered a hypothesis that Opsahl and Dunnettee (1965) support as being most likely. According to Vroom, money is given a value equal to its perceived ability to obtain other desired outcomes such as security, a new car, a house, etc. In an approach similar to Atkinson's total motivation theory, Vroom equates the probability of a worker making a money-seeking response to the strength of his desire for the outcome multiplied by his personal probability estimate that these responses will successfully lead to more money. In the context of an incentive plan this hypothesis is the best alternative interpretation since it will equally support any of the previous hypotheses about the value of money and its role in worker on-the-job behavior.

The basis of virtually every payment scheme is the equality of benefit received (payment) for benefit contributed (productivity) in relation to other worker/employer alternatives. If this equality does not hold for the employer, the workforce, the employee, and the employee's social contacts, the relationship may be broken by either the worker or the employer depending on how they view the inequality. For groups of workers performing a common task, the payment has degenerated to a common payment based on the contribution of the group. There is no requirement in such a situation for a worker to perform above average expectations of the employer, especially where the supply of workers is less than the demand for such workers at the current wage rate or where group pressures discourage "rate busters."

Attempts have been made to increase production by identifying group or individual productivity and tailoring payments to the observed output. Group level plans, however, have drawbacks similar to the straight payment system. In groups, especially larger groups, the worker has great difficulty in relating his performance to the group's contribution. The efficiency of an incentive plan is considerably dulled in this situation.

The effects of individual payments are complicated by the fact that incentive plans are not implemented in a vacuum. Implementation requires a closer worker management relationship which alone can foster increases in productivity as was demonstrated in the Hawthorne study previously discussed. Often such plans are accompanied by workspace environmental improvements which also cloud the effect of the incentive plan. This is not to say such actions are bad. Actions that promote increased productivity are welcomed providing that they can be maintained over time or, if they should be gradually discontinued, their absence will not cause an even lower level of productivity.

Opsahl and Dunnette (1966) support Lawler's contention that if the pay plan is administered in secrecy it reduces money's effectiveness as a knowledge-of-results device that lets the employee evaluate his performance-to-reward relationship. They believe that most fears of pay disclosure stem from fear by salary administrators that they could not provide convincing arguments to support their present practices in regard to relating job performance to salary payments.

In publicizing the results of an incentive plan data processing management must effectively deal with the double approach-avoidance conflict, reported by Opsahl and Dunnette (1966), that is presented by the respective rewards and punishments offered by management and the work group, without destroying either. The incentive plan represents a potential reward to the individual while different publishing methods vary in their detrimental effect on group unity.

The recommendation of this thesis will be to plot the results of measuring worker productivity on a simple graph in the workspace. For a small installation, shift against shift may be a logical grouping. For larger units, each shift may be broken into smaller teams. To go to the individual level is considered detrimental since it holds an individual employee up to public scrutiny and is a heavy-handed method of dealing with the slow or marginal employee. Besides, workers in small groups are well aware of the abilities of individual group members.[13] Group pressure under a shift or team concept will accomplish much more without the risk of channeling group unity against data processing management.

D. AN ALTERNATIVE TO MONEY

Money has been described as a tool to gain other desired outcomes. One desired outcome is leisure time that is best described in terms of microeconomics.

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[13]Hollander, E. P., "Validity of Peer Nomination in Predicting A Distant Performance Criterion," Journal of Applied Psychology, Vol. 49, No. 6, 1965, p. 434-438, reports that the results of peer ratings are significantly valid in predicting ability to perform and that friendships do not have a major intrusive effect on the validity of the ratings.

According to Peterson (1971), the decision to spend time at leisure means to forego a certain amount of income. The price of an hour of leisure is the income foregone by not working that hour.

The market supply of labor is described by Peterson (1971) as an increasing function where the amount of labor offered by the work force will increase as the wage rate increases. Specifically, at a particular wage rate the workers will offer a certain number of hours of labor. As the wage rate increases, the cost of an hour of leisure also increases and a substitution effect of the workers trading hours of leisure for hours of labor is experienced. The workers by working more hours at a higher wage rate now have a higher income which they can use to purchase additional hours of leisure. This income effect results in the workers partially withdrawing their offer of additional hours of labor. The overall result of the substitution and income effects is the offering of additional hours of labor at the increased wage rate.

The behavior of the market supply of labor is determined by summing the labor supply behavior demonstrated by individual workers as they offer various hours of labor in return for various wage rates. Ferguson (1972) states that considerably more can be said about the sum than about the constituent parts because the individual worker may offer any sequence of labor hours at various wage rates. If the sequence is similar to the constantly increasing function previously described, the financial incentive offered by this thesis should prove attractive to that individual. If the wage rate increases reach a high level where the income effect of a bigger paycheck with which to purchase leisure hours dominates the substitution effect of trading leisure hours for labor hours for a particular worker, increases in the wage rate may only lead to reductions in the number of labor hours that individual offers. Since the point at which the income effect starts to dominate the substitution effect varies from worker to worker, the incentive plan proposed by this thesis will give the keypunch operator the option of trading incentive financial rewards for leisure hours.

E. WHAT OTHERS HAVE DONE

The remainder of this chapter concentrates on what others have done in attempts to increase worker productivity. The first part deals with a discussion of several formal incentive plans, some of which were developed in the late 1800's. The second part presents a discussion of the keypunch incentive plan at the Navy's Ships Parts Control Center. The third and final part reports on the direction several private firms have taken to increase productivity through "job enrichment."

Niebel (1958) divides what he calls direct wage financial plans into two classifications. One is where the worker receives direct payment in relation to a set standard of performance and the other is where the cost savings due to performance above this standard are shared by the worker and his employer. Under the first classification he discusses five plans, the first four of which have no guaranteed minimum income.

The first plan, straight piecework, is where all standards of performance are given in terms of dollars per unit produced. The worker receives no base salary and is only paid on the basis of his exact unit production. This method was used more than any other plan prior to World War II because of its simplicity, but the method was discontinued because rapidly changing base pay rates since World War II created an untenable clerical burden in updating the standards.

The standard hour plan is the second plan and is very similar to straight piecework just discussed. The difference is that in the standard hour plan, standards of performance are stated in terms of units of output per unit time. The immediate advantage over straight piecework is the elimination of the clerical update effort because the standards do not change when base pay rates change. The immediate disadvantage is that it is more difficult for the worker to evaluate his performance.

Taylor Differential Piece Rate, the third plan, used two different straight piecework rates. A low piecework rate was applied until a standard performance output level was reached, beyond this point a much higher piecework rate was used. This method is not popular today because it penalizes the average and slower worker and, due to its use of very high standards, only rewards the few exceptional workers.

Due to severe employee criticism of the Taylor Differential Piece Rate plan, the Merrick Multiple Piece Rate plan was introduced. This plan established three piecework rates. One rate for beginners, one for average workers, and one for superior workers. Because it was based on piecework rates and because of the unpopularity of the Taylor plan, the Merrick plan did not meet with success.

Measured daywork is the fifth plan and was established as a result of organized labor's effort to end piecework rates. Under measured daywork a worker established a base wage rate over three months of observation. He is then paid at this rate for the next three months regardless of his production, but his production will determine the base wage rate that will be applicable for the next three months. Measured daywork was not a success because of the time separation of performance and the reward, the detrimental effect of three months at a low rate, and the amount of clerical work required to maintain detailed records on each employee's wage and production rate.

Niebel (1958) concentrates on four additional formal plans in a discussion of the type of plan where the employee is guaranteed a minimum income and shares with his employer all cost savings created by performance above standard. These plans were primarily established to protect employers from runaway piecework rates that were erroneously established due to the absence of accurate time study techniques.

The first plan, known as the Halsey Plan, was established in 1890. It set performance standards in units of output per unit time. Workers that produced above standard split the resultant cost savings 50/50 with the employer.

The Bedaux Point System was established in 1916 and was more complex than the Halsey Plan. Basically, the Bedaux Point system's design is such that each job is qualified by the number of "B's" required to complete the job. Each "B" is equal to one minute of time that is composed of predetermined proportions of work and rest depending upon the difficulty of the job. The average worker had to complete 60 "B's" each hour. If the worker performed over standard, he was paid his base salary plus an amount equal to the number of excess "B's" earned multiplied by his wage rate per minute multiplied by seventy-five percent.

The Rowan Plan introduced in 1898 set a standard time for each job. The incentive was calculated on the basis of the ratio of time saved to this standard time. Since no worker can save more than the time allowed, an effective ceiling is placed on the amount of incentive that can be earned.

The Emerson Plan is similar to the Rowan Plan except that a small incentive is provided when a worker produces in the 66 2/3% to 100% range of standard and a straight 20% for all production above 100% of standard.

The major objection to each of these four plans, according to Niebel (1958), was that unlike the piecework rates which were growing in popularity during this time, they were not directly related to production and they required involved calculations. This thesis does not consider either of these objections important. Piecework rates are no longer popular and the power of the computer will be routinely utilized for all calculations.

Caro (1971) outlines various incentive plans in use in the Navy. These plans include beneficial suggestion rewards, one time meritorious performance awards, and meritorious pay step increases. According to Caro (1971), they presuppose the presence of satisfactory working conditions, adequate supervision, and fair pay for a day's work. In regard to what has been stated in this thesis, the largest drawback of Navy incentive plans is the untenable delay between performance and reward that renders them impractical for daily production.

In the later part of 1969 the Central Data Processing Division of the Navy's Ships Parts Control Center at Mechanicsburg, Pennsylvania, instituted an incentive awards program for keypunch unit personnel. The program consists of establishing production standards for each job for keypunch and verification operations. Each operator's performance is matched against the standard and quarterly bonuses are awarded on the basis of productivity ranges above standard.

The standards are established based on two main categories. The first is the quality of the source document. The elements of evaluation are: (1) legibility, (2) continuity of fields, (3) procedure complexity, (4) number of different transactions, (5) color contrast, and (6) size of the document. From these elements a composite rating of excellent, good, fair, or poor is established. The second category is the number of card columns punched and duplicated. For each of the four ratings there is a separate Production Range Table as shown in Table I for punching and verifying, for a total of eight tables. The tables are matricies of acceptable production ranges in cards per hour. The ordinates of the matrices are the number of card colunms duplicated and the number of card columns punched. As an example, the acceptable production range for punching an excellent rated job consisting of 45 columns of punching and 17 columns of duplication is from a low of 197 cards per hour to a high of 225 cards per hour.

Upon receipt of job batches the keypunch supervisor reviews the input documents and separates them into workable batches if necessary. The supervisor records the start and stop production time and the operator's number. The elapsed

TABLE I

PRODUCTION RANGE TABLE

Type of Operation: Punch

Source Document Classification: Excellent

CC'S DUPLICATED

CC'S PUNCHED	0-7	8-15	16-23	24-31	32-39	40-47	48-55	56-63	64-71	72-79
1-8	840 552	777 524	724 499	677 477	636 456	600 437	567 419	538 403	511 388	487 386
9-16	554 412	526 397	501 382	478 369	457 356	438 344	421 334	404 323	389 322	
17-24	413 329	398 319	383 309	370 301	357 292	345 284	334 277	324 276		
25-32	330 274	320 267	310 260	301 254	293 248	285 242	277 241			
33-40	274 234	267 229	260 224	254 219	248 215	242 214				
41-48	235 205	229 201	225 197	20 193	215 193					
49-56	205 182	201 179	197 176	194 175						
57-64	182 164	179 162	176 161							
65-72	164 149	161 148								
73-80	149 138									

CARDS PER HOUR

time includes all time expended except for lunch since a 15% personal time allowance has been built into the Production Range Table. Periodically the production statistics are processed to determine an individual production rating for each employee by comparing the actual number of cards processed to the production range. If the actual number of cards processed is within the range, the rate is 100%. If the actual number is below the lower boundry, the lower boundry is divided into the actual number of cards processed and the quotient represents the production rating. If the actual number is above the higher boundry, the higher boundry is divided into the actual number of cards processed and the quotient represents the production rating. Using the prior example, if 150 cards had been punched, the production rating would be 150 divided by 197 or 76%. If 200 had been punched, the rating would be 100%. If 250 had been punched, the rating would be 250 divided by 225 or 111%. The production rating is tempered by the number of errors made by an operator. An error rate of 2% to 3% reduces the rate by 3%, an error rate of 4% to 6% reduces the rate by 10%, and so on.

To qualify for an incentive award an operator must work a minimum of 350 hours of measured production during the quarter, have an error rate of 3% or less, and be satisfactory in all phases of performance and conduct. The award table shown in Table II is used with the qualification that: "the

TABLE II

QUARTERLY PRODUCTION RATE MONETARY AWARD TABLE

QUARTERLY PRODUCTION RATE	QUARTERLY MONETARY AWARD
115-124%	$25
125-134%	$35
135-144%	$45
145-154%	$55
155-164%	$65
165-174%	$75
175-184%	$90
185-up	$100

incentive awards plan was designed so that approximately 25% of the operators would qualify for awards each quarter. Should the number of operators qualified for an award exceed the 25% goal, we are obligated to adjust the table."[14]

There are two major limitations in this plan. First, using Atkinson's theory of motivation, both the incentive value of the award and the probability of success are low, thus resulting in low motivation for many employees to really work hard at playing the game. The second limitation is the time isolation of the reward from the labor that earned the reward. In the opinion of this thesis, three months is too long, one month is too long, even one hour is too long. The ideal would be for the data entry machine to display a productivity index upon completion of the last punch. This may seem impossible, but with the introduction today of the on-line mini-computer for controlling key-to-disk data entry systems, the potential is there; all that is needed is the software.

There is a trend in private industry towards "humanizing" monotonous jobs by providing increased "job enrichment" through eliciting employee participation in work decisions previously dictated by management.[15]

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[14] Navy Ships Parts Control Center, Central Data Processing Division, Standards and Procedures Manual, "EAM Standards and Procedures," Section 10, Chapter 1, Subject 2, p.2.

[15] U. S. News & World Report, "The Drive to Make Dull Jobs Interesting," July 17, 1972, p. 50.

According to Myers (1970), meaning is given or returned to work through a process known as job enrichment or job enlargement. He states that job enrichment may result from horizontal and/or vertical job enlargement. He defines horizontal job enlargement as an increase in the variety of functions performed at a given organizational level with the intention of first relieving boredom and then broadening the worker's perspective in order to pave the way for vertical job enlargement. Vertical job enlargement enables workers to participate in planning and control functions that had been previously reserved for supervisory and management personnel.

In implementing job enrichment procedures, organizations are becoming flatter with authority and responsibility being shifted downward in response to the increasing education level and changing values in the society.[16] According to Secretary of Commerce Peter G. Peterson, the young worker: "has different expectations and attitudes than workers in the present generation. Business must take account of that, look into the work environment it is providing. It must consider sharing profits, joining with the workers in a mutual commitment to boost production instead of squaring off and fighting."[17] Gary B. Bryner, 29, President of

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[16] Ibid.

[17] Ibid.

United Auto Workers Local 1112, has said: "the attitude of young people is going to compel management to make jobs more desirable in the workplace and to fulfill the needs of man... the attitude that a guy goes to work and slaves to get his $4 an hour is passé. The guys want to feel like they're making real contributions. They don't want to feel like a part of the machines."[18] Bryner backed up these statements by striking General Motor's new showcase plant at Lordstown, Ohio, for one month on the basis that the jobs were too dull and the pressure too intense.

Some industries are trying to capitalize on the known satisfaction derived from completing a task from start to finish. Many production assembly lines have been abolished for one worker assembling and testing the complete product as evidenced by the following examples offered by U.S. News & World Report.[19]

The hot-plate division of Corning Glass Works at Medfield, Massachusetts, abandoned the assembly line in 1965-66. Now each worker assembles and tests each hot-plate. Together the employees schedule their work to meet a weekly objective, suggest refinements and improvements, and devise their individual techniques. The operator's pride is solicited and accountability for quality is assured by requiring his initials

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[18] Business Week, "Job Monotony Becomes Critical," September 9, 1972, p. 108.

[19] U. S. News & World Report, p. 50-54.

on the final product. The results have well justified the approach. Rejects have fallen from 26% to 1%; absenteeism from 8% to 1%. As a result, this approach has spread throughout the plant and a team approach has been implemented in complex tasks.

At Donelly Mirrors, Inc., of Holland, Michigan, all workers are on a production related incentive plan with a team approach organization headed by a foreman. The foreman can grant a day off to any worker for any reason. The workers decide how much of an annual salary increase they receive and then must find ways to pay for it. Salaries have increased 25.5% in the past three years and they have been paid for in higher production, reduced costs, and elimination of unnecessary jobs.

In company after company the results of employee recognition can be seen. Monsanto textiles is using a classroom approach to get the worker: "to realize that he is not an extension of a machine, and to draw on his abilities to think, plan, and innovate for the good of all."[20]

General Electric at Columbia, Maryland, has emphasized recognition and participation: "Each employee is the supervisor's responsibility, he gives them recognition, rewards them, counsels them, and coaches them."[21] Rap sessions,

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[20] Ibid., p. 52.

[21] Ibid., p. 53

freedom in dress, and a strong equal opportunity program contribute towards their success.

Gains Pet-Food Plant in Topeka, Kansas, has taken a rotating team approach to processing, shipping, and office duties. There is one door for all to enter and leave, one lunchroom, and no reserved parking places.

At the Oak Brook, Illinois, plant of McDonald's Corporation, worker's wear casual clothes on Friday and leave work at noon. Time is made up by coming to work a half-hour early each day. The only segregated areas with doors are the rest rooms.

What has happened is that these companies have come to realize that the employee is their most valuable asset. Harry Heltzer, Chairman and Chief Executive Officer of Minnesota Mining and Manufacturing Company, has stated that, "Too many managers have the idea that the way to get better productivity is to stand over the worker with a club and make him push the wheelbarrow faster."[22] According to Dr. Michael Beer, Manager of Organizational Research and Development at Corning Glass Works, "This is an effort to deal with the changing needs of the work force. We have to manage to fit those needs, adapt to change in fast-changing industries. In the past, we have vastly underestimated what a person is capable of.

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[22] Business Week, "Management Itself Holds the Key," September 9, 1972, p. 143.

Now we give them an opportunity to grow into the job. Not all employees can do it, but I think a large percentage can. I think this concept will snowball. It may be an answer to the whole question of productivity."[23]

Myers (1970) warns against slavish emulation of any one particular firm's approach to job enrichment and urges development of job enrichment procedures particularly adapted to the installation in question. Several elements of this thesis are intended to provide the beginning steps towards job enlargement in keypunch. The Procedure Time Model, which is the foundation of the proposed incentive plan, is adjusted over time on the basis of observed performance in an attempt to allow the keypunch operator to set her own standards and goals. The easy recording and exclusion of training time from the incentive work period will facilitate data processing management's offering the keypunch operator a continuous opportunity to learn on the job. Through the use of negative reinforcements the proposed incentive plan encourages quality workmanship. The report output includes a detailed operator technical performance evaluation that is intended to be used by the unit supervisor in individual counselling of the operator or all aspects of her performance. The counselling should emphasize the relationships between the goals of the operator and those of the installation. These procedures

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[23] U. S. News & World Report, p. 54.

are beginning steps; each installation must review its own operation. One approach suggested by Myers (1970) is to form a task force composed of a vertical cross section of the firm. For data processing such a cross section would start with the Keypunch Unit Supervisor and continue through the Director. The task force should study the various methods available as suggested by Myers (1970) and situational descriptions, then, on a continuing basis, analyze, plan, develop, and implement procedures that will enable the installation to benefit from the potential of the individual operator.

V. MEASURING ATTITUDES

Changes in employee attitude towards the job will be measured using a questionnaire survey technique and the results analyzed to determine the effect of the various job enrichment and motivational procedures recommended in Chapter IV. Measuring worker attitudes is important because productivity increases should not rely solely on economic incentives and machinery improvements. "Other motives, such as ego, security, curiosity, and creativity are employed to enhance productivity through favorable attitudes."[24]

According to Massee (1971), management must be able to see the relationship between its behavior and the results of the survey questionnaire. If the results are unfavorable, management must resist the natural urge to reject the findings and, instead, implement corrective procedures. If management chooses to reject unfavorable findings as being untrue, Masse (1971) states the resultant conflict between superiors' and subordinates' evaluations of role performance and effectiveness will inhibit individuals from freely communicating important job matters with their superiors.

Porter and Lawler (1968) state that: "Attitudes traditionally have been studied by psychologists because they can

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[24]Masse, S., "The Questionnaire Survey Technique," The Journal of Navy Civilian Manpower Management, Vol. V, No. 3, Fall 1971, p. 10.

provide important insights into human cognitive processes, and, ultimately, because they can contribute to the understanding and prediction of human behavior."[25] Much of what is being recommended by this thesis deals with behavior modification. The results can be partially determined in terms of increased productivity as measured in record output per unit time, but since the recommended hardware changes alone are expected to increase productivity, some measure should be used to distinguish between productivity increases due to hardware and productivity increases due to behavior modification.

Two survey questionnaires are included in this thesis. The questionnaire in Table III is to be administered to the keypunch operator and the questionnaire in Table IV is to be administered to the shift supervisors and the unit supervisor. The questionnaires are to be administered prior to any indication that the ideas in this thesis are to be implemented. The questionnaires should be administered a second time after the recommendations have been implemented and the installation has become accustomed to the system and the benefits of employee counselling. The results of the two surveys should then be analyzed to determine what changes have occurred and what future modifications in managerial policies may be required. If the task force concept suggested by Myers (1970)

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[25]Porter, L. W. and Lawler, E. E., III, Managerial Attitudes and Performance, Irwin-Dorsey Limited, 1968, p. 2.

that was discussed in Chapter IV is utilized, the installation may choose to administer this type of questionnaire at infrequent intervals of time in order to provide the continuous feedback of information needed to further develop the process.

TABLE III

KEYPUNCH OPERATOR

		AGREE	?	DISAGREE
1.	Management is doing its best to give us good working conditions.........	( )	( )	( )
2.	My boss is too interested in his own success to care about the needs of employees.........................	( )	( )	( )
3.	My boss gives us credit and praise for work well done.................	( )	( )	( )
4.	Management here does everything it can to see that employees get a fair break on the job..............	( )	( )	( )
5.	My boss sees that we have the things we need to do our jobs......	( )	( )	( )
6.	My boss sees that employees are properly trained for their jobs....	( )	( )	( )
7.	Sometimes I feel that my job counts for very little in this organization	( )	( )	( )
8.	They expect too much work from us around here........................	( )	( )	( )
9.	I'm paid fairly compared with other employees.........................	( )	( )	( )
10.	The people I work with get along well together.....................	( )	( )	( )
11.	I have confidence in the fairness and honesty of management..............	( )	( )	( )
12.	My boss lets us know exactly what is expected of us....................	( )	( )	( )
13.	The people who get promotions around here usually deserve them..........	( )	( )	( )
14.	My boss has the work well organized	( )	( )	( )

15. How often during the past year has your boss discussed his evaluation of your work performance with you?

- 8 - 12 times or more.......... ( )
- 5 - 7 times.................. ( )
- 3 times...................... ( )
- 2 times...................... ( )
- 1 time....................... ( )
- No time...................... ( )

16. How satisfied are you with your boss's discussions with you about your work performance?

- More discussion than I desire..( )
- Discussion was about right.... ( )
- More discussion is needed..... ( )
- Much more discussion is needed ( )

17. Do you know what your boss wants you to get done during the coming year?

- Yes; we have discussed it..... ( )
- I have a pretty good idea..... ( )
- I'm not sure.................. ( )
- I have no idea as to his expectations.................. ( )

18. How aware is your boss of the job you have to do and how well are you doing it?

- He pretty well knows what is going on..................... ( )
- Most of the time he is well aware......................... ( )
- Sometimes he is aware......... ( )
- Rarely is he aware............ ( )
- When he does give it attention, he doesn't understand what's going on..................... ( )

19. Is your boss objective in evaluating those he supervises?

- He sees things the way they are( )
- Most of the time he is........ ( )
- Many times he is fooled by his people........................ ( )
- It is easy for his people to cover up their poor performance..... ( )
- He doesn't evaluate, or he goes by personality rather than work performance.................. ( )

TABLE IV

SUPERVISOR

		AGREE	?	DISAGREE
1.	Management is doing its best to give us good working conditions.........	( )	( )	( )
2.	My boss is too interested in his own success to care about the needs of employees.........................	( )	( )	( )
3.	My boss gives us credit and praise for work well done................	( )	( )	( )
4.	Management here does everything it can to see that employees get a fair break on the job..................	( )	( )	( )
5.	My boss sees that we have the things we need to do our jobs............	( )	( )	( )
6.	My boss sees that employees are properly trained for their jobs....	( )	( )	( )
7.	Sometimes I feel that my job counts for very little in this organization	( )	( )	( )
8.	They expect too much work from us around here.......................	( )	( )	( )
9.	I'm paid fairly compared with other employees..........................	( )	( )	( )
10.	The people I work with get along well together.....................	( )	( )	( )
11.	I have confidence in the fairness and honesty of management..........	( )	( )	( )
12.	My boss lets us know exactly what is expected of us....................	( )	( )	( )
13.	The people who get promotions around here usually deserve them..........	( )	( )	( )
14.	My boss has the work well organized	( )	( )	( )

15. How often during the past year has your boss discussed his evaluation of your work performance with you?

- 8 - 12 times or more............... (   )
- 5 - 7 times........................ (   )
- 3 times............................ (   )
- 2 times............................ (   )
- 1 time............................. (   )
- No time............................ (   )

16. How satisfied are you with your boss's discussions with you about your work performance?

- More discussion than I desire........... (   )
- Discussion was about right.............. (   )
- More discussion is needed............... (   )
- Much more discussion is needed.......... (   )

17. Do you know what your boss wants you to get done during the coming year?

- Yes; we have discussed it............... (   )
- I have a pretty good idea............... (   )
- I'm not sure............................ (   )
- I have no idea as to his expectations... (   )

18. How aware is your boss of the job you have to do and how well you are doing it?

- He pretty well knows what is going on... (   )
- Most of the time he is well aware....... (   )
- Sometimes he is aware................... (   )
- Rarely is he aware...................... (   )
- When he does give it attention, he doesn't understand what's going on...... (   )

19. Is your boss objective in evaluating those he supervises?

- He sees things the way they are......... (   )
- Most of the time he is.................. (   )
- Many times he is fooled by his people... (   )
- It is easy for his people to cover up their poor performance................. (   )
- He doesn't evaluate, or he goes by personality rather than work performance(   )

20. How often during the past year have you specifically discussed your evaluation of the work performance of your operators (those you directly supervise) with them?

- 8 - 12 times/man or more................ (   )
- 5 - 7 times/man......................... (   )
- 3 - 4 times/man......................... (   )
- 2 times/man............................. (   )
- 1 time/man.............................. (   )
- No times or only with a few............. (   )

VI. THE INCENTIVE PLAN

The incentive plan offered in this chapter is designed to increase the marginal physical product of labor by providing an incentive object in the form of money or time off that may be earned by the individual keypunch operator in reward for her demonstrated increased productivity. The keypunch incentive plan is centered around a Procedure Time Model for each documented keypunch procedure. This model is initially mathematically predetermined on the basis of the results of a time test, but adjusted over time to reflect the current productivity level of the installation. Daily system inputs include production data at the job level from the operator (or her machine), supervisor input on non-productive operator hours (training, leave, etc.), and input on the jobs that are backlogged. A series of computer programs, written in COBOL, are used to create the system and to produce a periodic report output tailored to the organizational structure.

The following sections outline the action required to create and maintain the Procedure Time Model, the system files, the input data collection procedures from machine operations and the supervisor, the calculation of production effectiveness and incentive hours earned, the basic reports, and the MUACS option for Naval Supply Centers.

A. THE PROCEDURE TIME MODEL

Before a job or employee can be measured, a ruler must be provided. This ruler must accurately represent existing conditions if it is to be the base of a payroll system, provide a continuing competitive incentive, and portray an up-to-date comparative measure of unit productivity. The ruler for this thesis is the Procedure Time Model. "Procedure" because there is one time model for each recognized and documented keypunch evolution. "Time" because time is a unit of measurement that is both convenient and universal to all jobs and installations. "Model" because it is an idealized representation that describes the keypunch evolution for one procedure and reveals important relationships between the operator, her machine, and the source document. The use of modeling permits the indication of relevant data, facilitates dealing with the entire problem, and permits the use of the computer to perform the analysis of data and consolidation of results.

A logical property of a model is that its solution is only good as long as the model is good. For this reason, the Procedure Time Model is not a time standard in the sense of Time and Motion Study. Rather, it is a self-adjusting level-of-performance indicator that will be used in comparison with actual operator output. This concept yields two major benefits to management. First, the accuracy of the initial Procedure Time Model, while important to the speed at which the system stabilizes, is not critical to the long run ability of the system to perform. Second, the population of Procedure Time Models will be moulded over time to the particular characteristics of the particular installation, taking into lump-sum consideration the difficult to measure variables such as environment attitude, personality, effect of social status rewards in off-the-job relations, and a multitude of other variables. For the operator the system offers a realistic, accurate, and competitive yardstick for the equitable distribution of rewards on the basis of personal effort and ability.

Initially the time model must be established as if the "average worker" were available for measurement. The acceptable methods for establishing time standards are through the use of Standard Data, Time Study, Methods Time Measurement, and/or Work Sampling. The details of these methods will not be discussed here since they are readily available from any primer on Time and Motion Study.[26] All are valid methods but all require talented specialists and a considerable amount of time. Considering that an activity may have one hundred, two hundred, or more different keypunch evolutions this task can become an untenable expense if it were to be done manually. Fortunately, through the use of the computer, the time required to establish these initial benchmarks can be greatly reduced as can be the expertise requirements of the personnel providing the information. While this may raise a question of accuracy, accuracy is an economic, not an engineering consideration. With the self-adjusting properties of the

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[26] See Niebal (1958).

Procedure Time Model the slight loss in accuracy is of little relevance when compared to the significant savings in implementation manpower cost. Additionally, it might be questioned as to how accurate one can get. Accuracy here can only be validated over time since there is no "exact" way to do a particular keypunch operation. What works for one operator may not work for another. The Procedure Time Model thus must attempt to determine an average time to do an operation. If the operator performs identically to the Procedure Time Model approximation, the job will be accomplished as planned. The probability, however, is greater that the operator will deviate from the planned path. If the operator performs with an expectable degree of intelligence and skill the time actually consumed and the planned time will be about the same. If it differs, the Procedure Time Model must be sufficiently flexible to move in the direction of the variance while historically retaining for data processing management review the relative magnitude and direction of the evolution.

1. Initial Creation of the Procedure Time Model

The creation of the Procedure Time Model is a complex process of meshing many variables into a best estimate of productivity. The sequence of events that will be described in detail starts with the documentation of every acknowledged keypunch procedure. Most installations already have this documentation and so this step is at most a clerical process. At the same time, the experience of the unit supervisor is called upon in the selection of a representative cross-section of established procedures routinely performed by the installation. Keypunch operators from the installation will perform one or more of these procedures and be timed. The results of this time trial will be combined with the procedure documentation in the predetermination of the Procedure Time Model. The end result when combined with an Operator Identification File will be the system file ready for implementation.

(a) Units of Measurement

The basic unit of measurement of the system is the "Time Measurement Unit." The Time Measurement Unit is a term familiar to Time and Motion Study and is referred to as a "TMU." Table V shows the conversion of TMU's to standard clock time.

If the Procedure Time Model is to be predetermined with sufficient accuracy to enable initialization and stabilization of the system within an effective time frame, the relationships of the various elements that comprise a keypunch evolution must be defined. While many elements will vary significantly from installation to installation based on everything from the color of the walls to the personality of the supervisor, the fact that all keypunches function basically on the 64-character standard keyboard permits the declaration of the primary procedure elements as constants. These primary procedure elements are shown in Table VI and apply to mechanical punches of the IBM 029 variety.

TABLE V

TMU - TIME MEASUREMENT UNIT CONVERSION TABLE

1 TMU	=	.00001 hours
1 TMU	=	.00060 minutes
1 TMU	=	.03600 seconds
1 Hour	=	100,000 TMU's
1 Minute	=	1,670 TMU's
1 Second	=	28 TMU's

TABLE VI

PRIMARY KEYPUNCH PROCEDURE ELEMENTS

Procedure Elements	Unit of Measurement	Equivalent Level of Difficulty
Numeric	Columns	1.00
Alphabetic	Columns	1.20
Alphameric	Columns	1.40
Manual Duplication	Columns	0.60
Manual Skipping	Columns	0.08
*Auto Duplication	Columns	0.30
*Auto Skipping	Columns	0.04
Manual Dup/Skip	Times	2.20
*Auto Dup/Skip	Times	1.20

*delete for machines that electronically duplicate and skip.

For machines that electronically duplicate and skip, the asterisked procedure elements in Table VI that deal with automatic duplication and skipping should be deleted.

The first group of the primary keypunch procedure elements listed in Table VI is self-explanatory in that they are standard functions of the machine operation. The equivalent levels of difficulty were estimated with numeric punching as a base with a weight of 1.00 per column punched. Accordingly, aphabetic punching is slightly more difficult and a larger weight is attached to that type of activity. The remaining elements of the first group were established in the same manner. Concerning the last group of two primary procedure elements, the operations of duplication and skipping require a shift in the concentration of the operator. This shift is compensated for by adding a TMU factor for each occurrence.

There are additional known differences in procedures due to the source document. The evaluation of these differences, while mainly subjective, are, nevertheless, well know. to the operator and it is advantageous to include this knowledge in the predetermination of the Procedure Time Model. Procedures can be complicated due to poorly engineered documents that require the operator's eyes to jump around the document. Carbon copies, poor penmanship, and documents filled with irrelevant data can all add to the time requirements of a particular procedure documentation. The units of measurement for the evaluation consist of subjective ratings of excellent, good, fair, or poor.

(b) Preparation of Procedure Documentation

Preparation of the procedure documentation for each keypunch evolution is basically a clerical operation, but it is beneficial to have the work performed by a keypunch operator experienced in the various procedures performed at the installation. The documentation consists of three records - a header, the entry format, and the verification format. The formats of these records are shown in APPENDIX B. The header contains the procedure number, a suffix (for multiple record outputs), source document evaluation ratings, and record size. Additional optional entries are provided for procedure name and MUACS code. The entry and verification format records consist of standard format control records (i.e., IBM 029/059 program drum control cards).

There will undoubtedly be a few jobs that cannot be documented such as "Punch Print Return," "999," "Corrections," or any of the other tags used to describe miscellaneous jobs that escape from true identity. Also, the installation may have instituted various "Hotline" operations that vary from low volume inputs of standard procedures to miscellaneous and correction punching with no verification. Such operations, due to their extremely variable nature, will not qualify for earning incentive hours and will not be documented.

Remote terminal operations also vary greatly from installation to installation. At the present time this function will be excluded from this thesis although the desirability of including this increasingly important activity is strong.

Each keypunch procedure will be reviewed for legibility (penmanship - typed or handwritten), contrast (original or carbon, colored paper), continuity of fields (degree of jumping around on the document), difficulty in handling (large or multiple source documents), and complexity (front and back information, document filled with irrelevant data, etc.). The procedure is rated in each of the above areas as being excellent, good, fair, or poor. These ratings are then entered in the header card as specified in the header card format in APPENDIX B. Since it is possible to more than double the time allowed for any job through the results of the source document rating, the reviewer must be consistent and accurate in his evaluation.

The documentation is then reviewed for accuracy of coding via the COBOL Computer Program Number 1. In return, the keypunch supervisor will receive the input documentation cards and an error listing in the same sequence as the input. Once the errors have been corrected and re-validated, the documentation is held pending completion of the time trials.

(c) Time Trials

The Procedure Time Model is predetermined on the basis of how long it takes the particular installation to punch and then to verify one character of numeric data. These two time factors are obtained from a series of time trials and entered by a programmer into the program that calculates the initial Procedure Time Model.

The time trials are based on representative samples of procedures and operators. Since this thesis is applicable to any keypunch installation, only rough guidelines can be offered as to proper sample sizes. The ultimate sample sizes selected should be determined on the basis of desired accuracy and the cost of conducting the trials. If the installation has 150 documented procedures and 30 operators, the recommendation would be to select 15 jobs and use all 30 operators.

Once the procedures have been selected based on their representative nature of the type of work performed by the installation, fictitious batches are created from actual source documents. The batch size should be such that the data entry operation will consume 15 to 20 minutes. Each participating entry and verifier operator is then assigned and timed on their performance in completing the job. The operator should be allowed to set up the job and machine prior to starting the trial and use a format control record (program drum card) if this is typically done for the procedure being performed. The time should be recorded from first punch to last punch with the operator proceeding at her normal speed. It is recommended that the time recorder not stand near the operator during the trial. Upon completion of the time trial, the procedure number and time result should be recorded with the entry and verification trials being kept separate through all trials and subsequent calculations. If any entry operation results in more than a 3% error rate, that time trial must be rejected and the task repeated by another operator because jobs with more than a 3% error rate would invalidate the follow-on verification time trial.

The TMU factors for entry and verification will be calculated using the formula shown in Table VII. The calculations must be performed twice. Once using only the entry results and once using only the verification results.

The entry and verification TMU factors are then patched by a programmer into Computer Program Number 2 that calculates the predetermined Procedure Time Model and creates the system file. The TMU factors are patched into the program so that they will be readily available in the future when changes and adds are processed that will require recalculation of the Procedure Time Model.

2. Routine Adjustment of the Procedure Time Model

Daily, jobs are received, batched, and completed by the keypunch installation. Each batch has a control form which upon completion of the job is retained by the keypunch supervisor. The accumulation of these batch control forms over the month provides the input to the program that adjusts the Procedure Time Models. The results of actual monthly production is averaged with the Procedure Time Model by Computer Program Number 4 using the formula in Table VIII. The formula uses a moving four month average of actual production in addition to the predetermined procedure time in

TABLE VII

CALCULATION OF THE BASIC NUMERIC TMU FACTOR

$$\text{TMU FACTOR} = \frac{\sum_i t_i}{\left(\sum_j \sum_i n_{ij} f_j\right)\left(\frac{1.2 - (0.04)\left(\sum_k c_k\right)}{N}\right)}$$

where:

t_i = results of time trials for trials i = 1, 2, ...

n_{ij} = number of occurrences of the procedure elements j = numeric, alpha, ... for trials i = 1, 2, ...

f_j = equivalent levels of difficulty for procedure elements j = numeric, alpha, ...

c_k = numeric conversion of the five quality ratings of the source document for k = 1, 2, ..., 5 where the rating excellent = 1, good = 2, ..., poor = 4 (see page 75).

N = number of time trials

TABLE VIII

ADJUSTMENT OF THE PROCEDURE TIME MODEL

$$\text{PROCEDURE TIME MODEL} = \frac{2p + a_c + \sum_{i=1}^{3} a_i}{6}$$

where:

p = Predetermined Procedure Time Model

a_c= actual production data for the current month

a_i= actual production data for prior months i = last month, 2 months ago, and 3 months ago.

KEYPUNCH PROCEDURE REPORT

JANUARY 1972

JOB-NR	M	PROCEDURE NAME	* DATE *	SIZE	-RATINGS-	DATA ENTRY STROK	PRED	3-MO	2-MO	1-MO	USE1	USE2	VERIFICATION STROK	PRED	3-MO	2-MO	1-MO	USE1	USE2
001000	E	JOB NR. 1000	15 12 72	60	G G E E F	70	500	510	520	500	490	500	60	400	410	425	390	400	400
002000		JOB NR. 2000	15 12 72	60	G G E E F	80	600	610	620	600	580	600	50	500	510	520	490	500	500
003300	E	JOB NR. 3300	15 12 72	60	G G E E F	70	500	510	520	500	490	500	60	400	410	425	390	400	400
005000	E	JOB NR. 5000	15 12 72	80	G E F P G	70	500	520	500	500	500	420	60	400	425	390	400	400	336*
006000		JOB NR. 6000	15 12 72	60	G G E E F	80	600	620	600	333	600	459	50	500	520	490	278	500	381*
007000	D	JOB NR. 7000	15 12 72	75	P P P P F	65	700	720	700	306	700	521	60	600	590	620	263	600	446*
007001		JOB NR. 7001	15 12 72	60	G G E E F	80	600	610	620	600	580	600	50	500	510	520	490	500	500
008000	D	JOB NR. 8000	15 12 72	120	P P F G E	100	900	900	900	900	890	900	95	850	850	850	850	850	850
008300	E	JOB NR. 8300	15 12 72	60	G G E E F	70	500	510	520	500	490	500	60	400	410	425	390	400	400
009000		JOB NR. 9000	15 12 72	60	G G E E F	80	600	610	620	600	580	600	50	500	510	520	490	500	500

TABLE IX

PROCEDURE TIME MODEL REPORT

order to dampen any violent or sudden changes on the basis that such deviations are unusual, and while they may key a trend, cannot be deterministic in major model shifts. The original predetermined estimate carries a double weight in the formula and serves two purposes. First, if the installation experiences large productivity gains, the predetermined estimate holds the model back thus giving the operators a greater initial reward. It prevents the standard from reaching the new high thus guaranteeing continuing rewards for universal outstanding productivity and provides a continuing incentive to maintain this high level. Also, it softens the blow of any sudden drop in productivity from this high level. The second reason for including the predetermined estimate is in the case where productivity declines below the initial level. In this case the predetermined level will assist in keeping the carrot before the cart, highlight low productivity, and protect a downward spiralling installation by slowing the decline of the model.

The new Procedure Time Model will be used the following month. The reason for the delay is to give management a full opportunity to review the recalculation and take action in the case of questionable deviation. The report shown in Table IX will be provided. The report lists all procedures first in procedure number sequence and then again in procedure number sequence within percent change in Procedure Time Model.

3. Sensitivity Analysis

There are many factors that can change the productivity level of an installation. Some are subtle and occur without identification, some are dramatic and of obvious origin. Some are difficult to measure and all will rapidly invalidate any fixed productivity indicator. The basis of this system, the Procedure Time Model, is an indicator that will slowly drift upward or downward as changes occur to effect productivity. It can accommodate many factors, but some could create such a large shift in productivity that it would be better to start over and recalculate the predetermined time model

(a) Factors that Suggest a Need for Recalculation

The most obvious need for recalculation would be a change in hardware. Such changes are usually made due to aspirations for higher productivity. It is best in such cases to recalculate after the operators have a few months experience on the new machines and new time trials are run.

(b) Factors for which Adjustment can be Automatic

Minor changes in the workspace environment, organization, or personnel can be accommodated by the Procedure Time Model update. Any new procedure or change to an existing procedure will involve a recalculation, but the recalculation is performed automatically by the program that updates the system file. If management disagrees with any resultant model, methods are available to set the time where desired via a management override card.

B. THE OPERATOR IDENTIFICATION FILE

The Operator Identification File is an input to the system file. The Operator Identification File consists of one record for each keypunch employee. This includes all keypunch supervisors but not remote terminal operators. The operator identification record contains the operator's name, number, shift, pay grade, and step. The format of this record is provided in APPENDIX B. The Operator Identification File is combined with the procedure documentation and processed by Computer Program Number 2 in the creation of the system file. Operator identification records coded add, change, or delete are also processed by this program in follow-on updates to the system file.

C. THE SYSTEM FILE

There is one file in the system and it can be maintained on cards, tape, disk, drum, or data cell with appropriate modifications to the COBOL program file description and the Job Control Language (JCL). The file contains three records - the operator identification record, the procedure description header, and the Procedure Time Model. The format of each of these records is provided in APPENDIX B.

The files are created and updated by Computer Program Number 2. The input to the program consists initially of the Operator Identification File and the procedure documentation. Updates are performed by the same program by inputting operator identification and procedure documentation records coded add, change, or delete as described in the input description documentation for Computer Program Number 2. Any Procedure Time Model can also be changed by a management override card which is a specially coded card in the format of the Procedure Time Model record as shown in APPENDIX B and described in the input description documentation for Computer Program Number 2.

D. INPUT DATA COLLECTION

Many of the new key-to-tape, key-to-disk and buffered punch hardware systems will provide production data either in the form of a punched card or a data bank that can be retained until requested. Such methods are superior to manual methods since they are usually more accurate and reduce the clerical operation time of entering such data in a utilization log. For the purpose of this system, however, a batch control form will be utilized to provide uniformity and ease of future modification as the newer hardware becomes available.

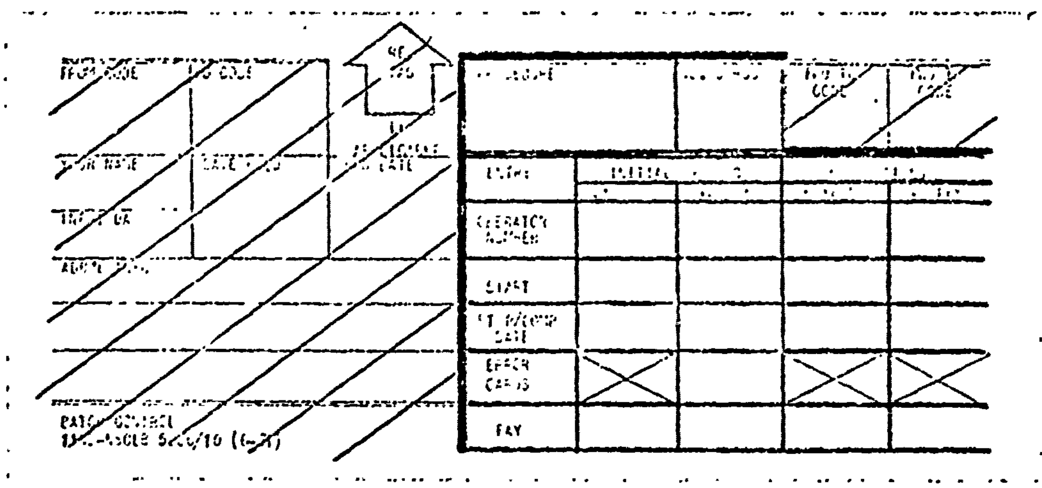
In addition to the production statistics obtained from the batch control form, the supervisor is responsible for reporting exception utilization of employee manhours and a daily measurement of all work queued for processing.

1. The Batch Control Form

The batch control form, shown in Table X, will arrive in keypunch or at a keypunch hotline with the procedure block

TABLE X

THE BATCH CONTROL FORM



and number of source documents block already completed. In the main keypunch unit, the supervisor is responsible for control over all jobs. If the data entry hardware does not have a record counting capability, the supervisor must verify the record count. Additionally, many requests do not contain an economical batch size and must be bundled together with a master batch control form, processed, and separated again by the supervisor after job completion.[27] Some jobs contain too many records for one employee to efficiently start and complete in the remaining time available; such jobs must be split apart

[27]The definition of an economical batch size varies from installation to installation. An economical batch according to this thesis will be a batch that contains sufficient source documents to occupy an operator for 45 to 50 minutes.

by the supervisor, separate batch control forms attached, processed, and rejoined by the supervisor at job completion time. The point being made is that the supervisor should not be a pail passer in the local fire brigade. Rather, the supervisor should exercise control over batch sizes to obtain economically sized jobs and equitably distribute the work to the operators.

Upon receipt of a job, the operator will enter her two digit operator number and the start time. The verifier will make the same entries plus an additional entry on the number of cards that contained errors. All operators will enter the appropriate two letter pay code if they are working other than regular time, i.e., night time differential (NT), overtime (OT), compensatory time earned (CE), or holiday premimum (HP). As each operator completes the job she will enter the stop time. If there were no errors, the corrections section will be left blank. If the verifier operator makes the corrections, only the verifier column is completed. If a keypunch operator makes the corrections and then a verifier operator verifies the corrections, the two operators will enter the production data in the corrections block identically to the way it was entered in the initial process block. Since correction time is not considered as qualifying time for incentive calculations, the start and stop times for such operations must be entered on the batch control form by the supervisor when the job is assigned and returned completed.

The operators at the hotline stations will receive the same batch control form on jobs submitted but need only complete the initial process section by entering their operator numbers and pay type if other than regular. Any additional clerical effort would be detrimental to the function of hotline. Since there is presently no incentive plan for hotline operators, some equitable rotation plan should be initiated by the installation for these employees.

Upon completion of the keypunch and verification evolution the batch control form is removed by the supervisor and retained for punching and inputting to the system. In commands where it is desirable to have a copy of the batch control form continue on with the job or be returned to the user, the printing of the form on carbonless (NCR) paper has been beneficial.

It should be noted that while the job start and stop time is written on the batch control form during the initial processing of the job, elapsed job time is not a production effectiveness data element. The production effectiveness and incentive reward calculations are based on comparing the time allowed by the Procedure Time Model to the time available for production. The time available for production is defined as the workday less all authorized absences such as breaks, correction time, and those operations listed in Table XI. For this reason, the Supervisor Exception Log, to be discussed next, is of importance to the system.

2. The Supervisor Exception Log

The keypunch supervisor must provide data on all exception utilization of employee manhours. Such reporting will include all types of absenteeism, training, clerical, and non-standard keypunch assignments. The shift supervisor will enter in the Supervisor Exception Log, shown in Table XII, the total number of hours each employee spends each day performing the duties listed in Table XI.

TABLE XI

EXCEPTION WORK CODES

OPERATIONS	CODE
Clerical work..................................	CL
Formal classroom training.....................	TF
On-the-job training or informal training......	TJ
Training assignment to the TAB room...........	TB
Annual leave..................................	LA
Sick leave....................................	LS
Holiday leave.................................	LH
Administrative leave..........................	LE
Compensatory time taken.......................	CT
Assignment to a Hotline (keypunch)............	HK
Assignment to a Hotline (verifier)............	HV
Assignment to a remote terminal (temporary)...	RM

The Supervisor Exception Log may be maintained in either a log book, a lined pad, or a special form. It should be similar to the format shown in Table XII. The operator's numeric operator number (1 to 3 digits) will be entered followed by the work code from Table XI. The time so spent in hours and tenths will be entered as will the appropriate pay scale code from Table XIII.

TABLE XII

SAMPLE SUPERVISOR EXCEPTION LOG

DATE	OPERATOR NUMBER	WORK CODE	HOURS & TENTHS	PAY TYPE
12/15/72	05	LA	8.0	
	10	TF	1.0	
	12	CT	8.0	
	07		5.7	ND
	07	TJ	3.0	ND
	25		5.7	ND
	25		1.0	OT
	25		1.0	NS

TABLE XIII

PAY CODES

FUNCTION	CODE
Regular time.................................	BLANK
Night-time differential during normal shift hours	ND
Night-time differential outside normal shift hours while earning overtime, holiday premium, or compensatory time......................	NS
Overtime......................................	OT
Earning compensatory time....................	CE
Holiday premium.............................	HP

The supervisor exception log will also be used to accurately report employee manhours spent earning additional pay such as overtime or night-time differential. The supervisor will enter the operator's number as before, but the work code will be left blank since the actual work performed will be reported via a batch control form or another supervisor log entry. This entry is only to accurately report exception time for payroll purposes, not to report what work was done. The time will be entered in hours and tenths followed by the pay type from Table XIII. The following explanations are offered of the entries in the sample log to help clarify the use of the log.

OP NR 05 - took one day annual leave.

OP NR 10 - Had one hour formal classroom training.

OP NR 12 - Took one day off after having earned 8 hours compensatory time.

OP NR 07 - A normal swing shift employee who received her normal 5.7 hours of night-time differential and three hours of on-the-job training during the part of her shift where she was earning night-time differential.

OP NR 25 - A normal swing shift employee who received her normal 5.7 hours of night-time differential but after the end of the shift, worked an additional hour of overtime. Since she normally earns night-time differential, she will also earn night-time differential while she is earning overtime but because it is outside her normal hours, the code used is "NS" vice "ND."

3. Backlog Statistics

Backlog statistics are reported as of a fixed time each day for input to the optional MUACS routine for Naval Supply Centers. Since the term "backlog" is open to many interpretations, it will be defined as being all work in progress and queued for processing. The format shown in Table XIV will be utilized to record the necessary information. Either a log book or a lined pad should provide a satisfactory form.

The supervisor will enter the date in the log and the procedure number of each job backlogged. If the job is at the point where both punching and verifying are required, the code entry will be left blank. If the job has been punched but not verified, the code "V" will be entered in the code column. The input document count from the batch control form will be entered as the volume.

TABLE XIV

BACKLOG STATISTICS LOG

DATE	PROCEDURE NUMBER	CODE	VOLUME
12/15/72	238D2		1,000
	038S1		345
	038S1		986
	038S1		543
	038S1	V	245
	465D2	V	123
	543A1	V	253

E. CALCULATING PRODUCTION EFFECTIVENESS AND THE INCENTIVE REWARD

Two calculations are made in evaluating employee performance. The first is to calculate a production effectiveness indicator that will be used for comparing group performance, employee performance, and performance trends. The second calculation is to determine the incentive rewards earned.

Employee production effectiveness is determined by taking the ratio of how long the job should have taken to how much time was available to do the job. The time allowed to perform a job is calculated by multiplying the respective Procedure Time Model by the volume of records in each job performed. Because no operator can or will work 60 minutes of every hour or maintain top speed throughout the day, an extra allowance is applied for Personal, Fatigue, and Miscellaneous time. This allowance is in the form of a management set percentage of total allowed keying time with 15% being used in this thesis. An additional five minutes per job is added to account for set-up time. The time available to perform the work is calculated by taking the basic time available or 7.5 hours (8 hours less 1/2 hour to account for two authorized 15 minute breaks) and subtracting all non-productive time reported in the Supervisor Exception Log and time spend in making or verifying corrections. This ratio is shown in the formula in Table XV.

The incentive reward calculation uses the same concept of available time and the production effectiveness indicator in determining the number of incentive hours earned. These hours earned may either be reported as incentive hours earned for pay or time off purposes depending upon the option selected by the operator. The incentive reward calculation employs an incentive base factor that determines at which point incentive calculations are to start. In a labor market where the hours of work offered by the workers equals the hours of employment offered by management this factor is 100. If the market is

TABLE XV

PRODUCTION EFFECTIVENESS FORMULA

$$PE = \left[\frac{\dfrac{p\left(\sum_{i=1}^{n} m_i v_i\right)}{100,000} + \dfrac{n}{12}}{7.5\ t_a - t_e} \right] - \left[-4 + \frac{7}{3}e \right]$$

where:

p = Personal, Fatigue, and Miscellaneous Time Factor (set at 1.15 for 15%)

m_i = Procedure Time Model time in TMU's (100,00 TMU = 1 hour) for job i = 1, 2, ...

v_i = record volume of job i = 1, 2, ...

n = number of jobs performed

t_a = time available expressed in work days

t_e = summation of the exception times reported in the Supervisor Exception Log and the time spent making or verifying corrections.

e = average error rate if 2% or more (applied only to the keypunch PE portion of overall PE)

such that the supply of worker hours is below the hours required at a particular wage rate, the incentive base factor may be decreased as necessary in order to generate the increased wage rate needed to secure employees. The advantage here is that no modification need be made to a formal wage plan used for other employees and the incentive wage plan can be used to adjust to labor market fluctuations. The formula for incentive hour calculations is shown in Table XVI.

TABLE XVI

INCENTIVE HOURS FORMULA

$$\text{INCENTIVE HOURS} = \left[7.5\ t_a - t_e\right]\left[\frac{PE - I}{200}\right]$$

where:

t_a = time available expressed in work days

t_e = summation of the exception time reported in the Supervisor Exception Log and the time spent making corrections

PE = Production Effectiveness

I = Incentive base. A base effectiveness level from which incentive calculations will be made. This thesis will consider all performance above 100% (I = 100) as qualifying for incentive rewards.

There are three critical data elements in the calculations of Production Effectiveness and Incentive Hours that demand careful attention. These elements are the Procedure Time Model, the input volumes, and the inputs from the Supervisor Exception Log. If any one of these inputs is reported in error either through design or neglect, the incentive hours earned would be wrong and the results could be expensive in terms of payroll funds and employee attitude. If these three elements are monitored, the system will provide an incentive whose limit is dictated only by the probability of an operator surpassing the average performance of the installation. For example, if an operator performs 120 hours of work in 80 hours, she will receive 20 hours of incentive pay or time off, but the probability of any operator performing 120 hours of work in 80 hours is very small. Since this system has never been implemented, no actual ceiling has been observed. Nevertheless, an attempt at predicting system cost behavior will be made in Chapter VIII.

The report shown in Table XVII is produced by Computer Program Number 3. The report is provided at the individual, shift, and installation total levels. The individual level report is provided for employee counselling and performance evaluation. The shift reports and competitive group reports are provided for publication of group competitive indicators on a simple graph in the workspace and review by the unit supervisor. The installation level report is provided for review by higher levels of data processing management.

F. MUACS OPTION FOR NAVAL SUPPLY CENTERS

As a part of the Defense Integrated Management Engineering Systems Survey Program (DIMES) the Management Utilization and Control Standards Program, or MUACS, was developed for use in the Naval Supply Centers. MUACS is designed to measure employee productivity for all tasks performed at a Naval Supply Center. It consists of a table of standards that are matched with actual employee performance to form a ratio of employee productivity. The standards for keypunch are engineered standards based on Time and Motion Study where, like this thesis, the unit of measurement is the Time Measurement Unit expressed in hours where 1 TMU = .00001 Hours.

PRODUCTION REPORT - INDIVIDUAL

REPORT FOR MARCH 1972

DODSON, GLENDA   OPERATOR NUMBER 012   SHIFT 1   GRADE GS-03   STEP 02

INCENTIVE TIME AVAILABLE	INCENTIVE TIME ALLOWED	KEYPUNCH ERROR RATE	PRODUCTION EFFICIENCY RATE	INCENTIVE HOURS EARNED	EMPLOYEE UTILIZATION RATE
64.0	70.3	0.0%	109.0%	2.6	80.0%

FUNCTION	JOB ORDER	RG REGULAR	ND NITE DIFF	OT OVER TIME	CE COMP EARN	HP HOL PREM	TOTALS
NORMAL PRODUCTION							
KP EASY	622A 00108	14.5	0.0	0.0	0.0	0.0	14.5
KP NORM	622A 00109	38.1	0.0	0.0	0.0	0.0	38.1
KP DIFF	622A 00110	35.3	0.0	0.0	0.0	0.0	35.3
VR EASY	622A 00111	0.0	0.0	0.0	0.0	0.0	0.0
VR NORM	622A 00112	0.0	0.0	0.0	0.0	0.0	0.0
VR DIFF	622A 00113	0.0	0.0	0.0	0.0	0.0	0.0
MISCELLANEOUS							
CLERICAL	6224 00110	22.9	0.0	0.0	0.0	0.0	22.9
CORRECTION	6224 00110	12.0	0.0	0.0	0.0	0.0	12.0
TRAINING	620N 00082	1.0	0.0	0.0	0.0	0.0	1.0
OJ TRAIN	6224 00110	1.0	0.0	0.0	0.0	0.0	1.0
TAB RCOM	6212 00100	1.0	0.0	0.0	0.0	0.0	1.0
ABSENT FROM WORK							
ANNUAL LV	620N 00150	0.0	0.0	0.0	0.0	0.0	0.0
SICK LV	620N 00151	0.0	0.0	0.0	0.0	0.0	0.0
HOLIDAY	620N 00155	0.0	0.0	0.0	0.0	0.0	0.0
ADMIN LV	620N 00158	0.0	0.0	0.0	0.0	0.0	0.0
COMP TKN	620N 00160	0.0	0.0	0.0	0.0	0.0	0.0
HOTLINE OPERATIONS							
KEYPUNCH	622A 00117	0.0	1.0	1.0	0.0	0.0	2.0
VERIFY	622A 00118	0.0	0.0	0.0	0.0	0.0	0.0
REMOTE OPERATIONS							
ALL	621A 00101	0.0	0.0	0.0	0.0	0.0	0.0
TOTALS		80.0	1.0	1.0	0.0	0.0	82.0

TABLE XVII

PRODUCTION REPORT (INDIVIDUAL)

The actual performance is reported in workunits completed (records punched or verified) and the time consumed to perform the task. For example, if a standard allowed .00620 hours per record punched and an operator punched 1000 records in 7 hours, the production efficiency would be (.00620 x 1000) / 7 = .885 or 88.5%.

The report shown in Table XVIII is provided as an optional feature of Computer Program Number 3. It lists the work units (record count) completed and backlogged under the various production categories of the MUACS system. It is designed to facilitate the data collection effort for the Naval Supply Center MUACS system, but may provide information of interest to any data processing installation.

MUACS REPORT

	WORK UNITS:	COMPLETED	BACKLOGED
NORMAL PRODUCTION			
KP EASY	622A 00108	2,000	100
KP NORM	622A 00109	4,400	200
KP DIFF	622A 00110	3,500	300
VR EASY	622A 00111	2,000	100
VR NORM	622A 00112	4,400	200
VR DIFF	622A 00113	3,500	300
HOTLINE OPERATIONS			
KEYPUNCH	622A 00117		
VERIFY	622A 00118		

TABLE XVIII

DIMES/MUACS REPORT (optional)

VII. SELECTION OF KEYBOARD DATA ENTRY SYSTEMS

In the family of data entry equipment, genus "keypunch," there are four species: card punch and card verifier, buffered card punch/verifier, key-to-non-compatible and key-to-compatible computer tape, and key-to-disk or drum. Depending upon the volume and nature of the data preparation evolution, each machine could be optimal in the data processing environment.

Card punch and card verifiers of the IBM 029 and 059 variety are direct descendants of the machines in use over the past seven decades.[28] Their use is best confined today to small decentralized operations and areas where the electronics expertise of maintenance personnel may be a problem (i.e., combat zones, shipboard use). The primary drawbacks of this equipment are that: (1) mechanical speeds are significantly slower than electronic speeds in duplication and skipping, (2) error correction is clumsy, (3) separate machines are required for entry and verification, (4) there is an 80-column limitation per record, (5) it is difficult to selectively verify multiple card records, (6) errors caught by computer validation must recycle through the entire process, and (7) mechanical equipment is subject to greater wear than electronic circuits.[29]

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[28] Cary, Robert F., "A History of Keyboard Data Entry Equipment," DATAMATION, June 1970, p. 79.

[29] EDP ANALYZER, Vol. 9, No. 10, October 1971, p. 11.

Buffered card punch/verifiers of the UNIVAC 1710/1701 and IBM 129 variety represent the latest evolution in card punching. They are vastly superior to the prior types in that they perform all entry operations electronically in one 80-column buffer, while the alternate 80-column buffer is being mechanically punched. For operations that cannot eliminate their dependency on the punched card, this is the best alternative.

Key-to-non-compatible and key-to-compatible computer tape are similar to each other except that the former uses tape cartridges and the latter uses standard computer tape reels. The advantage of this type of equipment is that the 80-column barrier is potentially broken, and yet each station is a stand alone machine. Disadvantages include (1) relatively high set-up time, (2) difficulty in interrupting jobs, (3) lost time and motion due to the fact that errors caught at computer validation must recycle through the entire process, and (4) mechanical equipment being subject to greater wear than electronic circuits.[30]

Key-to-disk or drum represents a significant improvement in data entry equipment capability because of increases in productivity due to the replacement of mechanical machine functions with electronic circuits and the ability of its small on-line computer to manipulate and validate data. Key-to-disk or drum combines the best of the potentials of variable

[30] Ibid., p. 12.

length records, electronic speeds, and format control. Since its use is new, it will be the topic of the remainder of this chapter.

Most of the available literature on the subject of key-to-disk or drum can be divided into two categories - one dealing with hardware specifications, and the other with the results experienced by companies that have installed the equipment. The approach taken in the remainder of this chapter is similarly divided.

The first task was to develop general and specific hardware requirements based on the advice and recommendations offered by private and Navy sources.[31] The requirements outline the features that should be considered in comparing different systems.

The second part of this chapter reports on the experiences of a few Navy installations and private companies that have utilized key-to-disk or drum equipment. The Naval Supply Center at Newport, Rhode Island, has been the Navy's test site for this type of equipment since 1970. Since 1971, the Naval Supply Center at Oakland, California, has installed a system and in September 1972, installations took place at the Naval

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[31]The specifications represent a composite of:

(a) EDP ANALYZER, Vol 9, No. 9, September 1971.
(b) EDP ANALYZER, Vol 9, No. 10, October 1971.
(c) Trimble, G. R. and Penta, A. J., "Evaluation of Keyboard Data Entry System," DATAMATION, June 1970, p. 93-99.
(d) Interview with CDR John Briggs, SC, USN, Director of Data Processing, Naval Supply Center, Long Beach, California, 17 July 1972.

Supply Centers at San Diego, Long Beach, and Puget Sound. In addition to reporting on what action the Navy has taken, a sampling of civilian industry experiences is offered in further support of the value of key-to-disk or drum systems.

A. HARDWARE REQUIREMENTS

1. General Hardware Description

a. Configuration

Each system is comprised of a processor, an immediate access storage device (disk or drum), a magnetic tape unit, a supervisory console, and keyboard entry stations, as shown in Table XIX on page 127.

b. Processor

The processor has sufficient speed, capacity and capability to simultaneously process all data entered from the key data entry stations connected to the system; to control all input, storage, and output devices including the supervisory console; and to perform data management operations.

c. Immediate Access Storage Device (Disk or Drum)

The on-line immediate access storage devices are available in a wide range of capacities. The device accumulates the data entered, displays the data for key verification, and permits selective pooling of output jobs onto the magnetic tape device. It may also be used to receive data from the tape device for further entry - a process called "turnaround." The immediate access storage device is not connected to the main frame computer system of the installation. The average access time of the immediate access device is 150 milliseconds. The systems have warning indicators when the device is approaching capacity.

d. Magnetic Tape Unit

The tape unit is capable of reading and writing standard 10 1/2-inch diameter, 2400-foot reels of computer-compatible tape at 800 bits per inch in either 7- or 9-track configuration. The drives move the tape during data transfer at a minimum of 20 inches per second. Immediate read-after-write checks with error indication and retry capability are provided.

2. Specific Hardware Requirements

a. Keystation

(1) It should have a standard IBM 029 style, sixty-four character set layout.

(2) It should display by non-hard-copy means at least the last character entered and preferably the entire record. Displays must be in English graphic.

(3) The position indicator must be prominently displayed.

(4) Position control features must permit back-space and forward space by character, by fields, and by record during either entry or verification.

(5) The control switches must be convenient to operate but must preclude the likelihood of accidential operation.

(6) The keystation should consist of a desk-like structure with a surface for source documents (11" x 14"), keyboard, and display device.

(7) The system must be capable of both entry and verification at each station.

(8) The system must permit the start of verification by a second operator at another station anytime after 50 records have been entered.

(9) The system must be capable of correcting, deleting or adding records during entry or verification.

b. Formatting

(1) The system must be capable of providing up to four record formats of variable length to the operator for continuous or cyclic use during a job.

(2) The system must be capable of accommodating a library of up to 200 different variable-length formats.

(3) Updating the format library must be possible via a pre-recorded program library tape and through the supervisor's console keyboard.

(4) The same or different formats must be available to all stations at the same time.

(5) The format must be in the 0 to 200+ character range with no limit on the number of fields per record.

(6) The format must provide for automatic and/or operator controlled duplication and skipping, blank fill, left zero fill, and left or right justification.

(7) It is desirable that the device be capable of generating data for fields such as data or sequence number and cross-foot fields by adding, subtracting, dividing, or multiplying (i.e., extended price).

(8) It is desirable that the device be capable of reformatting input data so that the input format can be different from the output format.

c. Verification and Correction

(1) The system must provide key verification with keyboard lock and light on error.

(2) Verification must be possible by selected fields within records.

(3) It is desirable that verification by sampling be provided.

(4) The device must permit correction by back-spacing and rekeying one character, one field, or one record, with changes to all control totals being an automatic function of the system.

(5) The system must provide a means for handling uncorrectable errors.

d. Validation

(1) The system must provide a limit or range-checking capability for any field against a stored value.

(2) The system must be capable of accumulating batch totals on any field or set of fields, comparing these totals at job end with control totals entered by the operator

from a source document, and giving verification if they do not agree. Under verification, a zero balancing feature must be provided.

(3) The system must be capable of character validation by comparing entry fields with entries pre-recorded in a table or its equivalent.

(4) The system must accumulate and display at job end a record count of the number of records entered or verified.

(5) The system should provide for field checks and mandatory entry and completion fields.

(6) It is desirable that the system also provide range, value and/or total validation on the number of fields, length of fields, cross-field dependencies, and/or sequence checking.

(7) The system must provide some method of modulo check digit capability.

e. System and Software

(1) The system must operate all stations simultaneously, using either the same or different program formats regardless of mode (entry or verify). If one or more stations become inoperable, the other key stations must remain operational.

(2) The system must be capable, via a supervisory console, of initiating and transferring key entry data stored in immediate access storage to magnetic tape, or vice

versa (turnaround) without interrupting or degrading the performance and functions being accomplished at any of the key stations.

(3) The system must be capable of accommodating the interruption of a job at the end of a record within a batch, begin work on another job (the same or different format), and later resume keying on the former batch while maintaining all batch totals, production statistics, etc., separate.

(4) The system must permit a second operator to take over a job at the end of a record within a batch and complete the job while maintaining separate production statistics on each operator.

(5) All data transfers from or to main memory must be checked.

(6) The system must provide the capability of dumping data onto a "save tape" periodically during the work day, and on re-entering this tape to allow recapture of data that would have been lost in the event of equipment malfunction.

(7) The system must be able to control output tape blocking and header/trailer labels.

(8) The system must be capable of reformatting input data to meet output specifications.

(9) The system must be capable of locating a particular record using a 1 to 15 character search key and to have insertion/deletion capabilities with automatic control total and production statistic update.

(10) The system must provide the supervisor with status information by job and by batch on command, as follows:

(a) Keying started, suspended, not completed, not being keyed, and completed.

(b) Verifying started, suspended, not completed, not being verified, and completed.

(c) Transfer to tape started, cancelled, or completed.

(11) The supervisor must be capable of accomplishing, via the supervisory console, the following:

(a) Interrogate job and batch status.

(b) Load, add, delete or change program record formats.

(c) Initiate batch transfer of completed data from immediate access storage to magnetic tape.

(d) Establish jobs and/or batches.

(e) Delete records from the immediate access storage.

(f) Request display of production statistics.

(g) Receive system error messages if the system is not performing properly, such as disk error, non-recoverable tape error, etc., on a display device (hard copy or CRT).

(h) Display all communications between the supervisor and the key entry system (hard copy or CRT).

(i) Initiate tape entry operation of turn-around document processing.

(12) The system must provide the follc .ng production statistics by shift, operator, and job or a 24-hour basis via transfer to tape on supervisor command:

(a) Start date.

(b) Start time and stop time (or elapsed time).

(c) Stop date.

(d) Number of records.

(e) Mode (data entry or data verify).

(f) Number of errors, corrections and retries.

(g) Number of actual keystrokes.

This concludes the listing of the requirements which should be considered when evaluating key-to-disk or drum systems. The following section reports on the experiences of some Navy installations and private companies that have utilized key-to-disk or drum equipment. Unfortunately, these experiences start with a system already selected and evaluate it against previously used methods. Therefore, the experiences are (especially in the Naval Supply Center, Newport, evaluation) cost/benefit studies of a given representative system without comparison of detailed differences in characteristics and features as would be undertaken in selection of a new system. Although the studies lacked selection criteria, sufficient information was presented to compare the effectiveness of new key-to-disk or drum systems with previous methods.

B. NAVY EXPERIENCES

1. Navy Supply Center, Newport, Evaluation[32]

a. General Information

(1) Background. During the period December 1970 to March 1971, the Naval Supply Center, Newport, Rhode Island, conducted an evaluation of a key-to-drum data entry system. The system evaluated was the Key Edit Model 100 manufactured by Consolidated Computer International, Inc., Toronto, Canada. The test involved comparison of the Key Edit system against conventional keypunch/verifier equipment and NCR-735 key-to-tape equipment. The center had considerable experience with both types of machines. The systems were compared on the basis of difficulty and duration of operator retraining, operator productivity, accuracy of data preparation, system reliability, and overall system costs.

(2) Physical Configuration. The key Edit Model 100 is a computer controlled source data entry system in which data is entered through keyboards onto a magnetic drum storage unit. The data is subsequently transferred from the drum to a magnetic tape in logical batches for further processing on the main computer.

The keyboards are similar to those used on keypunch/verifer machines and on stand-alone key-to-tape machines.

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[32]Condensed from Kittock, K. E., LCDR, SC, USN., "Evaluation of Computer Controlled Source Data Entry Equipment: Final Report," Naval Supply Center, Newport, Rhode Island, April 1971, p. 1-45.

Each keyboard is capable of both entering and verifying data. NSC Newport has 12 keystations which replaced ten NCR-735's, three IBM 029's, and two IBM 059's. The Key Edit system can handle from 8 to 32 keystations.

Keystations are under the control of a mini-computer which provides time division multiplexing, i.e., time-sharing service, to each keyboard. The mini is a PDP-8 with a 12K core memory which is controlled by an operating system provided by the vendor. External control of the system (communication to and from the supervisor) is via a console teletype unit.

Intermediate storage capability is provided by a magnetic drum. Data is entered on the drum by the keyboards and is recalled from the drum by keyboards for verification. Drum layout is 128 tracks of seventy 80-character records each. Two tracks are required for program format storage and for portions of the operating system. Data capacity is therefore equal to 705,600 characters or 8820 card images. Larger drums are available.

Finished batches of input stored on the drum are transferred to magnetic tape by commands entered via the supervisor's console. The tape drive used is a 7-track, 556 BPI unit.

(3) Software and System Operation. The Key Edit system operates in an on-line and off-line mode. Data can be entered from all keyboards while the system is in the

on-line mode. All keyboards are locked out in the off-line mode.

The operating system is resident in the PDP-8 core memory while the system is operating in the on-line mode. It is loaded from the tape drive after a bootstrap loader is entered through the supervisor's console.

The operating system permits each operator to enter or verify data at electronic speed. As time-shared keyboards are substantially faster than the operator, she has the illusion of being on-line to the computer at all times. Program formats are entered onto the drum through the keyboard designated as logical keyboard 1. A maximum of 63 program formats can be stored; program formats are available to any keyboard by depressing the appropriate function key. A batch is identified by four alphanumeric characters. Batches may be opened, verified, and closed at any keyboard.

The operating system is constantly monitoring the status of the drum. The supervisor receives a warning on the supervisory console when the drum load reaches 94 tracks (32 tracks remaining). The warning is then repeated every four tracks. The operating system permits the supervisor to enter commands through the console to control key entry operations.

The only function which must be performed off-line (with keyboards inoperative) is dumping and restoring the drum. A drum dump is taken to preserve on magnetic tape the entire contents of the drum. This is a security feature which is employed to prevent the loss of source data entry work in the event of CPU or drum failure. It also ensures that a second copy of the data is available after a given batch has been released from the drum. The tape obtained from a drum dump is uniquely coded and not useful for subsequent processing. In the event this data is subsequently desired, it must be reloaded to the drum and then transferred to tape. Ten to fifteen minutes are required to dump a fully-loaded drum. NSC Newport is currently taking two drum dumps per day. The first dump is taken during the lunch hour, and the second is taken after the close of business. This schedule ensures that there is no loss of operator production manhours while the system is off-line.

b. Test Description

(1) <u>Source Data Applications</u>. The source documents employed in this evaluation are used in the Afloat Consumption Cost and Effectiveness Surveillance System (ACCESS) and the CSMP sub-system of the 3M system. The mix of source data employed in this evaluation is representative of the source data found in business-oriented data processing installations. These applications require alpha, numeric, and alphanumeric source data entry. They all require duplication of certain fields/characters, and some require left zero fill. Two of the primary source documents are the E&R and AR formats (NAVSUP 1250) which are conventional 80-column layouts.

(2) Operator and Supervisor Profiles. The operators selected for training on the Key Edit equipment are representative of the operators employed as NSC Newport. The profile of these operators is shown in Table XX. Nine of the ten operators had experience on the NCR-735 (employee #3532 is the operator who does not have such experience). However, employees #3385, #3532, and #3514 had been using 029/059 equipment for six months or more prior to the commencement of the Key Edit evaluation, while the other seven operators had been using NCR-735 key-to-tape units for six months or more prior to the commencement of the study. One of the supervisors was experienced in the operation of 029/059 and 735 equipment and the other had only IBM experience.

(3) Productivity Measurement. NSC Newport utilizes the Management Utilization and Control Standards Program, or MUACS, that was explained in Chapter VI, paragraph F. The production efficiency statistics based on six months' experience were available for the operators identified in the study. The approach employed by the study was to maintain the MUACS standard constant and observe any changes in individual production effectiveness that could be attributed to the new hardware.

(4) Reliability. The reliability of the Key Edit equipment was closely monitored throughout the evaluation. There are two general types of malfunctions which can occur

with computer-controlled source data entry equipment. The first type of malfunction involves only an individual keyboard. This type of malfunction occurred only once during the evaluation and is not considered significant. The second type is a malfunction in the central control unit. This type of failure is extremely critical because all operators are idle until repairs are effected.

The criterion for reliability was set out in the GSA contract with Consolidated Computer International, Inc., which stated: "All equipment furnished under this contract shall perform the function for which it is intended in accordance with the manufacturer's specifications and other representations at an average effectiveness level of 90%."[33]

(5) Operator Accuracy. The error rates of all keypunch operators are recorded and maintained by the data processing department under the Zero Defects Program. Consequently, a six-month mean error rate was available for each operator for the period prior to the test. This rate was to be compared with error rates recorded for the same operators using the Key Edit equipment during the test.

c. Test Results

(1) Training. Operator training consisted of four hours of individual keyboard instruction provided by

[33] GSA Contract #GS-00S-84492, 1 July 1970 to June 1971.

the vendor. This was augmented by periods of on-the-job training. It was determined that six to ten hours of this training were required for operators having recent key-to-tape experience and 12 to 16 hours were required for those operators with recent 029/059 experience. At the conclusion of the formal instruction and on-the-job training, the operators were capable of producing at a production and error rate acceptable to the data processing management of NSC Newport. Supervisors were trained in both keyboard (4 hours formal and 16 OJT) and system (8 hours formal and 12 OJT) operation. Management had been concerned about the ability of former key-punch supervisors to operate the mini-computer, but neither supervisor had any difficulty in mastering all control functions required. In summary, no significant problems were encountered in training either operating or supervisory personnel to handle the new equipment.

(2) Productivity. Table XXI and XXII show the production learning curve and data for the seven operators with recent NCR-735 experience. About one month was required for them to regain their previous mean production efficiency. From that point, productivity continued to rise over the remainder of the test period ending with a 12.2% mean production increase. Table XXIII shows the production learning curve for operators with recent 029/059 experience. About two months were required by these operators to regain their previous level of efficiency. Their production continued to

increase sharply after that point, ending the test period at a 27% higher rate. It should be noted that the curve was still trending upward, so 27% is a conservative estimate of the 029/059 operator productivity increase. Table XXIV compares the productivity of individual operators previously using 029/059 equipment.

(3) System Reliability. System reliability during the test period is summarized by Table XXV. As is shown, the percentage of "up" time averaged 95%, well within the 90% specified in the GSA contract. The overall reliability and performance of the Key Edit equipment was found to be highly satisfactory.

(4) Operator Accuracy. Tables XXVI and XXVII specify the error percentages achieved during the test by previous NCR-735 and 029/059 operators respectively. Both groups showed initial increases in errors, but as they gained proficiency with the Key Edit equipment, error rates were reduced below pre-test levels. A substantial portion of the increased accuracy experienced was attributed to the capability of the Key Edit equipment to display the last character entered/verified directly. The NCR units displayed a binary pattern which required translation by the operator. There is, however, no current agreement among data processing personnel regarding display of records. Some argue to display the entire record and others argue that the display

of the entire record detracts the operator's attention and degrades performance.[34]

(5) Cost Analysis. The method used in LCDR Kittock's study was to reduce all costs associated with the Key Edit, NCR-735, and 029/059 equipment to an individual keyboard/worker basis. The volume of work that can be accomplished by one average operator with one keyboard during a given period of time is based on the productivity results already given and can be expressed by the following relationships:

1.27 029/059 keyboards equal one Key Edit keyboard,

1.12 NCR-735 keyboards equal one Key Edit keyboard.

It was necessary to reduce the 029/059 keyboards to a composite keyboard since two separate keyboards are required to punch and to verify a given volume of work. Experience at NSC Newport indicates that the 029 keypunch is required approximately 60% of the time and the 059 keyverifier is required approximately 40% of the time for a given volume of work.

The full range of operating costs for four data entry systems are shown in Table XXVIII. A detailed description of the cost analysis is presented in Table XXIX. All equipment rental and labor costs have been equated to the productivity levels previously mentioned; therefore, the

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[34] EDP ANALYZER, Vol 9, No. 9, September 1971.

costs represent identical volumes of work for each system. It should be noted that the significant costs associated with the Key Edit system are the equipment rental, operators' salaries, and fringe benefits. The Key Edit system is cost effective, even if all other costs are excluded from the analysis.

(6) Comments on the Newport Study. One major shortcoming of the NSC Newport evaluation is that all changes in productivity were attributed to the new machinery. Certainly the Hawthorne studies and the findings of the many behavioral scientists discussed in Chapter IV have shown that worker productivity is not solely a function of hardware capabilities. Some attempt should have been made to evaluate the selected workers' attitudes before starting and before ending the test. Additionally, a control group, subjected to the same management attention while performing the same tasks on the old machinery, should have been used in comparison to the results of the test group in order to attempt to isolate the productivity increases that could be attributed to the new hardware.

2. Naval Supply Center, Oakland, Study

In June 1971, the Naval Supply Center, Oakland, requested from the Naval Supply Systems Command, installation of a key-to-disk data entry system for processing of all applications in support of tape-oriented computer systems. Their previous equipment was all of the 029/059 variety.

They offered as justification: projected increases in productivity, lower costs, and enhanced data entry procedures. They did not wish complete replacement of keypunch/keyverify equipment due to certain applications which utilized an IBM 360/20 card-oriented computer.

The part of their operation recommended for conversion was composed of 160 procedures or formats with a monthly average of 600,000 records. This eligible group was divided into three categories of data entry effort, each requiring a different mode of operation in a key-disk environment. Group one consisted of typical keypunch procedures that could be entered normally into a key-disk system. Group two involved input that required batch-balancing to an accompanying adding machine tape. Group three, the most unique category, was composed of Supply Operations Assistance Program (SOAP) documents. Data was received in the form of prepunched cards that required alteration of some data and/or addition of new data.

NSC Oakland listed three major requirements and three desirable features for a key-disk system that would handle their applications. The major requirements were: the ability to accommodate the SOAP application in a cost-effective manner when compared to keypunch/keyverify systems, the ability to accumulate batch totals when processing fiscal data, and an intermediate storage capacity of 39,000 80-character records. The last requirement was quantified as the result of a five-month study involving data entry requirements both in number and timing, and the costs associated with various amounts of storage. The three desirable features mentioned were: a dual system configuration, removable disk packs for intermediate storage, and a separate supervisory console. The dual system configuration (two 7-keystation systems instead of one 14-keystation system) was requested in order to provide additional flexibility by allowing various cross-connection schemes and to provide a hedge against the risk of processor or disk failure. Interestingly, two seven-station CMC-5 systems had a lower rental than one CMC-7 system with fourteen stations. A separate supervisory console for each system was desired because of the large number of formats and batches involved in each day's processing. Systems without separate consoles must be queried or directed through one of the keystations, thereby causing it to be totally preempted from production in Oakland's case. The removable disk pack feature was requested in order to gain flexibility in times of processor or equipment malfunction, or when high priority work overrides occur.

The cost-saving proposal submitted by NSC Oakland was based on a projected 25% increase in data entry activity. A revised proposal submitted in 1972 predicted yearly savings of $59,340 for the CMC equipment. Primary savings components were in hardware (26 IBM 029/059 machines replaced by a 14-keystation system), and in personnel (six fewer operators required).

3. Naval Supply Systems Command Current Procurement

Almost two years ago the Naval Supply Centers began requesting in earnest for key-to-disk or drum hardware. The results of the Newport study had become known, and interesting tales of significant gains were being reported in the trade journals.[35] The Naval Supply Systems Command in Washington, D. C., honored the request of NSC Oakland, but held the others in abeyance until a consolidated request could be drawn and the results of Newport and Oakland studied in greater detail.

A solicitation of proposals is currently being prepared for issue in September 1972. On the basis of this solicitation, a single hardware manufacturer will be selected and hardware installed at all tidewater supply centers and inventory control points. In the interim, permission has been granted to the west coast tidewater supply centers to install CMC-7 systems.

C. CIVILIAN CORPORATE EXPERIENCES

1. Bonus Gifts Incorporated[36]

Bonus Gifts, Incorporated is a firm involved in the redemption of coupons carried on some 500 grocery products.

Their old system involved twelve IBM 2260 CRT terminals on line to an IBM 360/50. They decided to install a Redcor

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[35]See DATAMATION, June 1970.

[36]EDP ANALYZER, Vol. 9, No. 10, October 1971, p. 1.

Key Logic key-to-disk system with ten stations. The main reason for the change was a desire for an offline system independent of CPU availability. They also hoped for increased accuracy due to the Key Logic's edit capabilities.

The results of the conversion were impressive. In the first six months of operation, average operator productivity increased 25%. Operator requirements decreased from 8 to 10 full-time people to 6 to 8, and average productivity went from between 12,000 and 15,000 average keystrokes per hour to between 15,000 and 18,000. The error rate fell from over 5% to about 1/2%.

The Key Logic processor has been programmed to perform a number of validity checks. It rejects alpha characters in designated numeric fields. It checks to see if a field value is one of a specified set or within a pre-determined range. It also performs check digit validation and control total balancing. Because of these automatic validation capabilities, Bonus Gifts has found that key verification is required on only one field of each record type.

2. <u>Xerox Data Systems</u>[37]

Xerox Data Systems is the computer manufacturing division of Xerox Corporation. The company set three goals to be met by a new data entry system:

a. Higher productivity per operator,

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[37] <u>Ibid</u>., p. 2.

b. Ability to handle an increasing workload and at a reduced data conversion cycle time, and

c. Easy retraining requirements.

They selected a CMC-9 Key Processing System because they were able to contact six users of the system, all of whom were pleased with it, because the system provided a large 7 1/4 million character) disk storage, and because other users' experience indicated a retraining time of about two days was required to make operators productive. They ordered a system having 15 keystations and one supervisor station to replace 17 keypunches and verifiers. They would have had to add more keypunches and hire more operators due to the increasing workload had they not converted to the CMC-9. In an eight-month period, the system was down twice - once for twenty minutes and once for an hour. Their error rate went from 2% to below 1%, some weeks being virtually error free. A productivity increase of 24% for an average operator on an average job was realized. They have experienced 25% to 40% less turnover of operators leaving with no reason.

3. <u>Columbia Broadcasting System</u>[38]

A regional data processing center of the Columbia Broadcasting System in Hollywood, California, recently replaced a two-site operation totaling nine keypunches and six verifiers with a six-station Inforex system at a single location. Their operator requirements were reduced from ten

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[38]*Ibid.*, p.

to eight. Input equipment rental costs were reduced by 10% and both floor space and supply costs went down. Production rates went from an average of 10,000 keystrokes per hour to 13,000. CBS is planning to do batch proofing and file maintenance on the system to reduce main computer time.

4. Blue Cross[39]

A much larger operation was converted at Blue Cross of Southern California. They converted from an NCR-735 key-to-tape system to a 60-station CMC-9 key-to-disk operation. One of the biggest advantages to Blue Cross involved the limited verification feature. They redesigned their record formats incorporating some of up to 480 characters which greatly simplified procedures. With the Key Processing system, any individual field may be selected for verification. They recorded productivity increases of 15% to 20% over the tape units. Although keying speeds remained about constant, reduced time in tape handling and program loading accounted for the increased productivity. Elimination of pooling needed for consolidation of like records for submission to the computer equipment resulted in $2500 per month savings and 10% savings on other hardware. Operator requirements were lowered by five, and it is anticipated that fewer operators and supervisors will be required to handle an increasing workload. Retraining times for operators was one day, and

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[39] Landon, J. R., "Data Preparation at Blue Cross," DATAMATION, June, 1970, p. 91-92.

they returned to previous output levels in one to one and one-half days as opposed to the one month time period required by such operators at NSC Newport. A 98.3% hardware reliability has been recorded.

D. CONCLUSIONS

The requirements of individual installations vary depending on the type of data being entered and the peripheral hardware on the installations' computers. These influences must be considered in any selection process. Keypunch/keyverify equipment or buffered card equipment is most efficient if the volume is low, cards are required, and/or operators are decentralized. Key-to-tape may be preferred in such an environment if the volume is higher or if variable record lengths are required. Key-to-disk or drum is most efficient in high volume, batch-entry operations where the data entry process is centralized. If a few jobs remain that require cards, a cost analysis should be performed to determine if it would be less expensive to retain standard punch/verify machines, to utilize key-to-tape or key-to-disk or drum equipment and have the main computer punch the required cards, or to obtain an optional card punch unit for use with a key-to-disk or drum system. The peripheral hardware of the CPU must also be investigated to ensure that it will accept the entry unit output without intermediate modifications. A comparison of various available entry hardware is presented in Table XXX.

One major advantage of key-to-disk or drum hardware that has not been fully developed is the potential of the equipment to restructure the workload by performing data validation. The power of the mini-computer to perform operations such as table look-up, range checking, field continuity, cross referencing, etc. offers to data processing management the ability to shift these time-consuming tasks from the expensive, over-burdened main frame.

It appears that shared processor keyboard data entry systems are a cost-effective possibility for many data processing installations. With the use of this equipment in these installations, the result should be an increase in the marginal physical product of keypunch machinery.

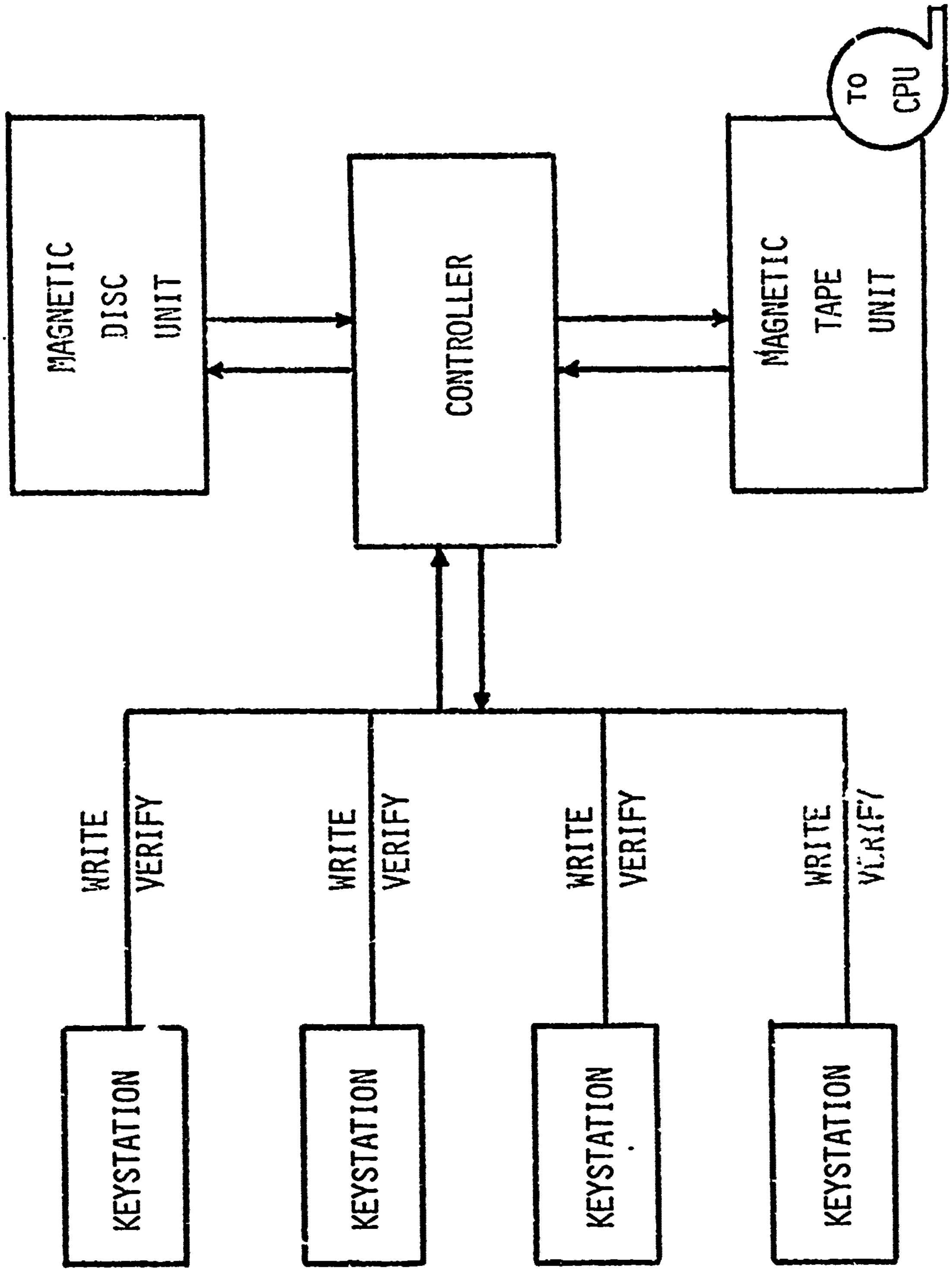


TABLE XIX

TYPICAL SYSTEM CONFIGURATION

TABLE XX

PROFILE OF OPERATORS ASSIGNED TO KEY EDIT EVALUATION

EMP. NO.	AGE	PREVIOUS EXPERIENCE (YRS) 029/059	PREVIOUS EXPERIENCE (YRS) NCR 735	MOST RECENT EXPERIENCE
2531	24	1.0	3.5	NCR 735
3333	28	0.3	2.5	NCR 735
3279	23	3.0	1.0	NCR 735
3520	22	1.5	0.25	NCR 735
3328	41	2.5	1.0	NCR 735
3383	21	2.0	1.5	NCR 735
2950	20	1.0	1.0	NCR 735
3385	21	0.5	1.5	029/059
3532	19	1.75	-0-	029/059
3514	22	4.25	0.25	029/059
MEAN	24	1.78	1.25	

TABLE XXI

PRODUCTION LEARNING CURVE

OPERATORS PREVIOUSLY USING NCR 735 EQUIPMENT

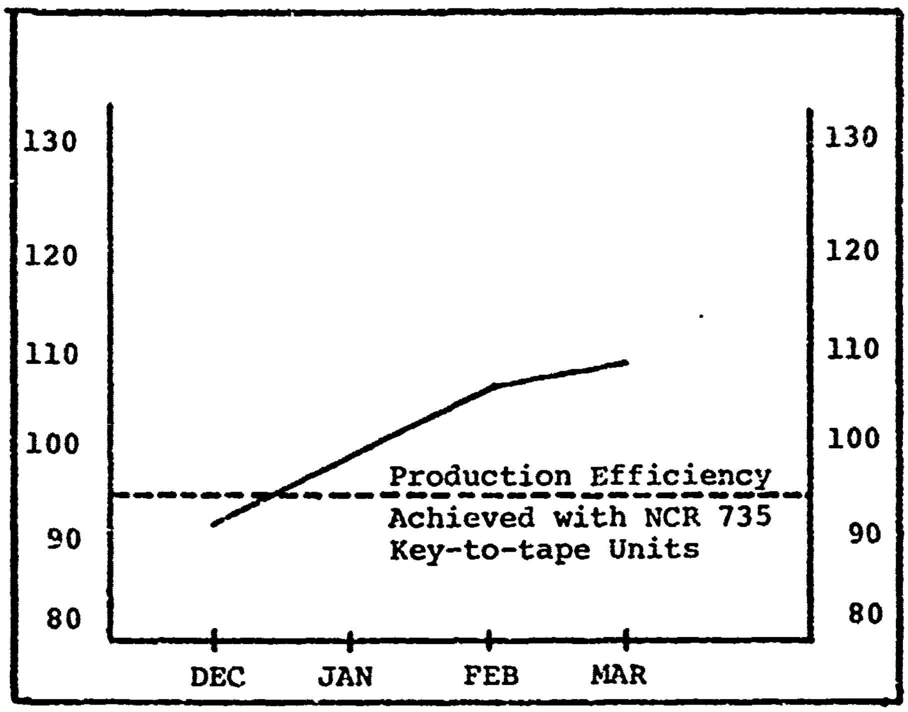


TABLE XXII

PRODUCTIVITY OF OPERATORS PREVIOUSLY USING NCR 735

EMP. NO.	NCR 735 MEAN 1/PROD. EFF.	KEY EDIT MEAN 2/PROD. EFF.	% INCREASE (DECREASE)
2950	102.8	122.4	19.0
3520	75.7	91.8	21.2
3383	98.9	106.5	7.6
2531	107.0	106.8	0.0
3333	88.1	105.1	19.2
3328	99.8	109.5	9.7
3279	91.0	101.9	11.9
MEAN	94.6	106.2	12.2

1/ BASED ON MAY-OCT 1970 PRODUCTION RECORD

2/ BASED ON FEB-MAR 1971 PRODUCTION RECORD

TABLE XXIII

PRODUCTION LEARNING CURVE

OPERATORS PREVIOUSLY USING 029/059 EQUIPMENT

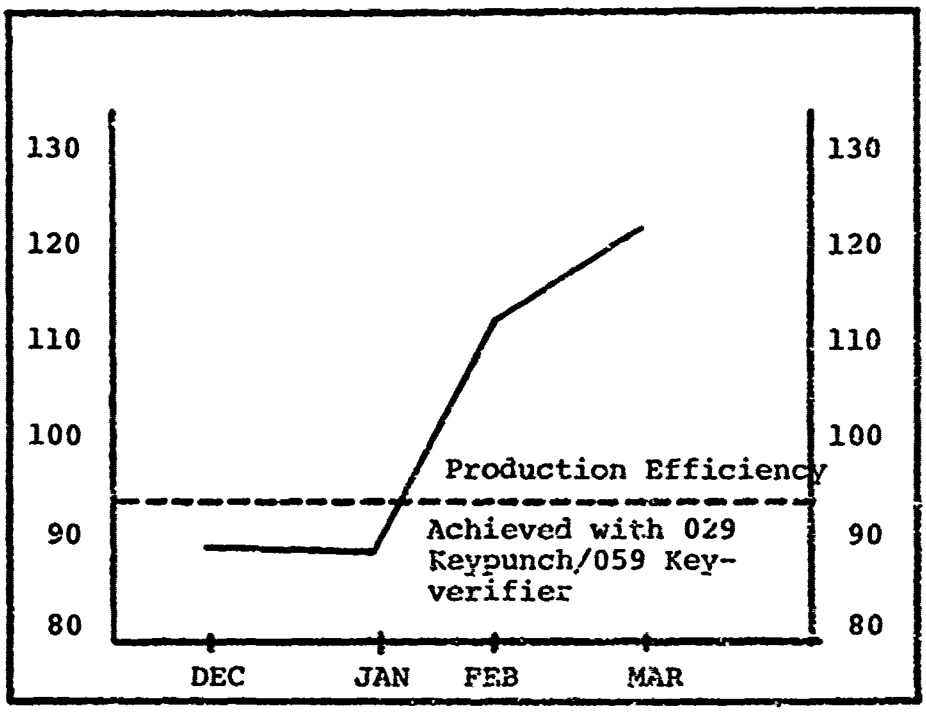


TABLE XXIV

PRODUCTIVITY OF OPERATORS PREVIOUSLY USING 029/059

EMP. NO.	029/059 MEAN 1/PROD. EFF.	KEY EDIT MEAN 2/PROD. EFF.	% INCREASE (DECREASE)
3814	108.7	129.1	18.7
3385	83.1	108.3	30.3
3532	82.9	113.3	36.6
MEAN	92.0	116.9	27.0

1/ BASED ON MAY-OCT 1970 PRODUCTION RECORD

2/ BASED ON FEB-MAR 1971 PRODUCTION RECORD

TABLE XXV

SYSTEM RELIABILITY

MON	SCHEDULED HOURS*	PRODUCTIVE HOURS	DOWNTIME HOURS	% EFFEC-TIVENESS
DEC	187.0	178.0	9.0	95.2
JAN	170.0	156.7	13.3	92.1
FEB	161.5	152.5	9.0	94.4
MAR	195.5	190.5	5.0	97.5
AVG.	178.5	169.4	9.1	94.8

*The scheduled hours are based on a system availability of 8.5 hours a day, 5 days a week.

TABLE XXVI

ERROR RATES
(PERCENT)
OPERATORS PREVIOUSLY USING NCR 735

EMP. NO.	1/NCR 735 (6 MO MEAN)	DEC	KEY EDIT EQUIPMENT JAN	FEB	MAR
2950	0.7	1.2	1.0	0.6	0.7
3520	1.7	3.3	2.8	2.0	1.6
3383	2.1	3.0	2.5	1.7	1.3
2531	2.4	3.9	2.2	1.6	2.0
3333	1.5	2.3	2.1	1.4	1.2
3328	1.6	2.3	1.9	1.3	1.2
3279	2.0	1.9	1.9	1.6	1.3
MEAN	1.6	2.6	2.1	1.5	1.3

1/ MEAN BASED ON MAY-OCT 1970 ERROR RATES

TABLE XXVII

ERROR RATES
(PERCENT)
OPERATORS PREVIOUSLY USING 029/059 KEY ENTRY UNITS

EMP. NO.	029/059 (6 MO MEAN)	DEC	KEY EDIT EQUIPMENT JAN	FEB	MAR
3514	1.7	3.1	1.6	1.6	1.5
3385	2.0	2.8	2.4	1.8	1.6
3532	6.4	5.4	3.7	2.8	2.1
MEAN	3.4	3.8	2.6	2.1	1.7

TABLE XXVIII

OPERATING COST PER KEYBOARD PER MONTH

	029/059	NCR 735	1/KEY EDIT 12 KB	2/KEY EDIT 20 KB
EQUIPMENT RENTAL	$110	$171	$153	$114
SALARY GS-3/1	584	516	460	460
FRINGE 10%	58	52	46	46
SUB-TOTAL	$752	$739	$659	$620
PUNCH CARDS	$ 24			
CARD SALVAGE	(4)			
CARD TO TAPE	12			
EDITING/POOLING AT 200 BPI		$ 37		
EDITING AT 556 BPI			$ 4	$ 4
CONTROL UNIT DOWNTIME			25	25
SUBTOTAL	$ 32	$ 37	$ 29	$ 29
TOTAL............	$784	$776	$688	$649

1/ KEY EDIT SYSTEM 100/100 WITH 716,800 CHARACTER DRUM (CURRENT INSTALLATION)

2/ KEY EDIT SYSTEM 100/85 WITH 1,427,600 CHARACTER DRUM

TABLE XXIX

FORMULATION OF MONTHLY OPERATING COSTS

1. 029/059

   a. Equipment Rental

   For a given volume of work, the 029 is required 60% of the time and the 059 is required 40% of the time. Cost of composite 029/059 keyboard is 0.6 x 85 + 0.4 x 89 = $86.60. Cost of composite keyboard adjusted to Key Edit productivity (throughput) level is $86.60 x 1.27 = $109.98.

   NOTE: IBM charges extra shift rental on this equipment. This increases the cost by 10% of 1/176th of the basic monthly rental for each hour over 176 hours that the average machine is used during the month.

   b. Salary

   GS-3/1 at $460 per month adjusted to Key Edit productivity (throughput) level is $460 x 1.27 = $584.20.

   c. Fringe Benefits

   10% Fringe is .10 x $584.20 = $58.42.

   d. Punch Cards

   Mean cards punched/verified per keyboard (based on March 1970 production) is 24,200. Mean cost per 1000 cards is $1.00. Punch card cost is 24.2 x $1.00 = $24.20.

TABLE XXIX (CONT)

e. Card Salvage

Card salvage value is \$.04 per pound, 24,200 cards weigh 96.8 pounds.

Card salvage is 96.8 x \$.04 = \$3.87.

f. Card-to-Tape Cost

Effective card read speed is 450 cards per minute.

Time required to read cards produced by one 029/059 keyboard is $\frac{24,200}{450}$ = 54 minutes.

Out-of-pocket costs associated with government-owned 1401 components required for card-to-type operation is \$13.50 per hour.

Card-to-tape cost is $\frac{54}{60}$ x \$13.50 = \$12.15.

NOTE: These costs may not be valid if cards are input directly to the main computer. However, except in the case of very low volume, the main CPU time would be more costly than card-to-tape conversion.

2. NCR 735

a. Equipment Rental

Keyboard rental is \$152.

Cost of keyboard adjusted to Key Edit productivity (throughput) level is \$152 x 1.122 = \$170.54.

NOTE: There is no extra shift rental for this equipment.

TABLE XXIX (CONT)

b. Salary

GS-3/1 at $460 per month adjusted to Key Edit productivity (throughput) level is $460 x 1.122 = $516.12.

c. Fringe Benefits

10% Fringe is .10 x $516 = $51.60.

d. Editing/Pooling at 200 BPI

UNIVAC 1500 cost is $14.75 per hour.

1.75 hours required for pooling.

0.75 hours required for editing.

Editing/Pooling cost is 2.50 x $14.75 = $36.87.

3. Key Edit 12-Keyboard Configuration

a. Equipment Rental

Monthly rental for Key Edit 100/100 system with 716,800 character drum is $1840.

Keyboard unit cost is $\frac{\$1840}{12}$ = $153.33.

NOTE: There is no extra shift rental for this equipment.

b. Salary

GS-3/1 is $460 per month.

c. Fringe Benefits

10% Fringe is .10 x $460 - $46.00.

TABLE XXIX (CONT)

d. Editing at 556 BPI

UNIVAC 1500 cost is $14.75 per hour.

0.25 hours required for editing.

Editing cost is 0.25 x $14.75 = $3.69.

e. Control Unit Downtime

$2.70 per operator/hour x 9.1 hours/mo. = $25.00.

4. Key Edit 20-Keyboard Configuration

a. Equipment Rental

Monthly rental for Key Edit 100/85 system with 1,427,600 character drum is $2280.

Keyboard unit cost is $\frac{\$2280}{20}$ = $114.

NOTE: There is no extra shift rental for this equipment.

b. Salary

GS-3/1 is $460 per month.

c. Fringe Benefits

10% Fringe is .10 x $460 = $46.00.

d. Editing at 556 BPI

UNIVAC 1500 cost is $14.75 per hour.

0.25 hours are required for editing.

Editing cost is 0.25 x $14.75 - $3.69.

e. Control Unit Downtime

$2.70 per operator/hour x 9.1 hours/month = $25.00.

TRADE NAME	MANUFACTURER	FULL TRADE NAME	CHARACTERISTICS OF DATA		
			CHAR-ACTER RANGE	MAX CHAR PER FIELD	MAX FIELDS PER RECORD
CMC-9	COMPUTER MACHINERY CORPORATION	KEYPROCESSING SYSTEM MODEL 9	1-240	64	32
KEY-EDIT	CONSOLIDATED COMPUTER	KEY-EDIT SERIES 100	20-240	RECORD SIZE	RECORD SIZE
DATA-TAPE 2100	GENERAL COMPUTER SYSTEMS INC.	DATA-TAPE 2100	1-200	50	
KEYPLEX	HONEYWELL DATA PRODUCTS DIVISION	KEYPLEX	1-400	400	400
INFOREX	INFOREX, INC.	INFOREX KEY ENTRY STATION 2901 Keystation 1301 Control Unit	16-125	125	125
LC-720 KeyDisc	LOGIC CORPORATION	LC-720 KeyDisc System	1-160	RECORD SIZE	RECORD SIZE
Key-Logic	PENTA COMPUTER ASSOCIATES, INC.	KeyLogic	14-400	200	57

COMPARATIVE TABLE OF KEY-TO-DISK SYSTEMS

TABLE XXX

TRADE NAME	EDITING		NUMBER OF STD FORMATS	KEYBOARD		DISPLAY		PROCESSOR	
	BEFORE RELEASE	AFTER RECORDING		IBM 029 COMPAT	TYPE	FORM	DISPLAY NR CHAR	PROGRAMMABLE	OPERATOR CHANGE
CMC-9	YES	YES	300	YES	SOLID-STATE	ALPHA-NUMERIC	1	YES	NO
KEY-EDIT	YES	YES	63	YES	SOLID-STATE	ALPHA-NUMERIC	1	YES	YES
DATA-TAPE 2100	YES	YES	none	YES		STRIP PRINTER	1 ALPHA AND 9 NUMERIC		
KEYPLEX	YES	YES	400	YES		ALPHA-NUMERIC	1-4	YES	
INFOREX	YES	YES	4	YES	SOLID-STATE	ALPHA-NUMERIC	125	NO (BY MFGR ONLY)	NO (BY MFGR ONLY)
LC-720 KeyDisc	YES	YES	1000	YES	SOLID-STATE	ALPHA-NUMERIC	1 (optional crt-240)	YES	YES
KeyLogic	YES	YES	200 + 1000 on tape	YES	IBM 029	ALPHA-NUMERIC	1	YES	NO

COMPARATIVE TABLE OF KEY-TO-DISK SYSTEMS

TABLE XXX

TRADE NAME	OUTPUT MEDIA						COSTS		
	COMPUTER FORMAT	NR OF TRACKS	REEL SIZE	BPI	IBM COMPAT	OPTIONS	PURCHASE	MAINTENANCE	RENTAL PER MONTH
CMC-9	CHAR SERIAL ASCII EBCDIC	7	10.5	556 800	YES		$98,000 10 stations	$336.	$2,225
KEY-EDIT	CHAR SERIAL ASCII EBCDIC	7 9	10.5	556 800	YES	CARD PUNCH PRINTER	$87,000 to $131,700	$400 to $630	$1,660 to $2,510
DATA-TAPE 2100	CHAR SERIAL	7 9	10.5	200 556 800 1600	YES		$155,000		$4,250
KEYPLEX	CHAR SERIAL ASCII EBCDIC	7 9		556 800	YES		$150,000		$2,800 to $3,800
INFOREX	CHAR SERIAL ASCII EBCDIC	7 9	8.5	556 800	YES		$25,000 processor $ 1,200 station	$50 processor $ 4 station	$560 processor $ 50 station
LC-720 KeyDisc	CHAR SERIAL ASCII EBCDIC	7 9	10.5	200 556 800 1600	YES	PAPER TAPE CARD PUNCH	$150,000	$510 14 stations	$2,500
KeyLogic	CHAR SERIAL ASCII EBCDIC	7 9	10.5	556 800	YES	PAPER TAPE CARD PUNCH	$110,000	$375	$3,000

COMPARATIVE TABLE OF KEY-TO-DISK SYSTEMS

TABLE XXX

TRADE	KEYSTATIONS		INTERMEDIATE ACCESS STORAGE DEVICE		
NAME	NUMBER	SUPER-VISOR	CAPACITY	RECORDS	DEVICE
CMC-9	10-32	ASR-33	7.25M CHARACTERS	56,099	DISC 12.5ms avg. latency 80ms seek time
KEY-EDIT	8-32	ASR-33	.7M-5.6M Char.	8,820-70,560	DRUM 17ms avg. access time
DATA-TAPE 2100	19-31	STD GCS KEYBRD & PRINT TERMINAL	850K CHARACTERS		FIXED HEAD DISC
KEYPLEX	8-64	ASR-33	3.5M CHARACTERS		DISC
INFOREX	8-16	ANY STATION	688K CHARACTERS	5,500 125 CHAR LONG	DISC
LC-720 KeyDisc	12-64	ASR-33	7.25M or 29 M CHARACTERS	40,000-160,000	IBM 2311
KeyLogic	8-64	IBM Selectric	2M CHARACTERS	106,000	FIXED HEAD DISC 17ms Avg. access time

COMPARATIVE TABLE OF KEY TO DISK SYSTEMS

TABLE XXX

VIII. COST ANALYSIS

The recommendations of the previous chapters will yield benefits in increased productivity in terms of increased marginal physical product of labor and machinery, but recalling from Chapter I:

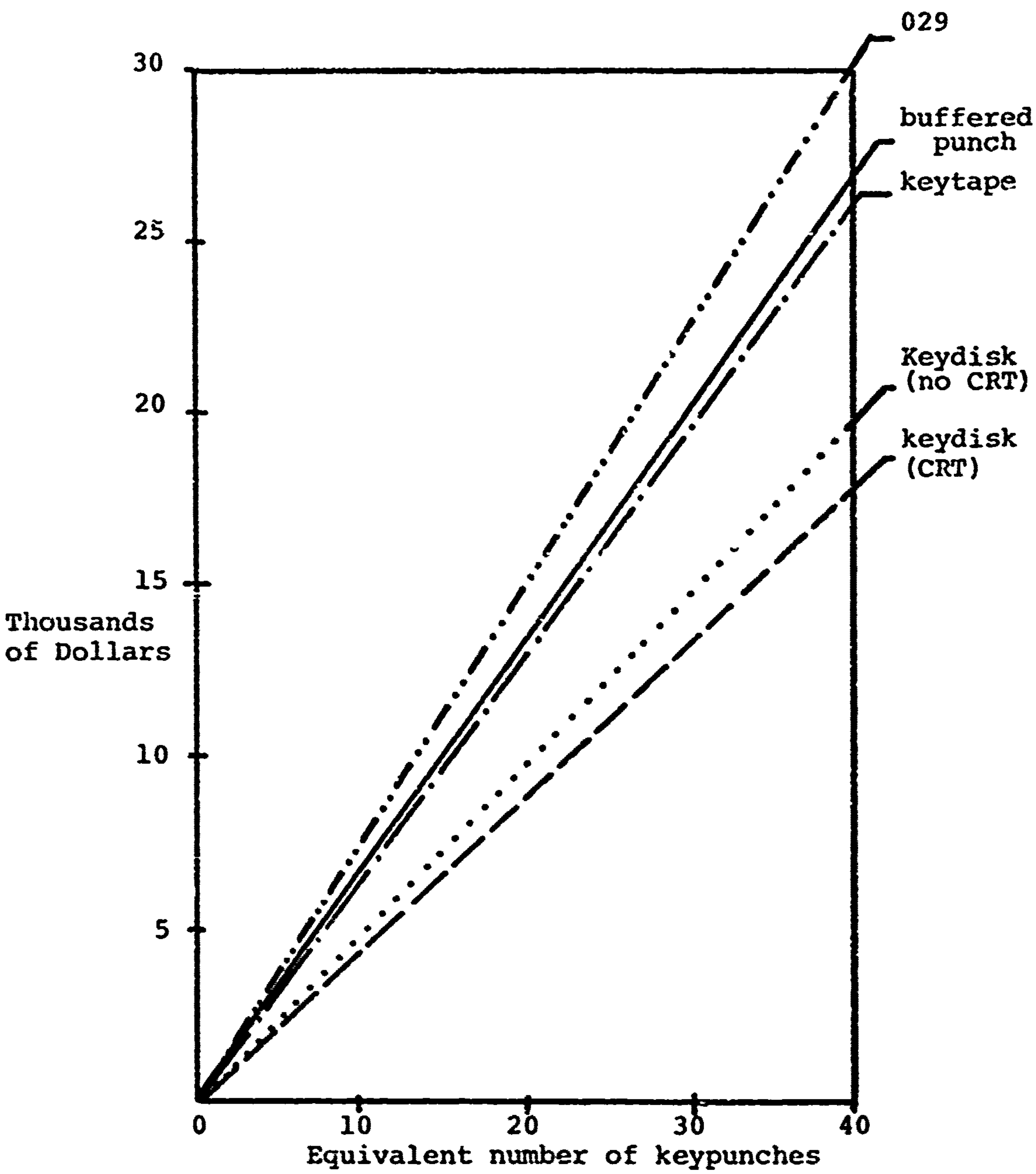
$$\text{Marginal Cost} = \frac{\text{Price Per Unit of Labor}}{\text{Marginal Physical Product of Labor}}$$

If the price per unit of labor (or machinery) increases proportionally with the increase in marginal physical product, no cost saving will result. One objective, therefore, should be to restrain the increase in the price per unit of labor (or machinery) so that it is proportionately less than the increase in marginal physical product of labor (or machinery). Even though there are many variables that are installation dependent, such as the savings generated by reducing the error rate on procedure XXX from 3% to 1%, major machine cost elements can be identified and projected based on previous experience with various hardware configurations. Additionally, if the probability of a worker falling below or exceeding the average installation productivity level is normally distributed about the average production level of the installation, the cost behavior of the proposed incentive plan can be developed.

Greenblatt (1972), in a comparative analysis of various types of keyboard entry systems, offers a projection of labor costs and equipment costs that are shown in Table XXXI and XXXII. While it may be argued that wages vary from one

TABLE XXXI

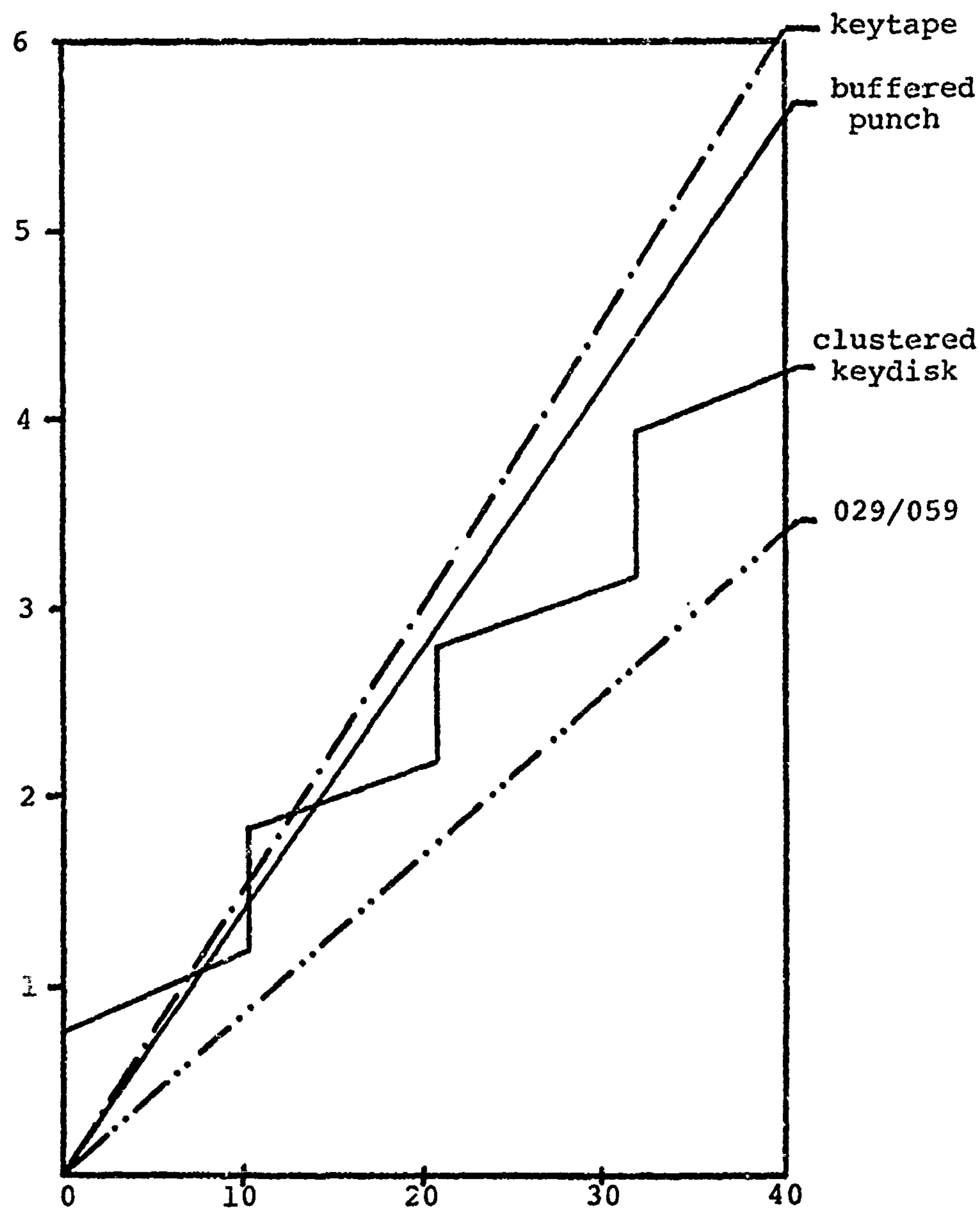
DATA ENTRY LABOR COSTS



Source: Greenblatt, S., "Delete Delays and Dollars with Direct Data Entry," INFOSYSTEMS, September, 1972, p. 21.

TABLE XXXII

MONTHLY EQUIPMENT COSTS



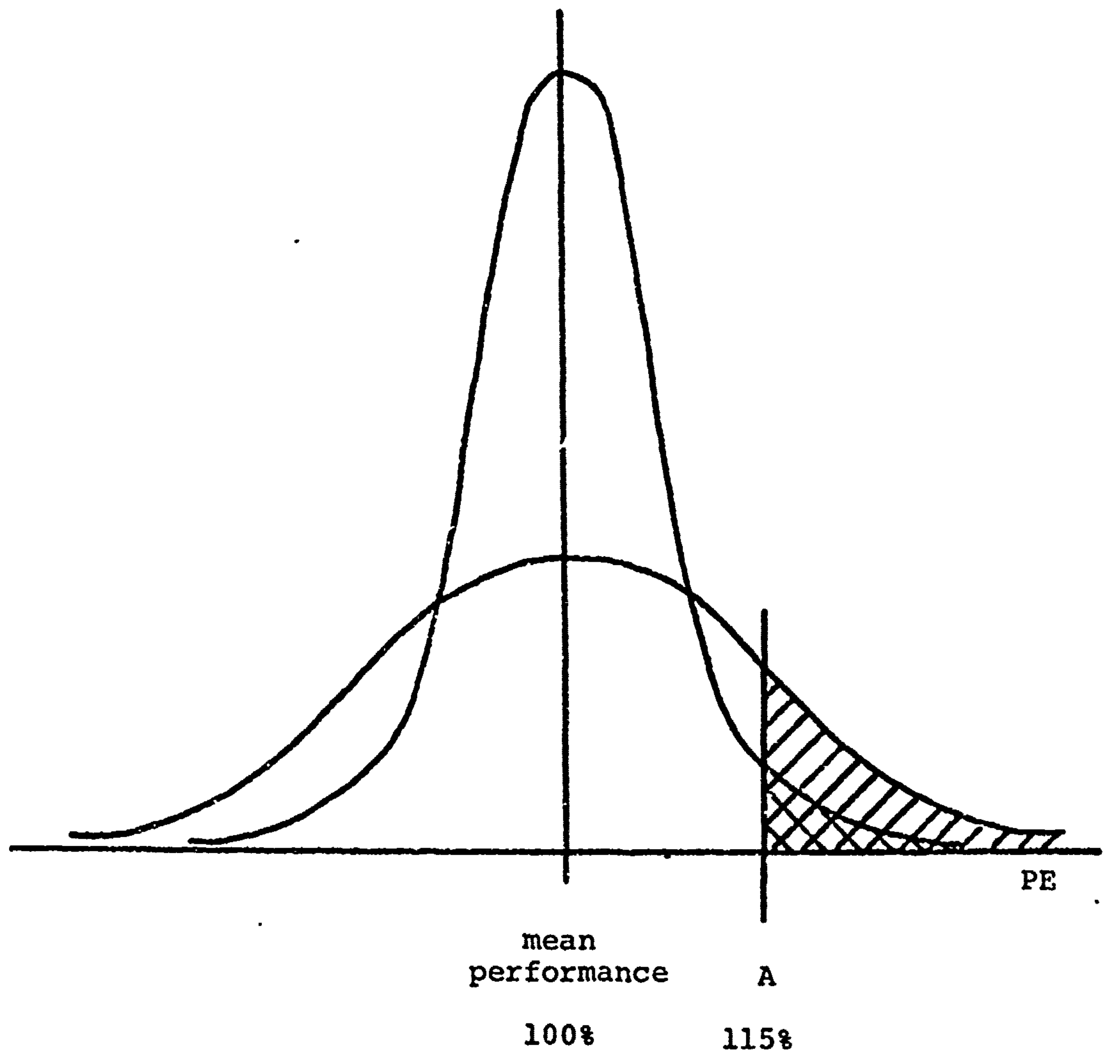
Source: Greenblatt, S., "Delete Delays and Dollars with Direct Data Entry," INFOSYSTEMS, September, 1972, p. 21.

geographical area to another, what is important to observe in Table XXXI is not the slopes of the cost lines, but, rather, the slopes in proportion to each other. The relation of the slopes is due to observed productivity (throughput) differences in the machines. The cost lines presented in Table XXXII, however, are subject to individual fluctuations as equipment manufacturers modify their prices. Currently, key-to-disk or drum systems first become economically competitive with key-to-tape and buffered punches at about 6 machines. It should be noted, however, that Greenblatt's (1972) costs are average costs, and that because of the wide range in prices for key-to-disk hardware, many systems are available that have an economic advantage such as was discussed in the NSC Newport study in Chapter VII and Tables XXVIII and XXIX.

The average level of productivity is represented by the formula in Table VIII which determines an average for a particular job on the basis of the predetermined Procedure Time Model and observed production. Assuming that operator productivity on any one job is distributed about a mean productivity level that is approximated by the calculated average, the installation's productivity on the total population of jobs can be shown via the Central Limit Theorem to be normally distributed about the mean or average productivity level of the installation. This distribution is shown in Table XXXIII in several forms to indicate the effect the variance has on the shape of the distribution. The

TABLE XXXIII

DISTRIBUTION OF PRODUCTION EFFICIENCY

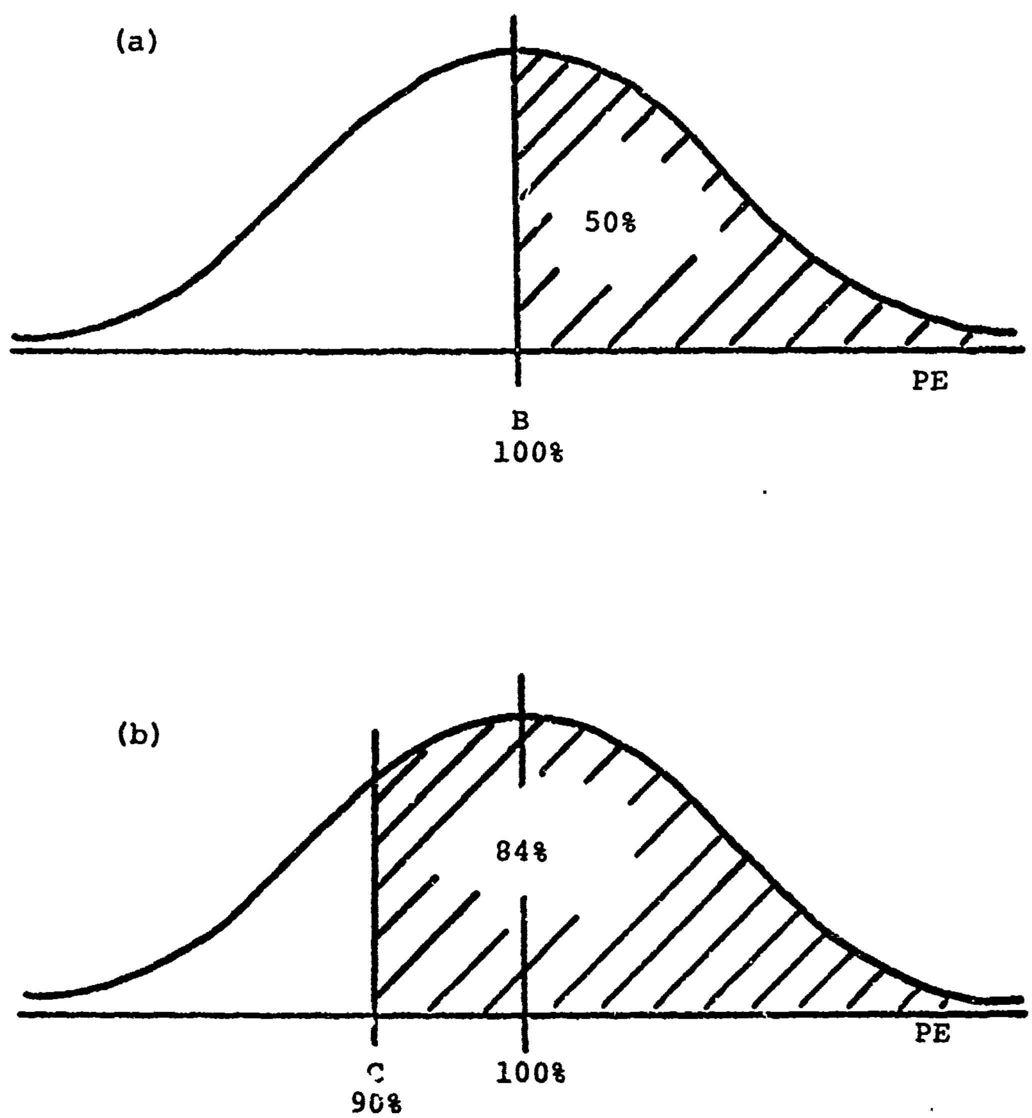


variance is a measure of the frequency and distance individual performances fall from the average. If there is a great difference between the individual performances of the installation's operators, the distribution will be flat and spread out. If the individual operators are very similar in their performance, the distribution will be tall and thin. If the average represents a 100% production efficiency level and point A in Table XXXIII represents 115% production efficiency, the probability of an operator performing at 115% or more may be considered as being represented by the shaded area under the curve. In the tall curve this area is small and thus the probability is small. In the flat curve the area is larger and the probability is larger. The spread of operator performance can not be predicted in this thesis because no actual keypunch installation is being considered; since the spread of operator performance determines the probability of an operator exceeding the average productivity level of the installation, no actual system cost can be derived at this time.

One other major factor in the probability of an operator receiving an incentive reward is the placement by management of the Incentive Base described in Chapter VI and shown in Table XVI. If the incentive base is set at 100%, as shown by point B in Table XXXIV(a), then the probability of an operator performing at 100% production efficiency or more is 50%. If the incentive base is set at 90%, represented by

TABLE XXXIV

EFFECT OF THE INCENTIVE BASE



point C in Table XXXIV(b), and if 90% is one standard deviation from 100%, the probability of an operator performing at 90% or more and earning an incentive award is 84%. As the probability of an operator earning an incentive reward increases, more operators will earn more money causing an increase in the price per unit of labor and a decrease in the overall cost savings.

In summary, the goal is to proportionally increase the marginal physical product of labor and machinery more than their respective unit costs. No exact dollar costs can be derived at this time since no specific keypunch installation is being considered. Given a specific installation, a cost analysis could be performed based on hardware replacement, environmental improvements required, and a measure of the variance in operator production ability.

IX. CONCLUSION

The responsibility for civilian incentive plans within the Navy has been assigned to the Director of Civilian Manpower Management. The Director is authorized to establish the policies and standards concerning incentive awards and to grant approval to exception requests. He has assigned the responsibility and authority for incentive award promotion and administration to the Head of the Motivation and Incentives Branch, Office of Civilian Manpower Management.

The purpose of the civilian incentive program is, first, "to encourage employees to participate in improving the efficiency and economy of Government operations," second, "to recognize and reward employees, individually or in groups, for their suggestions, inventions, superior accomplishments, or other improvement in Government operations," and, third, "to recognize and reward employees, individually or in groups, who perform special acts or services in the public interest in connection with, or related to, their employment."[40] The incentive plan offered by this thesis is intended to recognize and reward the individual keypunch employee for her superior accomplishment in Government operations. Specifically, the incentive will be granted on the basis of individual performance contribution that meets the Government established

[40] Federal Personnel Manual, Chapter 451, Paragraph 1.2.

standards of: "performance of assigned duties, with special effort or special innovation, that results in significant economies or other highly desirable benefits," or "performance of assigned tasks so that one or more important job requirements is significantly exceeded."[41]

The value of the awards presently authorized for contributions of a performance nature range from $100 to $150 per year for employees in the keypunch grade levels. For contributions of a one-time beneficial suggestion nature, the award is in the range of 10% of the anticipated annual savings that would result from implementation of the suggestion. The incentive award offered by this thesis is based on a percentage of the savings generated by the measured and documented increased productivity of the keypunch operator. The actual percentage used can be adjusted to permit competitive bidding for labor hours in the labor markets of various geographical areas.

The government incentive plan urges "prompt action on contributions to encourage maximum employee participation and obtain all possible benefits to the Government."[42] The period of measurement of the incentive plan offered by this thesis coincides with the two-week pay period for federal civilian employees. The incentive award is paid in the paycheck

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[41] Ibid., Paragraph 3.2c.3 and 4.

[42] Ibid., Paragraph 2.4.

immediately following the period of measurement on the premise that any greater separation will disorient the payment from the effort that earned the award.

Unlike financial incentive rewards, improvements in the physical environment of the workspace may not foster an increase in worker productivity, but they may ensure that working conditions do not inhibit the motivational and technological recommendations of this thesis. Workspace improvements provide a relatively inexpensive method for data processing management to initially solicit operator participation in what happens in the keypunch installation. The experience of Naval Supply Center, Long Beach, California, was that when the keypunch operators were invited to participate in decisions regarding workspace improvements, their reaction was enthusiastic and they readily adopted the general conservative guidelines suggested by data processing management.

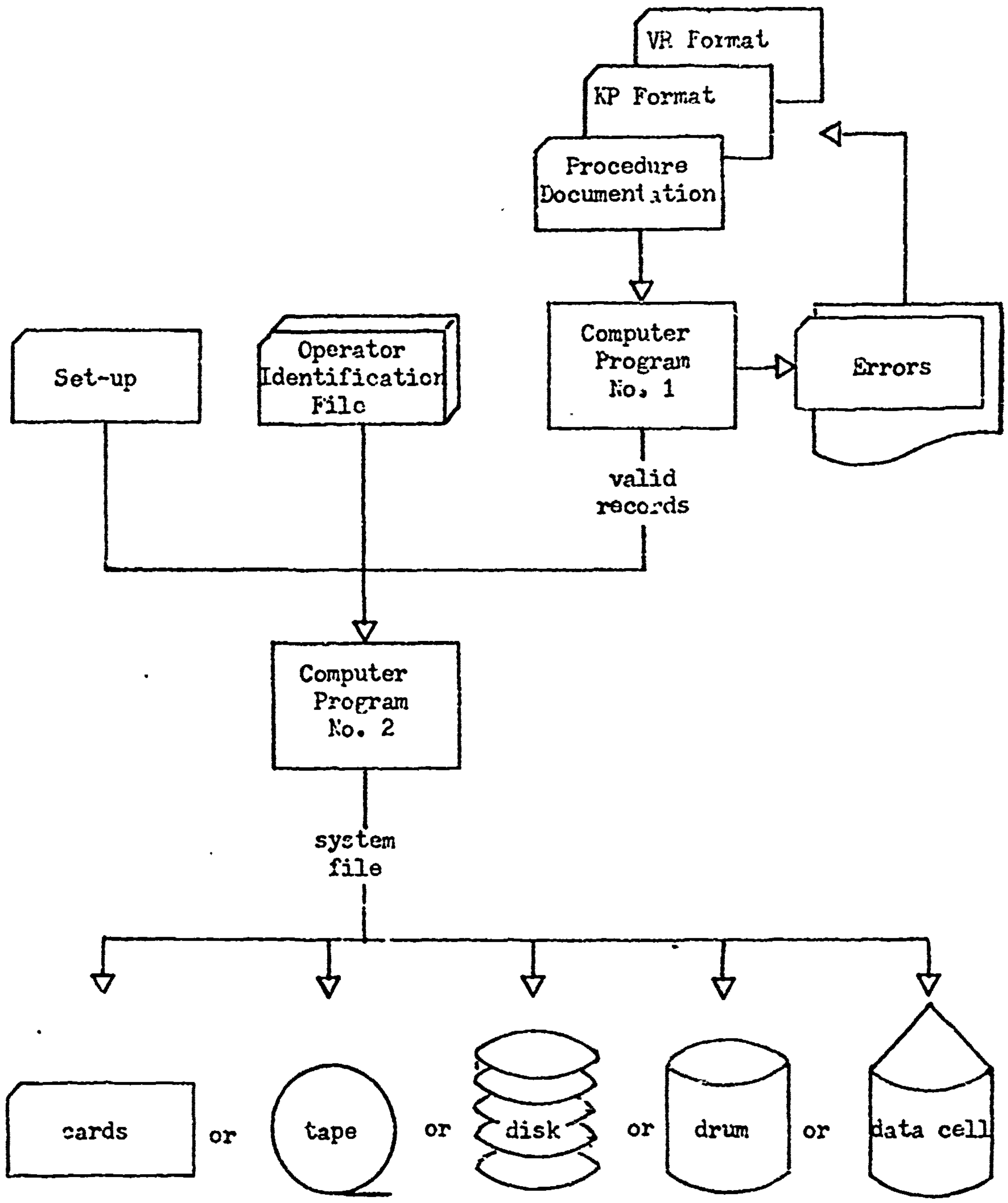
Improvements in the marginal physical product of machinery may be possible through evaluation of the installation's production load, degree of centralization, and output requirements with the object of selecting the appropriate hardware to match the workload. Many installations are finding that the new key-to-disk and drum configurations are providing significant throughput increases and error rate reductions. As the capabilities of the on-line mini-computer are expanded through software development to utilize the optional card punches and printers that some manufacturers now offer, this equipment may replace much of the background punch-sort-validate-print-return processing that now requires main frame or slave computer time.

Additional gains in productivity can be made by expanding the role of the keypunch operator by encouraging her participation in planning and control functions that have been previously reserved for supervisory and management personnel, by keeping her informed of her performance and how it relates to the goals of the organization, and by employing the motivational techniques that have been discussed. Hardware replacement and the incentive plan are external signs that a new management approach is being taken in keypunch and are obvious factors in increasing the marginal physical product of machinery and labor. But these factors are mechanical in their application and required in part for the production information and employee measurements they provide. The internal approach taken to provide job enrichment, to implement meaningful employee counselling, and to accurately employ motivational techniques provides the largest challenge to data processing management, and if successful, will result in the most significant improvements in the keypunch installation.

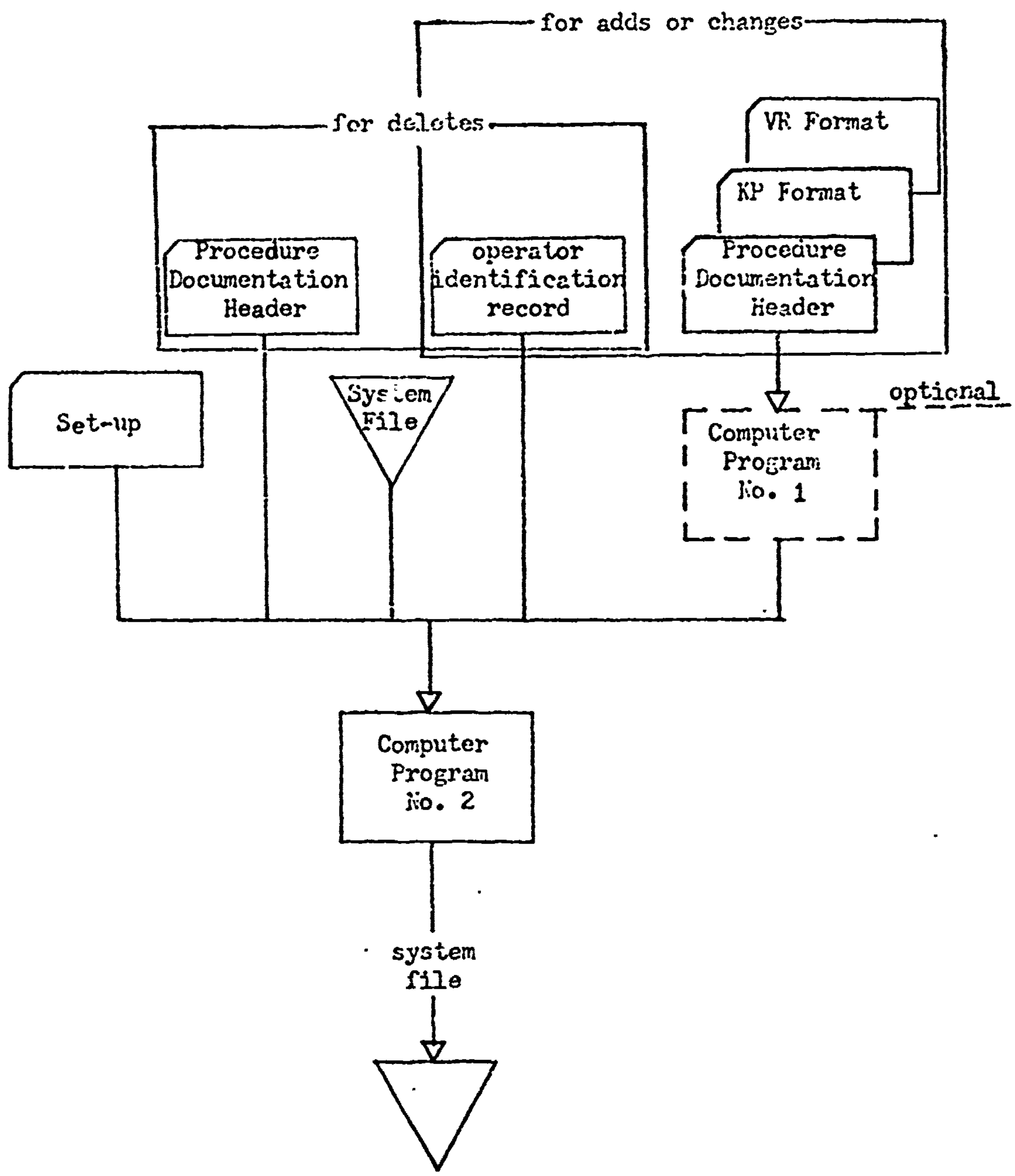
APPENDIX A

SYSTEM FLOWCHART

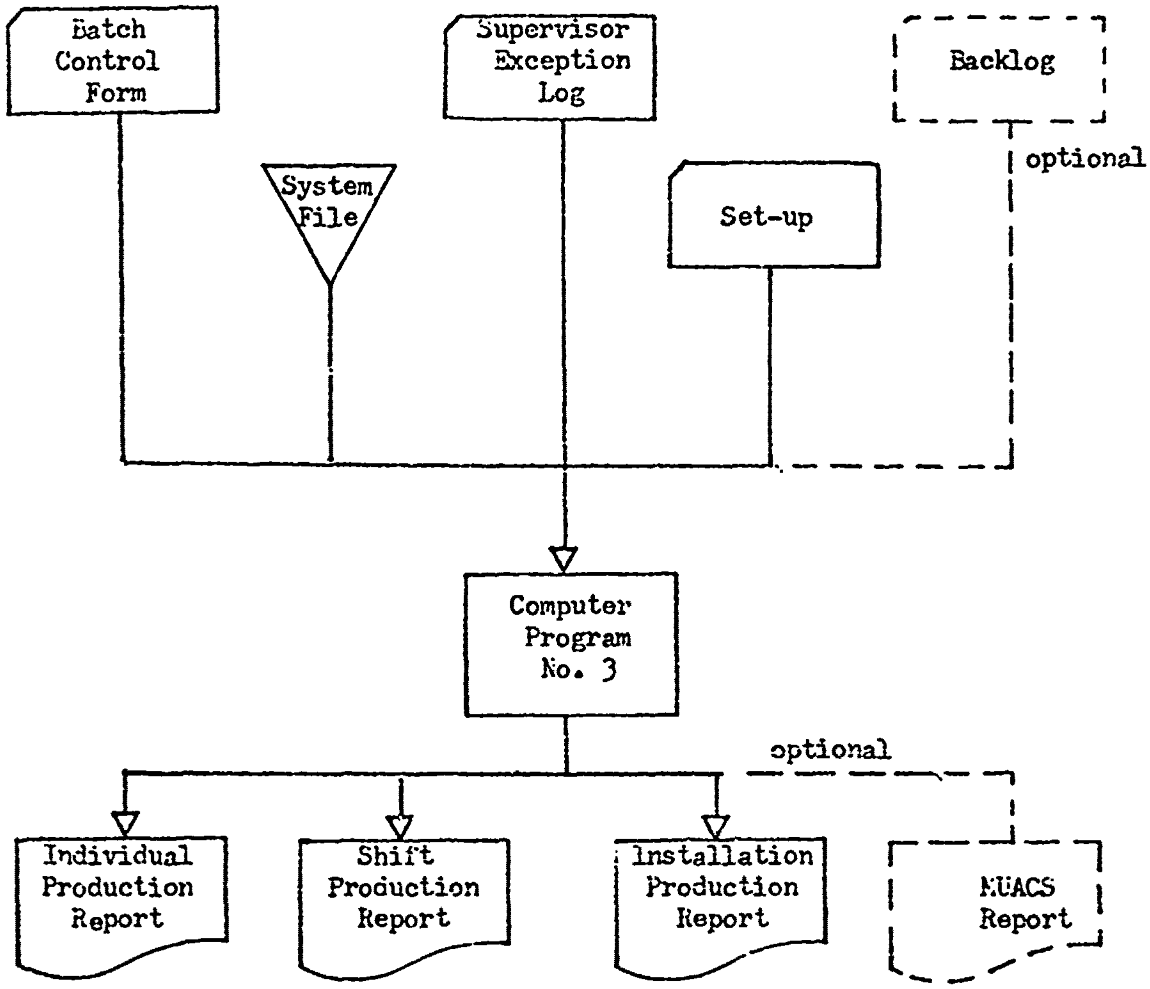
1. Creating the System File



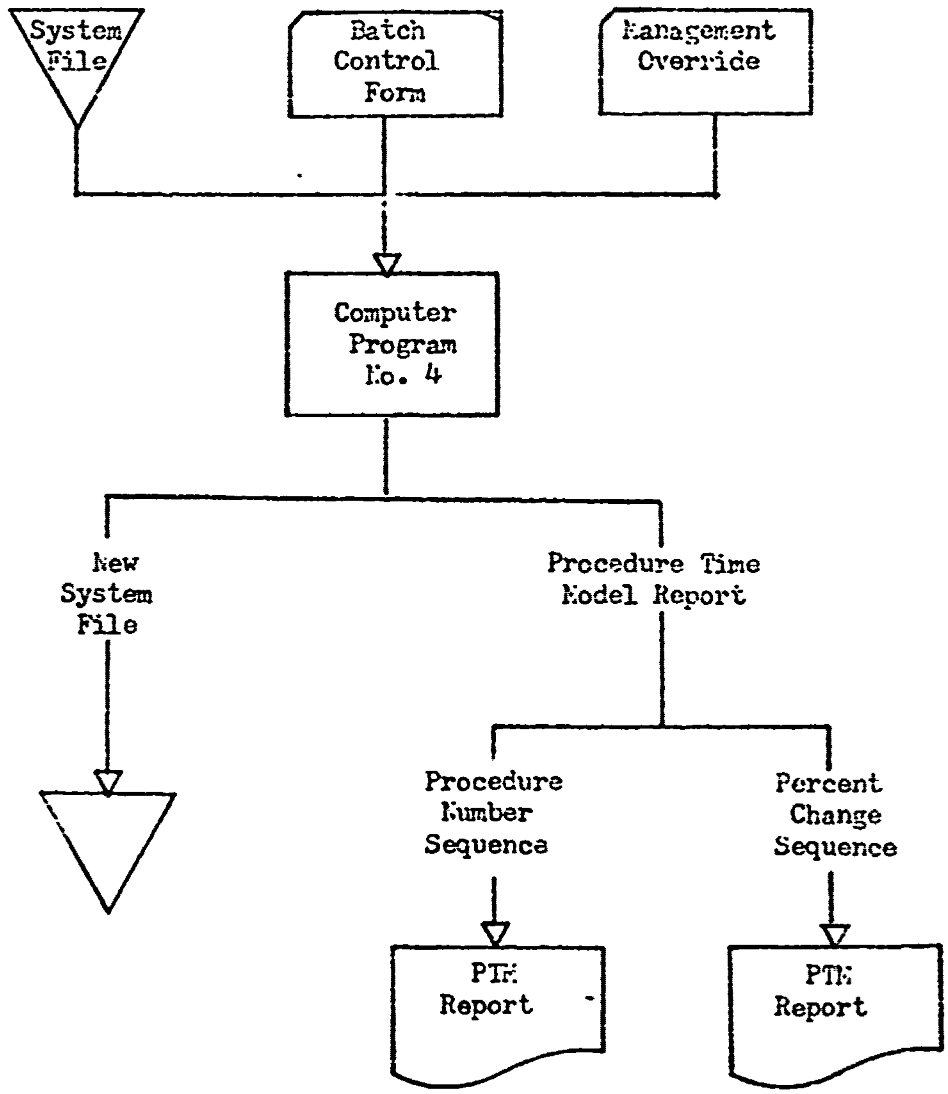
2. Updating the System File



3. Incentive Reward Period Processing



4. Adjusting the Procedure Time Model



APPENDIX B

RECORD FORMATS

1. Set-up Record

Field	Column	Content
Document Identifier	1 - 3	"ZU1"
Month	4 -17	Report month and year
Work Days	18-19	Days in pay period for Program #3
blank	20-80	blank

2. Supervisor Exception Log

Field	Column	Content
Document Identifier	1 - 3	"ZU2"
Date	4 - 9	Day-month-year (ddmmyy)
Operator Number	10-12	Three digit numeric
Code	13-14	See Table XI
Time	15-17	Time in hours
	18	Time in tenths
Pay Type	19-2[illegible]	See Table XIII
blank	21-[illegible]	blank

3. Batch Control Form

Field	Column	Content
Document Identifier	1 - 3	"ZU3" for regular production "ZU4" for Hotline operations
Date	4 - 9	Day-month-year (ddmmyy)
Procedure Number	10-15	Any alphameric
Volume	16-20	Numeric source document count

3. Batch Control Form - Continued

Field	Column	Content
Operator Number		
Initial Process		
Keypunch	21-23	Numeric
Verification	24-26	Numeric
Corrections		
Keypunch	27-29	Numeric
Verification	30-32	Numeric
Start Time		
Initial Process		
Keypunch	33-36	24-hour time - blank if hotline
Verification	37-40	24-hour time - blank if hotline
Corrections		
Keypunch	41-44	24-hour time - blank if hotline
Verification	45-48	24-hour time - blank if hotline
Stop Time		
Initial Process		
Keypunch	49-52	24-hour time - blank if hotline
Verification	53-56	24-hour time - blank if hotline
Corrections		
Keypunch	57-60	24-hour time - blank if hotline
Verification	61-64	24-hour time - blank if hotline
Errors	65-67	Numeric - blank if hotline
Pay Type		
Initial Process		
Keypunch	68-69	See Table X discussion
Verification	70-71	See Table X discussion
Corrections		
Keypunch	72-73	See Table X discussion
Verification	74-75	See Table X discussion
blank	76-80	blank

4. Backlog Input (Optional-for MUACS)

Field	Column	Content
Document Identifier	1 - 3	"ZU5"
Date	4 - 9	Day-month-year (ddmmyy)
Procedure Number	10-15	Any alphameric
Code	17	Blank or "V" See Table XIV discussion
Volume	18-21	Numeric source document count
blank	22-80	blank

5. Operator Identification Record

Field	Column	Content
Document Identifier	1 - 3	"ZU6"
Date	4 - 9	Day-month-year (ddmmyy)
Operator Number	10-12	Three digit numeric
blank	13-16	blank
Change Code	17	Add = blank, Delete = "D" Change = "C"
Shift	18	1, 2, or 3
Pay Grade	19-20	GS grade
Pay Step	21-22	GS shift
Name	23-42	Last, first, middle initial
blank	43-80	blank

6. Procedure Documentation

a. Header

Field	Column	Content
Document Identifier	1 - 3	"ZU7"
Date	4 - 9	Day-month-year (ddmmyy)
Procedure Number	10-15	Any alphameric
Suffix	16	A, B, ... for multiple outputs.
Change Code	17	Add = blank, Delete - "D", Change = "C"
Size	18-20	Number of columns in record
Ratings (5)	21-25	Excellent = "E", Good = "G", Fair = "F", or Poor = "P"
Name	26-45	Procedure Name (optional)
MUACS Code	46	Easy = "E", Normal - blank, Diff = "D"
blank	47-80	blank
MUACS code	56	Easy = "E", Normal = blank, Difficult = "D"
blank	57-80	blank

b. Keypunch Format

Standard IBM 029 Program Drum Card

c. Verification Format

Standard IBM 059 Program Drum Card

7. Procedure Time Model

Field	Column	Content
Document Identifier	1 - 3	"ZU8" for the system file "ZU9" for the management override
Date	4 - 9	Day-month-year (ddmmyy)
Procedure Number	10-15	Any alphameric
MUACS Code	16	Easy = "E", Normal = blank, Diff = "D"
Keypunch data		
Strokes	17-19	Number of strokes in procedure
Predetermined	20-23	Predetermined Procedure Time Model
Month 3	24-27	Production time three months ago
Month 2	28-31	Production time two months ago
Month 1	32-35	Production time last month
Use Prior	36-39	Procedure Time Model used last month
Use Current	40-43	Procedure Time Model in use
Verification data		
Strokes	44-46	Number of strokes in procedure
Predetermined	47-50	Predetermined Procedure Time Model
Month 3	51-54	Production time three months ago
Month 2	55-58	Production time two months ago
Month 1	59-62	Production time last month
Use Prior	63-66	Procedure Time Model used last month
Use Current	67-70	Procedure Time Model in use
blank	71-80	blank

COMPUTER PROGRAM NUMBER ONE

PROCEDURE DOCUMENTATION VALIDATION

CONTENTS

PROGRAM SYNOPSIS

Program number one validates the procedure documentation records - the header, keypunch format, and verification format. Errors are printed in narrative form by procedure number. The listing is used by the keypunch supervisor to locate error records and make the appropriate corrections before the records are further processed.

INPUT DESCRIPTION

a. Set-up Record
b. Procedure Documentation Header
c. Keypunch Format
d. Verification Format

OUTPUT DESCRIPTION

a. Procedure Documentation Error Report

```
KEYPUNCH PROCEDURE DOCUMENTATION VALIDATION          DECEMBER 1972           PAGE    1

JOB NUMBER            ERROR

  001000              TWO HEADERS FOR THE SAME JOB NUMBER BUT NO SUFFIX INDICATED.

  002000              CHANGE CODE NOT BLANK, A, OR D.

  006000              CHANGE CODE NOT BLANK, A, OR D.
                      EXTRA HANDLING NOT E, G, F, OR P
                      MUACS CODE NOT BLANK, E, N, OR D.
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   25.  CHARACTER FOUND WAS M
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   21.  CHARACTER FOUND WAS H
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   32.  CHARACTER FOUND WAS F
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   43.  CHARACTER FOUND WAS M
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   55.  CHARACTER FOUND WAS R

  005000              EXTRA HANDLING NOT E, G, F, OR P
                      MUACS CODE NOT BLANK, E, N, OR D.
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   18.  CHARACTER FOUND WAS N
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   32.  CHARACTER FOUND WAS V
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   65.  CHARACTER FOUND WAS R
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   74.  CHARACTER FOUND WAS <

  007000              ILLEGAL CHARACTER FOUND IN RECORD COLUMN   17.  CHARACTER FOUND WAS G
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   69.  CHARACTER FOUND WAS *
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   70.  CHARACTER FOUND WAS *
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   71.  CHARACTER FOUND WAS *
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   72.  CHARACTER FOUND WAS *

  008000              MUACS CODE NOT BLANK, E, N, OR D.
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN   92.  CHARACTER FOUND WAS B
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN  109.  CHARACTER FOUND WAS L
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN  110.  CHARACTER FOUND WAS L
                      ILLEGAL CHARACTER FOUND IN RECORD COLUMN  111.  CHARACTER FOUND WAS L

  011000              TWO HEADERS BACK TO BACK.  FORMAT CARD MISSING.

  012000              STRAY FORMAT CARD FOUND AFTER SUBJECT PROCEDURE.  CARD IGNORED.

 12 JOBS PROCESSED.    8 JOBS INVALID WITH  28 ERRORS.
```

PROCEDURE DOCUMENTATION VALIDATION REPORT

```
000010 IDENTIFICATION DIVISION.                                                 PROG 1
000020 PROGRAM-ID.   'THESIS'                                                   PROG 1
000030 AUTHOR.   LCDR DANFORTH.                                                 PROG 1
000040 INSTALLATION.   NPGS MONTEREY.                                           PROG 1
000050 DATE-WRITTEN.                                                            PROG 1
000060 DATE-COMPILED.                                                           PROG 1
000070 REMARKS.                                                                 PROG 1
000080 ENVIRONMENT DIVISION.                                                    PROG 1
000090 CONFIGURATION SECTION.                                                   PROG 1
000100 SOURCE-COMPUTER.   IBM-360-67.                                           PROG 1
000110 OBJECT-COMPUTER.   IBM-360-67.                                           PROG 1
000120 INPUT-OUTPUT SECTION.                                                    PROG 1
000130 FILE-CONTROL.                                                            PROG 1
000140       SELECT IN-REC ASSIGN TO 'CARDIN' UTILITY.                          PROG 1
000150       SELECT OUTPUT-FILE ASSIGN TO 'PRINT' UTILITY.                      PROG 1
000160 DATA DIVISION.                                                           PROG 1
000170 FILE SECTION.                                                            PROG 1
000180 FD    IN-REC LABEL RECORDS ARE OMITTED RECORDING MODE IS F               PROG 1
000190       RECORD CONTAINS 80 CHARACTERS DATA RECORD IS INPUT-REC.            PROG 1
000200 01    INPUT-REC.                                                         PROG 1
000210       02  IDOC-ID                 PICTURE XXX.                           PROG 1
000220           88  ISET-UP                                VALUE 'ZU1'.        PROG 1
000230           88  IHEAD                                  VALUE ''U7'.        PROG 1
000240       02  CDATE                   PICTURE X(14).                         PROG 1
000250       02  IN-REK REDEFINES CDATE.                                        PROG 1
000260           03  IDATE               PICTURE X(6).                          PROG 1
000270           03  KEY-HEAD.                                                  PROG 1
000280               04  IPROC-NR        PICTURE X(6).                          PROG 1
000290               04  ISUFFIX         PICTURE X.                             PROG 1
000300           03  IKEY-CODE           PICTURE X.                             PROG 1
000310       02  ISIZE                   PICTURE 999.                           PROG 1
000320       02  IRATINGS                PICTURE X      OCCURS 5 TIMES.         PROG 1
000330       02  FILLER                  PICTURE X(20).                         PROG 1
000340       02  IMUACS                  PICTURE X.                             PROG 1
000350       02  FILLER                  PICTURE X(34).                         PROG 1
000360 FD    OUTPUT-FILE RECORDING MODE IS F LABEL RECORDS ARE OMITTED          PROG 1
000370       RECORD CONTAINS 133 CHARACTERS DATA RECORD IS PRINT-LINE.          PROG 1
000380 01    PRINT-LINE                          PICTURE X(133).                PROG 1
000390 WORKING-STORAGE SECTION.                                                 PROG 1
000400 77    PAGE-NR                 PICTURE 99     VALUE 0.                    PROG 1
000410 77    C                           PICTURE 9(3)   VALUE 0.                PROG 1
000420 77    JOBS                        PICTURE 9(3)   VALUE 0.                PROG 1
000430 77    LINEZ                       PICTURE 99     VALUE 0.                PROG 1
000440 77    SPASE                       PICTURE X      VALUE SPACES.           PROG 1
000450 77    EPR                         PICTURE 9      VALUE 0.                PROG 1
000460 77    ERRS                        PICTURE 9(3)   VALUE 0.                PROG 1
000470 77    ERRORS                      PICTURE 9(3)   VALUE 0.                PROG 1
000480 77    RUNCD                       PICTURE X.                             PROG 1
```

```
 77  PROC                         PICTURE X(6)   VALUE SPACES.              PROG 1
 77  I                            PICTURE S999   VALUE 0.                   PROG 1
 77  J                            PICTURE 9(3)   VALUE 0.                   PROG 1
 01  WORK-SPACE.                                                            PROG 1
     02  WORK                     PICTURE X(80)  OCCURS 6 TIMES.            PROG 1
 01  FORMIN REDEFINES WORK-SPACE.                                           PROG 1
     02  FORMAT                   PICTURE X      OCCURS 480 TIMES.          PROG 1
 01  OUTPUT-LINES.                                                          PROG 1
     02  TOP.                                                               PROG 1
         03  FILLER     PICTURE X        VALUE SPACES.                      PROG 1
         03  TA         PICTURE X(43)    VALUE 'KEYPUNCH PROCEDURE DO       PROG 1
-          'CUMENTATION VALIDATION'.                                        PROG 1
         03  FILLER               PICTURE X(10)  VALUE SPACES.              PROG 1
         03  H1-1                 PICTURE X(14)  VALUE SPACES.              PROG 1
         03  FILLER               PICTURE X(10)  VALUE SPACES.              PROG 1
         03  TB         PICTURE X(6)     VALUE 'PAGE  '.                    PROG 1
         03  TC         PICTURE ZZ9.                                        PROG 1
         03  FILLER               PICTURE X(46)  VALUE SPACES.              PROG 1
     02  HEAD.                                                              PROG 1
         03  FILLER     PICTURE X        VALUE SPACES.                      PROG 1
         03  HA         PICTURE X(10)    VALUE 'JOB NUMBER'.                PROG 1
         03  FILLER     PICTURE X(10)    VALUE SPACES.                      PROG 1
         03  HB         PICTURE X(5)     VALUE 'ERROR'.                     PROG 1
         03  FILLER     PICTURE X(10)    VALUE SPACES.                      PROG 1
     02  DETAIL-LINE.                                                       PROG 1
         03  FILLER     PICTURE XXX      VALUE SPACES.                      PROG 1
         03  DLA        PICTURE X(6)     VALUE SPACES.                      PROG 1
         03  FILLER     PICTURE X(12)    VALUE SPACES.                      PROG 1
         03  DLB        PICTURE X(112)   VALUE SPACES.                      PROG 1
     02  EOJ-LINE.                                                          PROG 1
         03  FILLER     PICTURE X        VALUE SPACES.                      PROG 1
         03  EL1        PICTURE ZZ9.                                        PROG 1
         03  EL2        PICTURE X(18)    VALUE ' JOBS PROCESSED.  '.        PROG 1
         03  EL3        PICTURE ZZ9.                                        PROG 1
         03  EL4        PICTURE X(19)    VALUE ' JOBS INVALID WITH '.       PROG 1
         03  EL5        PICTURE ZZ9.                                        PROG 1
         03  EL6        PICTURE X(8)     VALUE ' ERRORS.'.                  PROG 1
         03  FILLER     PICTURE X(78)    VALUE SPACES.                      PROG 1
 01  ERROR-MSGS.                                                            PROG 1
     02  E1             PICTURE X(60)    VALUE 'TWO HEADERS FOR THE S       PROG 1
-      'AME JOB NUMBER BUT NO SUFFIX INDICATED.'.                           PROG 1
     02  E2             PICTURE X(66)    VALUE 'MULTIPLE CARD JOBS BE       PROG 1
-      'ING PROCESSED SEPARATELY OR SUFFIX NOT BLANK.'.                     PROG 1
     02  E3             PICTURE X(31)    VALUE 'CHANGE CODE NOT BLANK       PROG 1
-      ', A, OR D.'.                                                        PROG 1
     02  E4             PICTURE X(33)    VALUE 'MUACS CODE NOT BLANK,       PROG 1
-      ' E, N, OR D.'.                                                      PROG 1
     02  E5                       PICTURE X(32)  VALUE 'EXTRA HANDLING N    PROG 1
```

```
          'OT E, G, F, OR P'.                                                  PROG 1
       02  E6                PICTURE X(47)  VALUE 'TWO HEADERS BACK TO B      PROG 1
          'ACK.  FORMAT CARD MISSING.'.                                        PROG 1
       02  E7.                                                                 PROG 1
           03  E71           PICTURE X(41)  VALUE 'ILLEGAL CHARACTER FOU      PROG 1
              'ND IN RECORD COLUMN '.                                          PROG 1
           03  E72           PICTURE ZZ9.                                      PROG 1
           03  E73           PICTURE X(23)  VALUE '.  CHARACTER FOUND WA      PROG 1
              'S '.                                                            PROG 1
           03  E74           PICTURE X.                                        PROG 1
       02  E8                    PICTURE X(63)  VALUE 'STRAY FORMAT CAR       PROG 1
          'D FOUND AFTER SUBJECT PROCEDURE.  CARD IGNORED.'.                   PROG 1
 PROCEDURE DIVISION.                                                           PROG 1
       OPEN INPUT IN-REC OUTPUT OUTPUT-FILE.                                   PROG 1
                                                                               PROG 1
 LOOP-A.                                                                       PROG 1
                                                                               PROG 1
       READ IN-REC AT END GO TO EOJ.                                           PROG 1
       IF ISET-UP MOVE CDATE TO H1-I PERFORM NEW-PAGE GO TO LOOP-A.            PROG 1
       IF IHEAD GO TO HEAD-CHECK.                                              PROG 1
       MOVE 8 TO ERR PERFORM PRINT.                                            PROG 1
       GO TO LOOP-A.                                                           PROG 1
                                                                               PROG 1
 HEAD-CHECK.                                                                   PROG 1
       IF IPROC-NR NOT = PROC MOVE '0' TO SPASE ADD 1 TO JOBS.                 PROG 1
       IF IPROC-NR = PROC AND ISUFFIX = ' ' OR = 'A'                           PROG 1
          MOVE 1 TO ERR PERFORM PRINT.                                         PROG 1
       IF ISUFFIX NOT = ' ' IF IPROC-NR NOT = PROC                             PROG 1
          MOVE 2 TO ERR PERFORM PRINT.                                         PROG 1
       MOVE IPROC-NR TO PROC.                                                  PROG 1
       IF IKEY-CODE = ' ' OR = 'A' OR = 'C' OR = 'D' NEXT SENTENCE             PROG 1
          ELSE MOVE 3 TO ERR PERFORM PRINT.                                    PROG 1
       PERFORM RATE-CHECK THRU RC VARYING I FROM 1 BY 1 UNTIL I > 5.           PROG 1
       IF IMUACS = 'E' OR = 'N' OR = 'D' OR = ' ' NEXT SENTENCE                PROG 1
          ELSE MOVE 4 TO ERR PERFORM PRINT.                                    PROG 1
       MOVE ISIZE TO C.                                                        PROG 1
       MOVE 'K' TO RUNCD.                                                      PROG 1
                                                                               PROG 1
 LOOP-B.                                                                       PROG 1
       MOVE 1 TO J.                                                            PROG 1
       PERFORM LOAD-REC VARYING I FROM C BY -80 UNTIL I < 1.                   PROG 1
       IF IHEAD MOVE 6 TO ERR PERFORM PRINT GO TO HEAD-CHECK.                  PROG 1
       MOVE 1 TO I.                                                            PROG 1
                                                                               PROG 1
 LOOP-C.                                                                       PROG 1
       IF I > C GO TO LOOP-D.                                                  PROG 1
       IF FORMAT (I) = '&' OR = '-' OR = '0' OR = '/' OR = 'A'                 PROG 1
          OR = '1' OR = ' ' ADD 1 TO I GO TO LOOP-C ELSE MOVE I TO             PROG 1
```

```
         E72 MOVE FORMAT (I) TO E74 MOVE 7 TO ERR                     PROG 1
         PERFORM PRINT ADD 1 TO I GO TO LOOP-C.                       PROG 1
                                                                      PROG 1
 LOOP-D.                                                              PROG 1
     IF RUNCD = 'K' MOVE 'V' TO RUNCD MOVE 1 TO I GO TO LOOP-B.       PROG 1
     GO TO LOOP-A.                                                    PROG 1
                                                                      PROG 1
 LOAD-REC.                                                            PROG 1
     READ IN-REC AT END GO TO EOJ.                                    PROG 1
     IF IHEAD MOVE 0 TO I.                                            PROG 1
     MOVE INPUT-REC TO WORK (J).                                      PROG 1
     ADD 1 TO J.                                                      PROG 1
                                                                      PROG 1
 RATE-CHECK.                                                          PROG 1
     IF IRATINGS (I) = 'E' OR = 'G' OR = 'F' OR = 'P'                 PROG 1
        NEXT SENTENCE ELSE MOVE 5 TO ERR PERFORM PRINT.               PROG 1
 RC.  EXIT.                                                           PROG 1
                                                                      PROG 1
 PRINT.                                                               PROG 1
     IF LINEZ > 54 PERFORM NEW-PAGE.                                  PROG 1
     IF ERR = 1 MOVE E1 TO DLB.                                       PROG 1
     IF ERR = 2 MOVE E2 TO DLB.                                       PROG 1
     IF ERR = 3 MOVE E3 TO DLB.                                       PROG 1
     IF ERR = 4 MOVE E4 TO DLB.                                       PROG 1
     IF ERR = 5 MOVE E5 TO DLB.                                       PROG 1
     IF ERR = 6 MOVE E6 TO DLB.                                       PROG 1
     IF ERR = 7 MOVE E7 TO DLB.                                       PROG 1
     IF ERR = 8 MOVE E8 TO DLB.                                       PROG 1
     IF SPASE = '0' MOVE PROC TO DLA, ADD 1 TO ERRORS                 PROG 1
          ELSE MOVE SPACES TO DLA.                                    PROG 1
     WRITE PRINT-LINE FROM DETAIL-LINE AFTER SPASE.                   PROG 1
     ADD 1 TO ERRS.                                                   PROG 1
     ADD 1 TO LINEZ.                                                  PROG 1
     MOVE ' ' TO SPASE.                                               PROG 1
                                                                      PROG 1
 NEW-PAGE.                                                            PROG 1
     MOVE 0 TO LINEZ.                                                 PROG 1
     ADD 1 TO PAGE-NR.                                                PROG 1
     MOVE PAGE-NR TO TC.                                              PROG 1
     WRITE PRINT-LINE FROM TOP AFTER 0.                               PROG 1
     WRITE PRINT-LINE FROM HEAD AFTER 2.                              PROG 1
 EOJ.                                                                 PROG 1
     MOVE JOBS TO EL1.                                                PROG 1
     MOVE ERRORS TO EL3.                                              PROG 1
     MOVE ERRS TO EL5.                                                PROG 1
     WRITE PRINT-LINE FROM EOJ-LINE AFTER 3.                          PROG 1
     CLOSE IN-REC, OUTPUT-FILE.                                       PROG 1
     STOP RUN.                                                        PROG 1
```

COMPUTER PROGRAM NUMBER TWO

CREATE AND UPDATE THE SYSTEM FILE

CONTENTS

PROGRAM SYNOPSIS

Program number two processes all additions, changes, and deletions to the system file which is one file containing the operator identification records and a documentation header and time model record for each documented procedure.

INPUT DESCRIPTION

a. Set-up Record

b. Operator Identification Record

c. Procedure Documentation Header

d. Keypunch Format (for adds and changes)

e. Verification Format (for adds and changes)

f. Current System File

OUTPUT DESCRIPTION

a. New System File

```
IDENTIFICATION DIVISION.                                         PROG 2
PROGRAM-ID.  'THESIS'                                            PROG 2
AUTHOR.   LCDR DANFORTH.                                         PROG 2
INSTALLATION.  NPGS MONTEREY.                                    PROG 2
DATE-WRITTEN.                                                    PROG 2
DATE-COMPILED.                                                   PROG 2
REMARKS.                                                         PROG 2
ENVIRONMENT DIVISION.                                            PROG 2
CONFIGURATION SECTION.                                           PROG 2
SOURCE-COMPUTER.  IBM-360-67.                                    PROG 2
OBJECT-COMPUTER.  IBM-360-67.                                    PROG 2
INPUT-OUTPUT SECTION.                                            PROG 2
FILE-CONTROL.                                                    PROG 2
     SELECT IN-REC ASSIGN TO 'CARDIN' UTILITY.                   PROG 2
     SELECT SYSINP ASSIGN TO 'SYSINP' UTILITY.                   PROG 2
     SELECT SYSTEM-OUT ASSIGN TO 'SYSOPT' UTILITY.               PROG 2
DATA DIVISION.                                                   PROG 2
FILE SECTION.                                                    PROG 2
FD   IN-REC LABEL RECORDS ARE OMITTED RECORDING MODE IS F        PROG 2
     RECORD CONTAINS 80 CHARACTERS DATA RECORD IS INPUT-REC.     PROG 2
01   INPUT-REC.                                                  PROG 2
     02   IDOC-ID               PICTURE XXX.                     PROG 2
          88   ISET-UP                        VALUE 'ZU1'.       PROG 2
          88   IOP-ID                         VALUE 'ZU6'.       PROG 2
          88   IHEAD                          VALUE 'ZU7'.       PROG 2
     02   CDATE                 PICTURE X(14).                   PROG 2
     02   IN-REK REDEFINES CDATE.                                PROG 2
          03   IDATE            PICTURE X(6).                    PROG 2
          03   IKEY-OP.                                          PROG 2
               04   IOP-NR      PICTURE XXX.                     PROG 2
               04   FILLER      PICTURE X(4).                    PROG 2
          03   IKEY-HEAD REDEFINES IKEY-OP.                      PROG 2
               04   IPROC-NR    PICTURE X(6).                    PROG 2
               04   ISUFFIX     PICTURE X.                       PROG 2
          03   IKEY-CODE        PICTURE X.                       PROG 2
               88   IADD                      VALUE ' '.         PROG 2
               88   ICHG                      VALUE 'C'.         PROG 2
               88   IDELETE                   VALUE 'D'.         PROG 2
     02   ISIZE                 PICTURE 999.                     PROG 2
     02   IRATINGS              PICTURE X     OCCURS 5 TIMES.    PROG 2
     02   FILLER                PICTURE X(55).                   PROG 2
FD   SYSINP      LABEL RECORDS ARE OMITTED RECORDING MODE IS F   PROG 2
     RECORD CONTAINS 80 CHARACTERS DATA RECORD IS SYSINP.        PROG 2
01   SYSTEM-IN                  PICTURE X(80).                   PROG 2
FD   SYSTEM-OUT   LABEL RECORDS ARE OMITTED RECORDING MODE IS F  PROG 2
     RECORD CONTAINS 80 CHARACTERS DATA RECORD IS SYSOPT.        PROG 2
01   SYSOPT                     PICTURE X(80).                   PROG 2
WORKING-STORAGE SECTION.                                         PROG 2
```

```
000490 77  KP-TMU-FACTOR                  PICTURE 99      VALUE 5.                     PROG 2
000500 77  VR-TMU-FACTOR                  PICTURE 99      VALUE 5.                     PROG 2
000510 77  R                              PICTURE 99      VALUE 0.                     PROG 2
000520 77  COL                            PICTURE 999     VALUE 0.                     PROG 2
000530 77  K                              PICTURE S9      VALUE 0.                     PROG 2
000540 77  I                              PICTURE S999    VALUE 0.                     PROG 2
000550 77  RUNCD                          PICTURE X       VALUE 'K'.                   PROG 2
000560 77  TMU                            PICTURE 9(4)V9(3).                           PROG 2
000570 01  PTM.                                                                        PROG 2
000580     02  FILLER                     PICTURE X(3)    VALUE 'ZU8'.                 PROG 2
000590     02  PDATE                      PICTURE X(6).                                PROG 2
000600     02  PPROC-NR                   PICTURE X(6).                                PROG 2
000610     02  FILLER                     PICTURE X       VALUE SPACES.                PROG 2
000620     02  KP-DATA.                                                                PROG 2
000630         03  KP-STROK               PICTURE 9(3).                                PROG 2
000640         03  KP-TIME                PICTURE 9(4)    OCCURS 6 TIMES.              PROG 2
000650     02  VER-DATA.                                                               PROG 2
000660         03  VR-STROK               PICTURE 9(3).                                PROG 2
000670         03  VR-TIME                PICTURE 9(4)    OCCURS 6 TIMES.              PROG 2
000680     02  FILLER                     PICTURE X(10)   VALUE SPACES.                PROG 2
000690 01  SDATA-IN.                                                                   PROG 2
000700     02  SDOC-ID                    PICTURE XXX.                                 PROG 2
000710         88  SOP-ID                                 VALUE 'ZU6'.                 PROG 2
000720         88  SHEAD                                  VALUE 'ZU7'.                 PROG 2
000730         88  SPTM                                   VALUE 'ZU8'.                 PROG 2
000740         88  SYSPAD                 VALUE '999'.                                 PROG 2
000750     02  FILLER                     PICTURE X(6).                                PROG 2
000760     02  SKEY-OP.                                                                PROG 2
000770         03  FILLER                 PICTURE X(4) VALUE SPACES.                   PROG 2
000780         03  SOP-NR                 PICTURE XXX VALUE SPACES.                    PROG 2
000790     02  SKEY-HEAD REDEFINES SKEY-OP.                                            PROG 2
000800         03  SPROC-NR               PICTURE X(6).                                PROG 2
000810         03  FILLER                 PICTURE X.                                   PROG 2
000820     02  FILLER                     PICTURE X(64).                               PROG 2
000830 01  COUNTERS.                                                                   PROG 2
000840     02  TSKIP-DUP                  PICTURE 9(4)    VALUE 0.                     PROG 2
000850     02  SKIP                       PICTURE 9(4)    VALUE 0.                     PROG 2
000860     02  DUP                        PICTURE 9(4)    VALUE 0.                     PROG 2
000870     02  NUM                        PICTURE 9(4)    VALUE 0.                     PROG 2
000880     02  ALPHA                      PICTURE 9(4)    VALUE 0.                     PROG 2
000890     02  STROKES                    PICTURE 9(4)    VALUE 0.                     PROG 2
000900 01  WORK-SPACE.                                                                 PROG 2
000910     02  WORK                       PICTURE X(80)   OCCURS 6 TIMES.              PROG 2
000920 C1  FORMIN REDEFINES WORK-SPACE.                                                PROG 2
000930     02  FORMAT                     PICTURE X       OCCURS 480 TIMES.            PROG 2
000940
```

```
PROCEDURE DIVISION.                                                    PROG 2
                                                                       PROG 2
    OPEN INPUT  IN-REC, SYSINP     OUTPUT SYSTEM-OUT.                  PROG 2
    PERFORM READ-SYSINP.                                               PROG 2
    PERFORM READ-INREC.                                                PROG 2
                                                                       PROG 2
LOOP-A.                                                                PROG 2
    IF IOP-ID                                                          PROG 2
      THEN IF  SOP-ID                                                  PROG 2
        THEN IF IOP-NR > SOP-NR                                        PROG 2
          THEN GO TO LOOP-5                                            PROG 2
          ELSE GO TO LOOP-C                                            PROG 2
        ELSE MOVE '999' TO SOP-NR GO TO LOOP-C                         PROG 2
      ELSE IF SOP-ID GO TO LOOP-5.                                     PROG 2
                                                                       PROG 2
LOOP-B.                                                                PROG 2
    IF IHEAD                                                           PROG 2
      THEN IF SHEAD                                                    PROG 2
        THEN IF IPROC-NR > SPROC-NR                                    PROG 2
          THEN GO TO LOOP-10                                           PROG 2
          ELSE GO TO LOOP-D                                            PROG 2
        ELSE MOVE '999999' TO SPROC-NR GO TO LOOP-D                    PROG 2
      ELSE GO TO LOOP-9.                                               PROG 2
                                                                       PROG 2
LOOP-C.                                                                PROG 2
    IF IDELETE                                                         PROG 2
      THEN IF IOP-NR = SOP-NR                                          PROG 2
        THEN GO TO LOOP-3                                              PROG 2
        ELSE GO TO LOOP-4                                              PROG 2
      ELSE IF IOP-NR = SOP-NR                                          PROG 2
        THEN GO TO LOOP-1                                              PROG 2
        ELSE GO TO LOOP-2.                                             PROG 2
                                                                       PROG 2
LOOP-D.                                                                PROG 2
    IF IDELETE                                                         PROG 2
      THEN IF IPROC-NR = SPROC-NR                                      PROG 2
        THEN GO TO LOOP-8                                              PROG 2
        ELSE GO TO LOOP-9                                              PROG 2
      ELSE IF IPROC-NR = SPROC-NR                                      PROG 2
        THEN GO TO LOOP-6                                              PROG 2
        ELSE GO TO LOOP-7.                                             PROG 2
                                                                       PROG 2
LOOP-1.                                                                PROG 2
    PERFORM READ-SYSINP.                                               PROG 2
LOOP-2.                                                                PROG 2
    WRITE SYSOPT FROM INPUT-REC.                                       PROG 2
    PERFORM READ-INREC.                                                PROG 2
    GO TO LOOP-A.                                                      PROG 2
```

```
                                                      PROG 2
LOOP-3.                                               PROG 2
     PER~ORM READ-SYSINP.                             PROG 2
LOOP-4.                                               PROG 2
     PERFORM READ-INREC.                              PROG 2
     GO TO LOOP-A.                                    PROG 2
                                                      PROG 2
LOOP-5.                                               PROG 2
     WRITE SYSOPT FROM SYSTEM-IN.                     PROG 2
     PERFORM READ-SYSINP.                             PROG 2
     GO TO LOOP-A.                                    PROG 2
                                                      PROG 2
LOOP-6.                                               PROG 2
     PERFORM READ-SYSINP  2 TIMES.                    PROG 2
LOOP-7.                                               PROG 2
     PERFORM CALC THRU CALC-EXIT.                     PROG 2
     GO TO LOOP-A.                                    PROG 2
                                                      PROG 2
LOOP-8.                                               PROG 2
     PERFORM READ-SYSINP  2 TIMES.                    PROG 2
LOOP-9.                                               PROG 2
     PERFORM READ-INREC.                              PROG 2
     GO TO LOOP-A.                                    PROG 2
                                                      PROG 2
LOOP-10.                                              PROG 2
     PERFORM LOOP-11 2 TIMES.                         PROG 2
     GO TO LOOP-A.                                    PROG 2
LOOP-11.                                              PROG 2
     WRITE SYSOPT FROM SYSTEM-IN.                     PROG 2
     PERFORM READ-SYSINP.                             PROG 2
                                                      PROG 2
                                                      PROG 2
READ-INREC.                                           PROG 2
     PERFORM RI-START THRU RI-EXIT.                   PROG 2
RI-START.                                             PROG 2
     READ IN-REC AT END GO TO RI-END.                 PROG 2
RI-EXIT.  EXIT.                                       PROG 2
RI-END.                                               PROG 2
     IF SYSPAD GO TO EOJ.                             PROG 2
     READ SYSINP AT END GO TO EOJ.                    PROG 2
     WRITE SYSOPT FROM SYSTEM-IN.                     PROG 2
     GO TO RI-END.                                    PROG 2
EOJ.                                                  PROG 2
     CLOSE IN-REC, SYSINP, SYSTEM-OUT.                PROG 2
     STOP RUN.                                        PROG 2
                                                      PROG 2
READ-SYSINP.                                          PROG 2
     PERFORM RS-START THRU RS-EXIT.                   PROG 2
```

```
001910 RS-START.                                                          PROG 2
001920      IF SYSPAD GO TO RS-EXIT ELSE READ SYSINP                      PROG 2
001930         AT END MOVE '999' TO SDOC-ID GO TO RS-EXIT.                PROG 2
001940      MOVE SYSTEM-IN TO SDATA-IN.                                   PROG 2
001950 RS-EXIT.  EXIT.                                                    PROG 2
001960                                                                    PROG 2
001970                                                                    PROG 2
001980 CALC.                                                              PROG 2
001990      MOVE 0 TO KP-DATA, VER-DATA.                                  PROG 2
002000 LOOP-G.                                                            PROG 2
002010      MOVE 0 TO KP-STROK, KP-TIME (1), KP-TIME (2), KP-TIME (3),    PROG 2
002020         KP-TIME (4), KP-TIME (5), KP-TIME (6).                     PROG 2
002030      MOVE 0 TO VR-STROK, VR-TIME (1), VR-TIME (2), VR-TIME (3),    PROG 2
002040         VR-TIME (4), VR-TIME (5), VR-TIME (6).                     PROG 2
002050      MOVE SPACES TO WORK-SPACE.                                    PROG 2
002060      MOVE ZERO TO COUNTERS, TMU, R.                                PROG 2
002070      PERFORM LOOP-I THRU I-EXIT VARYING I FROM 1 BY 1              PROG 2
002080         UNTIL I > 5.                                               PROG 2
002090      MOVE ISIZE TO COL.                                            PROG 2
002100      MOVE IPROC-NR TO PPROC-NR.                                    PROG 2
002110      MOVE IDATE TO PDATE.                                          PROG 2
002120      IF RUNCD NOT = 'D' WRITE SYSOPT FROM INPUT-REC.               PROG 2
002130      MOVE 'K' TO RUNCD.                                            PROG 2
002140 LOOP-H.                                                            PROG 2
002150      MOVE 1 TO K.                                                  PROG 2
002160      PERFORM LOOP-J VARYING I FROM COL BY -80 UNTIL I < 1.         PROG 2
002170      MOVE 1 TO I.                                                  PROG 2
002180 LOOP-K.                                                            PROG 2
002190      IF FORMAT (I) = '-' THEN ADD 1 TO TSKIP-DUP, GO TO LOOP-SKIP. PROG 2
002200      IF FORMAT (I) = '0' OR FORMAT (I) = '/' THEN ADD 1 TO         PROG 2
002210         TSKIP-DUP, GO TO LOOP-DUP.                                 PROG 2
002220      IF FORMAT (I) = ' ' GO TO LOOP-NUM.                           PROG 2
002230      IF FORMAT (I) = '1' GO TO LOOP-ALPHA.                         PROG 2
002240      ADD 1 TO I.                                                   PROG 2
002250      GO TO K-EXIT.                                                 PROG 2
002260 LOOP-SKIP.                                                         PROG 2
002270      ADD 1 TO SKIP.                                                PROG 2
002280      ADD 1 TO I.                                                   PROG 2
002290      IF FORMAT (I) = '&' GO TO LOOP-SKIP ELSE GO TO K-EXIT.        PROG 2
002300 LOOP-DUP.                                                          PROG 2
002310      ADD 1 TO DUP.                                                 PROG 2
002320      ADD 1 TO I.                                                   PROG 2
002330      IF FORMAT (I) = '&' OR FORMAT (I) = 'A' GO TO LOOP-DUP,       PROG 2
002340         ELSE GO TO K-EXIT.                                         PROG 2
002350 LOOP-NUM.                                                          PROG 2
002360      ADD 1 TO NUM.                                                 PROG 2
002370      ADD 1 TO STROKES.                                             PROG 2
002380      ADD 1 TO I.                                                   PROG 2
```

```
           IF FORMAT (I) = '&' GO TO LOOP-NUM ELSE GO TO K-EXIT.         PROG 2
       LOOP-ALPHA.                                                       PROG 2
           ADD 1 TO ALPHA                                                PROG 2
           ADD 1 TO STROKES                                              PROG 2
           ADD 1 TO I.                                                   PROG 2
           IF FORMAT (I) = 'A' GO TO LOOP-ALPHA.                         PROG 2
           T.                                                            PROG 2
           IF I > CD  NEXT SENTENCE ELSE GO TO LOOP-K.                   PROG 2
           COMPUTE TMU = (NUM + ALPHA * 1.3 + DUP * .3 + SKIP * .04      PROG 2
                         + TSKIP-DUP * 1.2) * (1.2 - .04 * R).           PROG 2
           IF RUNCD = 'K'                                                PROG 2
             COMPUTE TMU = TMU * KP-TMU-FACTOR                           PROG 2
             ADD STROKES TO KP-STROK                                     PROG 2
             MOVE 'V' TO RUNCD                                           PROG 2
             PERFORM ADD-KP-TMU VARYING I FROM 1 BY 1 UNTIL I > 6        PROG 2
             MOVE SPACES TO FORMIN                                       PROG 2
             MOVE ZERO TO COUNTERS                                       PROG 2
             GO TO LOOP-H.                                               PROG 2
           COMPUTE TMU = TMU * VR-TMU-FACTOR.                            PROG 2
           ADD STROKES TO VR-STROK.                                      PROG 2
           MOVE 'K' TO RUNCD.                                            PROG 2
           PERFORM ADD-VR-TMU VARYING I FROM 1 BY 1 UNTIL I > 6.         PROG 2
           MOVE PTM TO SYSOPT.                                           PROG 2
           WRITE SYSOPT.                                                 PROG 2
       LOOP-L.                                                           PROG 2
           PERFORM READ-INREC.                                           PROG 2
           IF NOT IHEAD GO TO CALC-EXIT.                                 PROG 2
           IF IPROC-NR NOT = PPROC-NR GO TO CALC-EXIT.                   PROG 2
           IF ISUFFIX NOT = ' ' MOVE 'D' TO RUNCD GO TO LOOP-G.          PROG 2
           DISPLAY 'DUPLICATE INPUT'.                                    PROG 2
           DISPLAY INPUT-REC.                                            PROG 2
           GO TO LOOP-L.                                                 PROG 2
       CALC-EXIT.  EXIT.                                                 PROG 2
                                                                         PROG 2
       LOOP-I.                                                           PROG 2
           IF IRATINGS (I) = 'E' ADD 1 TO R GO TO I-EXIT.                PROG 2
           IF IRATINGS (I) = 'G' ADD 2 TO R GO TO I-EXIT.                PROG 2
           IF IRATINGS (I) = 'F' ADD 3 TO R GO TO I-EXIT.                PROG 2
           ADD 4 TO R.                                                   PROG 2
       I-EXIT. EXIT.                                                     PROG 2
                                                                         PROG 2
       LOOP-J.                                                           PROG 2
           PERFORM READ-INREC.                                           PROG 2
           MOVE INPUT-REC TO WORK (K).                                   PROG 2
           ADD 1 TO K.                                                   PROG 2
                                                                         PROG 2
       ADD-KP-TMU.                                                       PROG 2
           ADD TMU TO KP-TIME (I).                                       PROG 2
```

```
                                                       PROG 2
ADD-VR-TMU.                                            PROG 2
          ADD TMU TO VR-TIME (I).                      PROG 2
```

COMPUTER PROGRAM NUMBER THREE

PRODUCTION EFFECTIVENESS AND INCENTIVE REWARD CALCULATIONS

CONTENTS

PROGRAM SYNOPSIS

Program number three processes records of actual production each pay period. The output consists of a report series consisting of data on production efficiency, incentive hours earned, hours of work completed by job order for payroll reporting, and optional MUACS data.

INPUT DESCRIPTION

a. Set-up Record

b. Batch Control Form

c. Supervisor Exception Log

d. Backlog Record (optional)

e. Current System File

OUTPUT DESCRIPTION

a. Individual Production Report

b. Shift Production Report

c. Installation Production Report

d. MUACS Report (optional)

PRODUCTION REPORT - INDIVIDUAL

REPORT FOR MARCH 1972

DODSON, GLENDA   OPERATOR NUMBER 012   SHIFT 1   GRADE GS-03 STEP 02

INCENTIVE TIME AVAILABLE	INCENTIVE TIME ALLOWED	KEYPUNCH ERROR RATE	PRODUCTION EFFICIENCY RATE	INCENTIVE HOURS EARNED	EMPLOYEE UTILIZATION RATE
64.0	70.3	0.0%	109.0%	2.6	80.0%

FUNCTION	JOB ORDER	RG REGULAR	ND NITE DIFF	OT OVER TIME	CE COMP EARN	HP HOL PREM	TOTALS
NORMAL PRODUCTION							
KP EASY	622A 00108	14.5	0.0	0.0	0.0	0.0	14.5
KP NORM	622A 00109	38.1	0.0	0.0	0.0	0.0	38.1
KP DIFF	622A 00110	35.3	0.0	0.0	0.0	0.0	35.3
VR EASY	622A 00111	0.0	0.0	0.0	0.0	0.0	0.0
VR NORM	622A 00112	0.0	0.0	0.0	0.0	0.0	0.0
VR DIFF	622A 00113	0.0	0.0	0.0	0.0	0.0	0.0
MISCELLANEOUS							
CLERICAL	6224 00110	22.9	0.0	0.0	0.0	0.0	22.9
CORRECTION	6224 00110	12.0	0.0	0.0	0.0	0.0	12.0
TRAINING	620N 00082	1.0	0.0	0.0	0.0	0.0	1.0
OJ TRAIN	6224 00110	1.0	0.0	0.0	0.0	0.0	1.0
TAB ROOM	6212 00100	1.0	0.0	0.0	0.0	0.0	1.0
ABSENT FROM WORK							
ANNUAL LV	620N 00150	0.0	0.0	0.0	0.0	0.0	0.0
SICK LV	620N 00151	0.0	0.0	0.0	0.0	0.0	0.0
HOLIDAY	620N 00155	0.0	0.0	0.0	0.0	0.0	0.0
ADMIN LV	620N 00158	0.0	0.0	0.0	0.0	0.0	0.0
COMP TKN	620N 00160	0.0	0.0	0.0	0.0	0.0	0.0
HOTLINE OPERATIONS							
KEYPUNCH	622A 00117	0.0	1.0	1.0	0.0	0.0	2.0
VERIFY	622A 00118	0.0	0.0	0.0	0.0	0.0	0.0
REMOTE OPERATIONS							
ALL	621A 00101	0.0	0.0	0.0	0.0	0.0	0.0
TOTALS		80.0	1.0	1.0	0.0	0.0	82.0

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ORIGINAL
DOCUMENT

MUACS REPORT

	WORK UNITS:	COMPLETED	BACKLOGED
NORMAL PRODUCTION			
KP EASY	622A 00108	2,000	100
KP NORM	622A 00109	4,400	200
KP DIFF	622A 00110	3,500	300
VR EASY	622A 00111	2,000	100
VR NORM	622A 00112	4,400	200
VR DIFF	622A 00113	3,500	300
HOTLINE OPERATIONS			
KEYPUNCH	622A 00117		
VERIFY	622A 00118		

```
IDENTIFICATION DIVISION.                                                 PROG 3
      PROGRAM-ID. 'THESIS'.                                              PROG 3
AUTHOR.  LCDR DANFORTH.                                                  PROG 3
INSTALLATION.  NPGS MONTEREY.                                            PROG 3
DATE-WRITTEN.                                                            PROG 3
DATE-COMPILED.                                                           PROG 3
REMARKS.                                                                 PROG 3
ENVIRONMENT DIVISION.                                                    PROG 3
CONFIGURATION SECTION.                                                   PROG 3
SOURCE-COMPUTER.  IBM-360-67.                                            PROG 3
OBJECT-COMPUTER.  IBM-360-67.                                            PROG 3
INPUT-OUTPUT SECTION.                                                    PROG 3
FILE-CONTROL.                                                            PROG 3
      SELECT IN-REC ASSIGN TO 'CARDIN' UTILITY.                          PROG 3
      SELECT SYSINP ASSIGN TO 'SYSINP' UTILITY.                          PROG 3
      SELECT OUT-PUT ASSIGN TO 'PRINTS' UTILITY.                         PROG 3
DATA DIVISION.                                                           PROG 3
FILE SECTION.                                                            PROG 3
FD    IN-REC LABEL RECORDS ARE OMITTED RECORDING MODE IS F               PROG 3
      RECORD CONTAINS 80 CHARACTERS DATA RECORD IS INPUT-REC.            PROG 3
01    INPUT-REC.                                                         PROG 3
      02  IDOC-ID             PICTURE XXX.                               PROG 3
          88  ISET-UP                              VALUE 'ZU1'.          PROG 3
          88  IBC                                  VALUE 'ZU3'.          PROG 3
          88  IHL                                  VALUE 'ZU4'.          PROG 3
          88  ISE                                  VALUE 'ZU2'.          PROG 3
          88  IBL                                  VALUE 'ZU5'.          PROG 3
      02  SET-UP.                                                        PROG 3
          03  IDATE           PICTURE X(14).                             PROG 3
          03  IDAYS           PICTURE 99.                                PROG 3
          03  FILLER          PICTURE X(61).                             PROG 3
      02  SUP-EXP REDEFINES SET-UP.                                      PROG 3
          03  FILLER          PICTURE X(6).                              PROG 3
          03  SOP             PICTURE X(3).                              PROG 3
          03  SCD             PICTURE XX.                                PROG 3
          03  STIME           PICTURE 999V9.                             PROG 3
          03  SPTYP           PICTURE XX.                                PROG 3
          03  FILLER          PICTURE X(60).                             PROG 3
      02  BATCH-CONTL REDEFINES SET-UP.                                  PROG 3
          03  FILLER          PICTURE X(6).                              PROG 3
          03  BPROC           PICTURE X(6).                              PROG 3
          03  BVOL            PICTURE 9(5).                              PROG 3
          03  BOP-NR          PICTURE X(3) OCCURS 4 TIMES.               PROG 3
          03  BTIME           PICTURE 9(4) OCCURS 8 TIMES.               PROG 3
          03  BERR            PICTURE 9(3).                              PROG 3
          03  BPAYTYP         PICTURE X(2) OCCURS 4 TIMES.               PROG 3
          03  FILLER          PICTURE X(5).                              PROG 3
      02  BACKLOG REDEFINES SET-UP.                                      PROG 3
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            03  FILLER          PICTURE X(6).                           PROG 3
            03  BLPROC          PICTURE X(6).                           PROG 3
            03  BLCD            PICTURE X.                              PROG 3
            03  BLVOL           PICTURE 9(5).                           PROG 3
            03  FILLER          PICTURE X(59).                          PROG 3
 FD    SYSINP   LABEL RECORDS ARE OMITTED RECORDING MODE IS F           PROG 3
       RECORD CONTAINS 80 CHARACTERS DATA RECORD IS SYSTEM-IN.          PROG 3
 01    SYSTEM-IN.                                                       PROG 3
       02   SDOC-ID             PICTURE XXX.                            PROG 3
            88  SOP-ID                              VALUE 'ZU6'.        PROG 3
            88  SHEAD                               VALUE 'ZU7'.        PROG 3
            88  SPTM                                VALUE 'ZU8'.        PROG 3
       02   SKEY-OP.                                                    PROG 3
            03  FILLER          PICTURE X(6).                           PROG 3
            03  SOP-NR          PICTURE X(3).                           PROG 3
            03  FILLER          PICTURE X(5).                           PROG 3
            03  SSHIFT          PICTURE 9.                              PROG 3
            03  SOP-DATA        PICTURE X(24).                          PROG 3
            03  FILLER          PICTURE X(38).                          PROG 3
       02   SPTMODEL REDEFINES SKEY-OP.                                 PROG 3
            03  FILLER          PICTURE X(6).                           PROG 3
            03  PPROC           PICTURE X(6).                           PROG 3
            03  PMUACS          PICTURE X.                              PROG 3
            03  PSKP            PICTURE 999.                            PROG 3
            03  FILLER          PICTURE X(20).                          PROG 3
            03  PUKP            PICTURE 9999.                           PROG 3
            03  PSVR            PICTURE 999.                            PROG 3
            03  FILLER          PICTURE X(20).                          PROG 3
            03  PUVR            PICTURE 9999.                           PROG 3
            03  FILLER          PICTURE X(10).                          PROG 3
 FD    OUT-PUT  LABEL RECORDS ARE OMITTED RECORDING MODE IS F           PROG 3
       RECORD  ONTAINS 133 CHARACTERS DATA RECORD IS PRINT-LINE.        PROG 3
 01    PRINT-L.                 PICTURE  X(133).                        PROG 3
 SD    DETAILS  ECORDING MODE IS F                                      PROG 3
       RECORD CONTAINS 29 CHARACTERS DATA RECORD IS DETAIL-REC.         PROG 3
 01    DETAIL-REC.                                                      PROG 3
       02   SORT-OP-NR          PICTURE XXX.                            PROG 3
       02   SORT-KEY            PICTURE X.                              PROG 3
            88  SOPERTR                             VALUE '1'.          PROG 3
            88  SEXCEP                              VALUE '2'.          PROG 3
            88  SMUACBL                             VALUE '3'.          PROG 3
            88  SMUACMP                             VALUE '4'.          PROG 3
            88  SERRATE                             VALUE '5'.          PROG 3
            88  SPROD                               VALUE '6'.          PROG 3
       02   FILLER              PICTURE X(25).                          PROG 3
 WORKING-STORAGE SECTION.                                               PROG 3
 77    FIRST-PASS               PICTURE 9           VALUE 0.            PROG 3
 77    I                        PICTURE 99          VALUE 1.            PROG 3
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77  ARG-PROC                    PICTURE X(6)    VALUE SPACES.        PROG 3
77  ARG-PAY                     PICTURE XX.                          PROG 3
77  J-PAY                       PICTURE 99.                          PROG 3
77  ERR-PCNT                    PICTURE 999V99.                      PROG 3
77  ERR-FAC                     PICTURE 999V99.                      PROG 3
77  TIME-WORK                   PICTURE 999V99.                      PROG 3
77  OPER-NUM                    PICTURE XXX     VALUE SPACES.        PROG 3
77  TIME-ALLOWED                PICTURE 9999V9  VALUE ZERO.          PROG 3
77  HOURS-EXCEP                 PICTURE 999     VALUE ZERO.          PROG 3
77  TIME-AVAIL                  PICTURE 9999V9   VALUE 0.            PROG 3
77  HOURS-AVAIL                 PICTURE 999V9    VALUE 0.            PROG 3
77  PE                          PICTURE 999V9    VALUE 0.            PROG 3
77  INCT-HRS                    PICTURE 9999V9   VALUE 0.            PROG 3
77  HIGH                        PICTURE 999     VALUE 0.             PROG 3
77  LOW                         PICTURE 999     VALUE 0.             PROG 3
77  TEST                        PICTURE 999     VALUE 0.             PROG 3
77  MID                         PICTURE 999     VALUE 0.             PROG 3
77  NS-TIME                     PICTURE 9999V9  VALUE 0.             PROG 3
77  J                           PICTURE 99      VALUE 0.             PROG 3
77  K                           PICTURE 999     VALUE 0.             PROG 3
01  SORT-RECORDS.                                                    PROG 3
    02  PROD-REC.                                                    PROG 3
        03  POP                 PICTURE XXX.                         PROG 3
        03  FILLER              PICTURE X       VALUE '6'.           PROG 3
        03  P-I                 PICTURE 99.                          PROG 3
        03  P-J                 PICTURE 99.                          PROG 3
        03  PTIME               PICTURE 999V9.                       PROG 3
        03  FILLER              PICTURE X(17).                       PROG 3
    02  EXCEP-REC.                                                   PROG 3
        03  EOP                 PICTURE XXX.                         PROG 3
        03  FILLER              PICTURE X       VALUE '2'.           PROG 3
        03  E-I                 PICTURE 99.                          PROG 3
        03  E-J                 PICTURE 99.                          PROG 3
        03  ETIMEE.                                                  PROG 3
            04  EHOUR           PICTURE 999.                         PROG 3
            04  EMINS           PICTURE 9.                           PROG 3
        03  ETIME REDEFINES ETIMEE PICTURE 999V9.                    PROG 3
        03  NS-FLAG             PICTURE X.                           PROG 3
        03  FILLER              PICTURE X(16).                       PROG 3
    02  MUACS-BL.                                                    PROG 3
        03  FILLER              PICTURE X(4)    VALUE 'BLG3'.        PROG 3
        03  M-I                 PICTURE 99.                          PROG 3
        03  FILLER              PICTURE X.                           PROG 3
        03  M-VOL               PICTURE 9(5).                        PROG 3
        03  FILLER              PICTURE X(17).                       PROG 3
    02  MUACS-CMP.                                                   PROG 3
        03  FILLER              PICTURE XXXX    VALUE 'CMP4'.        PROG 3
        03  MC-I                PICTURE 99.                          PROG 3
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            03  FILLER             PICTURE X.                                   PROG 3
            03  MC-VOL             PICTURE 9(5).                                PROG 3
            03  FILLER             PICTURE X(17).                               PROG 3
        02  ERROR-RATE.                                                         PROG 3
            03  EROP               PICTURE XXX.                                 PROG 3
            03  FILLER             PICTURE X       VALUE '5'.                   PROG 3
            03  ERRS               PICTURE 9(3).                                PROG 3
            03  ERVOL              PICTURE 9(5).                                PROG 3
            03  FILLER             PICTURE X(17).                               PROG 3
        02  OP-DATA.                                                            PROG 3
            03  OOP-NR             PICTURE XXX.                                 PROG 3
            03  FILLER             PICTURE X       VALUE '1'.                   PROG 3
            03  OSHIFT             PICTURE 9.                                   PROG 3
            03  ODATA.                                                          PROG 3
                04  OGRADE         PICTURE XX.                                  PROG 3
                04  OSTEP          PICTURE XX.                                  PROG 3
                04  ONAME          PICTURE X(20).                               PROG 3
    01  PTM-TABLE.                                                              PROG 3
        02  PTMENTRY               OCCURS 50 TIMES.                             PROG 3
            03  PROC               PICTURE X(6).                                PROG 3
            03  KP-STROK           PICTURE 9(3).                                PROG 3
            03  KP-TMU             PICTURE 9(4).                                PROG 3
            03  VR-STROK           PICTURE 9(3).                                PROG 3
            03  VR-TMU             PICTURE 9(4).                                PROG 3
            03  MUACSCD            PICTURE X.                                   PROG 3
    01  MUACS-GRID.                                                             PROG 3
        02  MUACS-C                PICTURE 9(7)    OCCURS 8 TIMES.              PROG 3
        02  MUACS-B                PICTURE 9(7)    OCCURS 6 TIMES.              PROG 3
    01  TIME-GRID.                                                              PROG 3
        02  PEGRID                                 OCCURS  6 TIMES.             PROG 3
            03  PE-GRID            PICTURE 999V9   OCCURS  5 TIMES.             PROG 3
        02  MAIN-GRID.                                                          PROG 3
            03  JOGRID                             OCCURS 21 TIMES.             PROG 3
                04  JO-GRID                        OCCURS  6 TIMES.             PROG 3
                    05  GHOURS PICTURE 9(4)V9.                                  PROG 3
                04  GFLAGS          PICTURE 9.                                  PROG 3
            03  JO-ERR             PICTURE 9(7).                                PROG 3
            03  JO-VOL             PICTURE 9(8).                                PROG 3
    01  PRINTER-LINES.                                                          PROG 3
        02  H1.                                                                 PROG 3
          03  FILLER PICTURE X      VALUE SPACES.                               PROG 3
          03  A         PICTURE X(20) VALUE 'PRODUCTION REPORT - '.             PROG 3
          03  H1-0      PICTURE X(32).                                          PROG 3
          03  FILLER    PICTURE X(42) VALUE SPACES.                             PROG 3
          03  B         PICTURE X(11) VALUE 'REPORT FOR '.                      PROG 3
         03  H1-1    PICTURE X(27) VALUE SPACES.                                PROG 3
        02  L1.                                                                 PROG 3
          03  FILLER PICTURE X      VALUE SPACES.                               PROG 3
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           03  L1-1    PICTURE X(20) VALUE SPACES.                        PROG 3
           03  C       PICTURE X(25) VALUE '       OPERATOR NUMBER '.     PROG 3
           03  L1-2    PICTURE X(3)  VALUE SPACES.                        PROG 3
           03  D       PICTURE X(11) VALUE '    SHIFT '.                  PROG 3
           03  L1-3    PICTURE 9     VALUE 0.                             PROG 3
           03  E       PICTURE X(18) VALUE '       GRADE GS-'.            PROG 3
           03  L1-4    PICTURE XX    VALUE SPACES.                        PROG 3
           03  F       PICTURE X(7)  VALUE '  STEP '.                     PROG 3
           03  L1-5    PICTURE XX    VALUE SPACES.                        PROG 3
           03  FILLER PICTURE X(43) VALUE SPACES.                         PROG 3
       02  L2.                                                            PROG 3
           03  LA  PICTURE X(80) VALUE '      INCENTIVE              IN   PROG 3
-          'CENTIVE            KEYPUNCH               PRODUCTIO'.         PROG 3
           03  LB  PICTURE X(53) VALUE 'N                INCENTIVE        PROG 3
-          '         EMPLOYEE          '.                                 PROG 3
       02  L3.                                                            PROG 3
           03  LC  PICTURE X(80) VALUE '         TIME                     PROG 3
-          'TIME               ERROR             EFFICIENC'.              PROG 3
           03  LD  PICTURE X(53) VALUE 'Y                  HOURS          PROG 3
-          '       UTILIZATION          '.                                PROG 3
       02  L4.                                                            PROG 3
           03  LE  PICTURE X(80) VALUE '       AVAILABLE              A   PROG 3
-          'LLOWED              RATE                 RATE   '.            PROG 3
           03  LF  PICTURE X(53) VALUE '                  EARNED          PROG 3
-          '           RATE          '.                                   PROG 3
       02  L5.                                                            PROG 3
           03  FILLER PICTURE X(7)  VALUE SPACES.                         PROG 3
           03  L5-1 PICTURE ZZZ9.9.                                       PROG 3
           03  FILLER PICTURE X(16) VALUE SPACES.                         PROG 3
           03  L5-2 PICTURE ZZZ9.9.                                       PROG 3
           03  FILLER PICTURE X(15) VALUE SPACES.                         PROG 3
           03  L5-3 PICTURE ZZ9.9.                                        PROG 3
           03 FILLER PICTURE X VALUE '%'.                                 PROG 3
           03 FILLER PICTURE X(17) VALUE SPACES.                          PROG 3
           03  L5-4 PICTURE ZZ9.9.                                        PROG 3
           03 FILLER PICTURE X VALUE '%'.                                 PROG 3
           03 FILLER PICTURE X(15) VALUE SPACES.                          PROG 3
           03  L5-5 PICTURE ZZZ9.9.                                       PROG 3
           03 FILLER PICTURE X(17) VALUE SPACES.                          PROG 3
           03  L5-6 PICTURE ZZ9.9.                                        PROG 3
           03 FILLER PICTURE X VALUE '%'.                                 PROG 3
           03 FILLER PICTURE X(09) VALUE SPACES.                          PROG 3
       02  L6.                                                            PROG 3
           03  FILLER PICTURE X(47) VALUE SPACES.                         PROG 3
           03  G       PICTURE X(63) VALUE ' RG            ND             PROG 3
-          '     OT            CE            HP'.                         PROG 3
           03  FILLER PICTURE X(23) VALUE SPACES.                         PROG 3
       02  L7.                                                            PROG 3
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002410        03  FILLER PICTURE X(62) VALUE SPACES.                                  PROG 3
002420        03  H      PICTURE X(49) VALUE 'NITE                 OVER               PROG 3
002430-         '   COMP           HOL '.                                             PROG 3
002440        03  FILLER PICTURE X(22) VALUE SPACES.                                  PROG 3
002450      02  L8.                                                                   PROG 3
002460        03  LG   PICTURE X(80) VALUE '          FUNCTION            JOB         PROG 3
002470-          'ORDER           REGULAR          DIFF            TIM'.              PROG 3
002480        03  LH   PICTURE X(53) VALUE 'E             EARN              PRE       PROG 3
002490-         'M                 TOTALS '.                                          PROG 3
002500      02  L9.                                                                   PROG 3
002510        03  FILLER          PICTURE X(11)         VALUE SPACES.                 PROG 3
002520        03  L9-1                PICTURE X(10).                                  PROG 3
002530        03  FILLER          PICTURE X(4)  VALUE SPACES.                         PROG 3
002540        03  L9-2            PICTURE X(11) VALUE SPACES.                         PROG 3
002550        03  FILLER          PICTURE X(9)  VALUE SPACES.                         PROG 3
002560        03  L9-3            PICTURE ZZZ9.9.                                     PROG 3
002570        03  FILLER              PICTURE X(9)    VALUE SPACES.                   PROG 3
002580        03  L9-4            PICTURE ZZZ9.9.                                     PROG 3
002590        03  FILLER              PICTURE X(9)    VALUE SPACES.                   PROG 3
002600        03  L9-5            PICTURE ZZZ9.9.                                     PROG 3
002610        03  FILLER              PICTURE X(9)    VALUE SPACES.                   PROG 3
002620        03  L9-6            PICTURE ZZZ9.9.                                     PROG 3
002630        03  FILLER              PICTURE X(9)    VALUE SPACES.                   PROG 3
002640        03  L9-7            PICTURE ZZZ9.9.                                     PROG 3
002650        03  FILLER          PICTURE X(14) VALUE SPACES.                         PROG 3
002660        03  L9-8            PICTURE ZZZ9.9.                                     PROG 3
002670        03  FILLER          PICTURE X(2)  VALUE SPACES.                         PROG 3
002680      02  L10.                                                                  PROG 3
002690        03  FILLER              PICTURE X       VALUE SPACES.                   PROG 3
002700        03  L10-1               PICTURE X(20)   VALUE SPACES.                   PROG 3
002710        03  FILLER              PICTURE X(112)  VALUE SPACES.                   PROG 3
002720      02  M1.                                                                   PROG 3
002730          03  FILLER            PICTURE X(20)   VALUE SPACES.                   PROG 3
002740          03  FILLER            PICTURE X(12)   VALUE 'MUACS REPORT'.           PROG 3
002750          03  FILLER            PICTURE X(101)  VALUE  SPACES.                  PROG 3
002760      02  M11.                                                                  PROG 3
002770          03  FILLER            PICTURE X(41)   VALUE SPACES.                   PROG 3
002780          03  FILLER            PICTURE X(11)   VALUE 'WORK UNITS:'.            PROG 3
002790          03  FILLER            PICTURE X(05)   VALUE SPACES.                   PROG 3
002800          03  FILLER            PICTURE X(9)    VALUE 'COMPLETED'.              PROG 3
002810          03  FILLER            PICTURE X(11)   VALUE SPACES.                   PROG 3
002820          03  FILLER            PICTURE X(9)    VALUE 'BACKLOGED'.              PROG 3
002830          03  FILLER            PICTURE X(47)   VALUE SPACES.                   PROG 3
002840      02  M2.                                                                   PROG 3
002850          03  FILLER            PICTURE X       VALUE SPACES.                   PROG 3
002860          03  M2-1              PICTURE X(20)   VALUE SPACES.                   PROG 3
002870          03  FILLER            PICTURE X(10)   VALUE SPACES.                   PROG 3
002880          03  M2-2              PICTURE X(15)   VALUE SPACES.                   PROG 3
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002890             03  FILLER             PICTURE X(10)  VALUE SPACES.            PROG 3
002900             03  M2-3               PICTURE ZZ,ZZZ,ZZZ.                     PROG 3
002910             03  FILLER             PICTURE X(10)  VALUE SPACES.            PROG 3
002920             03  M2-4               PICTURE ZZ,ZZZ,ZZZ.                     PROG 3
002930             03  FILLER             PICTURE X(47)  VALUE SPACES.            PROG 3
002940 01   STIME-CON.                                                           PROG 3
002950      02  SHOURS                    PICTURE 99.                             PROG 3
002960      02  SMIN                      PICTURE 99.                             PROG 3
002970 01   ETIME-CON.                                                           PROG 3
002980      02  EHOURS                    PICTURE 99.                             PROG 3
002990      02  EMIN                      PICTURE 99.                             PROG 3
003000 01   CON-TIME.                                                            PROG 3
003010      02  CHOURS                    PICTURE 999.                            PROG 3
003020      02  CTENTHS                   PICTURE 9.                              PROG 3
003030 01   EXPANDED-TIME.                                                       PROG 3
003040      02  EXP-MIN                   PICTURE 999.                            PROG 3
003050      02  EXP-TENS                  PICTURE 99.                             PROG 3
003060 01   PH-TABLE.                                                            PROG 3
003070      02  PH-ENTRIES.                                                      PROG 3
003080        03  FILLER PICTURE X(20) VALUE 'NORMAL PRODUCTION   '.            PROG 3
003090        03  FILLER PICTURE X(20) VALUE 'MISCELLANEOUS       '.            PROG 3
003100        03  FILLER PICTURE X(20) VALUE 'ABSENT FROM WORK    '.            PROG 3
003110        03  FILLER PICTURE X(20) VALUE 'HOTLINE OPERATIONS  '.            PROG 3
003120        03  FILLER PICTURE X(20) VALUE 'REMOTE OPERATIONS   '.            PROG 3
003130      02  PH-TAB REDEFINES PH-ENTRIES PICTURE X(20) OCCURS 5 TIMES.       PROG 3
003140 01   J-TABLE.                                                             PROG 3
003150      02  J-ENTRIES.                                                       PROG 3
003160        03  FILLER   PICTURE X(11) VALUE '622A  00108'.                   PROG 3
003170        03  FILLER   PICTURE X(11) VALUE '622A  00109'.                   PROG 3
003180        03  FILLER   PICTURE X(11) VALUE '622A  00110'.                   PROG 3
003190        03  FILLER   PICTURE X(11) VALUE '622A  00111'.                   PROG 3
003200        03  FILLER   PICTURE X(11) VALUE '622A  00112'.                   PROG 3
003210        03  FILLER   PICTURE X(11) VALUE '622A  00113'.                   PROG 3
003220        03  FILLER   PICTURE X(11) VALUE '6224  00110'.                   PROG 3
003230        03  FILLER   PICTURE X(11) VALUE '6224  00110'.                   PROG 3
003240        03  FILLER   PICTURE X(11) VALUE '620N  00082'.                   PROG 3
003250        03  FILLER   PICTURE X(11) VALUE '6224  00110'.                   PROG 3
003260        03  FILLER   PICTURE X(11) VALUE '6212  00100'.                   PROG 3
003270        03  FILLER   PICTURE X(11) VALUE '620N  00150'.                   PROG 3
003280        03  FILLER   PICTURE X(11) VALUE '620N  00151'.                   PROG 3
003290        03  FILLER   PICTURE X(11) VALUE '620N  00155'.                   PROG 3
003300        03  FILLER   PICTURE X(11) VALUE '620N  00158'.                   PROG 3
003310        03  FILLER   PICTURE X(11) VALUE '620N  00160'.                   PROG 3
003320        03  FILLER   PICTURE X(11) VALUE '622A  00117'.                   PROG 3
003330        03  FILLER   PICTURE X(11) VALUE '622A  00118'.                   PROG 3
003340        03  FILLER   PICTURE X(11) VALUE '621A  00101'.                   PROG 3
003350        03  FILLER           PICTURE X(11)  VALUE SPACES.                 PROG 3
003360      02  J-TAB REDEFINES J-ENTRIES PICTURE X(11) OCCURS 20 TIMES.        PROG 3
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01  P-TABLE.                                                            PROG 3
    02  P-ENTRIES.                                                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'KP EASY   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'KP NORM   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'KP DIFF   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'VR EASY   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'VR NORM   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'VR DIFF   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'CLERICAL  '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'CORRECTION'.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'TRAINING  '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'OJ TRAIN  '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'TAB ROOM  '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'ANNUAL LV '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'SICK   LV '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'HOLIDAY   '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'ADMIN  LV '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'COMP TKN  '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'KEYPUNCH  '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'VERIFY    '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE 'ALL       '.                      PROG 3
      03 FILLER  PICTURE X(10) VALUE '    TOTALS'.                      PROG 3
    02  P-TAB REDEFINES P-ENTRIES PICTURE X(10) OCCURS 20 TIMES.        PROG 3
01  INST-TIMES.                                                         PROG 3
    02  SHIFT-BLOCK           OCCURS 4 TIMES.                           PROG 3
        03  ITAV              PICTURE 999V9.                            PROG 3
        03  ITAL              PICTURE 999V9.                            PROG 3
        03  KPERR             PICTURE 999V9.                            PROG 3
        03  <PCOUNT           PICTURE 999V9.                            PROG 3
        03 PER                PICTURE 999V9.                            PROG 3
        03  IHE               PICTURE 999V9.                            PROG 3
        03  EUR               PICTURE 999V9.                            PROG 3
PROCEDURE DIVISION.                                                     PROG 3
                                                                        PROG 3
MAIN-STREAM SECTION.                                                    PROG 3
    PERFORM SORT-SECTION.                                               PROG 3
    PERFORM TOTALS-DUMP.                                                PROG 3
    CLOSE OUT-PUT.                                                      PROG 3
    STOP RUN.                                                           PROG 3
                                                                        PROG 3
                                                                        PROG 3
SORT-SECTION.                                                           PROG 3
    SORT DETAILS ON ASCENDING KEY SORT-OP-NR SORT-KEY                   PROG 3
     INPUT PROCEDURE DUMP-SYSINP                                        PROG 3
     OUTPUT PROCEDURE REPORT-OUTPUT.                                    PROG 3
                                                                        PROG 3
                                                                        PROG 3
DUMP-SYSINP SECTION.                                                    PROG 3
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       OPEN INPUT SYSINP, IN-REC.                                    PROG 3
   LOOP-A.                                                           PROG 3
       READ SYSINP AT END GO TO INP-CLOSE.                           PROG 3
       IF SOP-ID THEN                                                PROG 3
          MOVE SOP-NR TO OOP-NR                                      PROG 3
          MOVE SSHIFT TO OSHIFT                                      PROG 3
          MOVE SOP-DATA TO ODATA                                     PROG 3
          MOVE OP-DATA TO DETAIL-REC                                 PROG 3
          RELEASE DETAIL-REC                                         PROG 3
          GO TO LOOP-A.                                              PROG 3
       IF SPTM THEN                                                  PROG 3
          ADD 1 TO I                                                 PROG 3
          MOVE PPROC TO PROC (I)                                     PROG 3
          MOVE PSKP TO KP-STROK (I)                                  PROG 3
          MOVE PUKP TO KP-TMU (I)                                    PROG 3
          MOVE PSVR TO VR-STROK (I)                                  PROG 3
          MOVE PUVR TO VR-TMU (I)                                    PROG 3
          MOVE PMUACS TO MUACSCD (I).                                PROG 3
          GO TO LOOP-A.                                              PROG 3
                                                                     PROG 3
   INP-CLOSE.                                                        PROG 3
       CLOSE SYSINP.                                                 PROG 3
       MOVE I TO HIGH.                                               PROG 3
       MOVE 'UNK' TO PROC (1).                                       PROG 3
       MOVE 60 TO KP-STROK (1).                                      PROG 3
       MOVE 60 TO VR-STROK (1).                                      PROG 3
       MOVE 500 TO KP-TMU (1).                                       PROG 3
       MOVE 500 TO VR-TMU (1).                                       PROG 3
       MOVE ' ' TO MUACSCD (1).                                      PROG 3
                                                                     PROG 3
   LOOP-B.                                                           PROG 3
       READ IN-REC AT END GO TO DS-EXIT.                             PROG 3
       IF ISET-UP MOVE IDATE TO H1-I                                 PROG 3
          COMPUTE HOURS-AVAIL = IDAYS * 8.0                          PROG 3
          GO TO LOOP-B.                                              PROG 3
       IF IBC                                                        PROG 3
          IF BOP-NR (1) NOT = SPACES PERFORM IP-KP                   PROG 3
          IF BOP-NR (2) NOT = SPACES PERFORM IP-VR                   PROG 3
          IF BOP-NR (3) NOT = SPACES PERFORM CR-KP                   PROG 3
          IF BOP-NR (4) NOT = SPACES PERFORM CR-VR                   PROG 3
          GO TO LOOP-B.                                              PROG 3
       IF ISE                                                        PROG 3
          IF SOP NOT = SPACES PERFORM EXCEPT THRU EX-EXIT            PROG 3
          GO TO LOOP-B.                                              PROG 3
       IF IBL PERFORM BACKLOG GO TO LOOP-B.                          PROG 3
       GO TO LOOP-B.                                                 PROG 3
                                                                     PROG 3
   IP-KP.                                                            PROG 3
```

```
           MOVE BPROC TO ARG-PROC.                                      PROG 3
           PERFORM SEARCH-RTN THRU SR-EXIT.                             PROG 3
           MOVE BOP-NR (1) TO POP, EROP.                                PROG 3
           MOVE BERR TO ERRS.                                           PROG 3
           MOVE BVOL TO ERVOL.                                          PROG 3
           MOVE ERROR-RATE TO DETAIL-REC.                               PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
           IF MUACSCD (I) = 'D' MOVE 3 TO P-I ELSE                      PROG 3
           IF MUACSCD (I) = 'E' MOVE 1 TO P-I ELSE MOVE 2 TO P-I.       PROG 3
           MOVE P-I TO MC-I.                                            PROG 3
           MOVE BVOL TO MC-VOL.                                         PROG 3
           MOVE MUACS-CMP TO DETAIL-REC.                                PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
           MOVE BPAYTYP (1) TO ARG-PAY.                                 PROG 3
           PERFORM PAY-TYPE THRU PT-EXIT.                               PROG 3
           MOVE J-PAY TO P-J.                                           PROG 3
           COMPUTE ERR-PCNT = (BERR / BVOL) * 100.                      PROG 3
           IF ERR-PCNT > 2.00                                           PROG 3
              THEN COMPUTE ERR-FAC = (-4 + (7 / 3) * ERR-PCNT)          PROG 3
              ELSE MOVE ZERO TO ERR-FAC.                                PROG 3
           COMPUTE TIME-WORK =                                          PROG 3
            ((BVOL - BVOL * ERR-FAC) * KP-TMU (I) / 100000) * 1.15 + .1. PROG 3
           MOVE TIME-WORK TO PTIME.                                     PROG 3
           MOVE PROD-REC TO DETAIL-REC.                                 PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
       IP-VR.                                                           PROG 3
           MOVE BPROC TO ARG-PROC.                                      PROG 3
           PERFORM SEARCH-RTN THRU SR-EXIT.                             PROG 3
           MOVE BOP-NR (2) TO POP.                                      PROG 3
           IF MUACSCD (I) = 'D' MOVE 6 TO P-I ELSE                      PROG 3
           IF MUACSCD (I) = 'E' MOVE 4 TO P-I ELSE MOVE 5 TO P-I.       PROG 3
           MOVE BPAYTYP (2) TO ARG-PAY.                                 PROG 3
           PERFORM PAY-TYPE THRU PT-EXIT.                               PROG 3
           MOVE J-PAY TO P-J.                                           PROG 3
           COMPUTE TIME-WORK = BVOL * VR-TMU (I) / 100000.              PROG 3
           MOVE TIME-WORK TO PTIME.                                     PROG 3
           MOVE PROD-REC TO DETAIL-REC.                                 PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
           MOVE P-I TO MC-I.                                            PROG 3
           MOVE BVOL TO MC-VOL.                                         PROG 3
           MOVE MUACS-CMP TO DETAIL-REC.                                PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
       CR-KP.                                                           PROG 3
           PERFORM TIME-CONVERSION THRU TC-EXIT.                        PROG 3
           MOVE BOP-NR (3) TO EOP.                                      PROG 3
           MOVE 8 TO E-I.                                               PROG 3
           MOVE BPAYTYP (3) TO ARG-PAY.                                 PROG 3
           PERFORM PAY-TYPE THRU PT-EXIT.                               PROG 3
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           MOVE J-PAY TO E-J.                                           PROG 3
           MOVE EXCEP-REC TO DETAIL-REC.                                PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
       CR-VR.                                                           PROG 3
           MOVE BOP-NR (4) TO EOP.                                      PROG 3
           MOVE 8 TO E-I.                                               PROG 3
           MOVE BPAYTYP (4) TO ARG-PAY.                                 PROG 3
           PERFORM PAY-TYPE THRU PT-EXIT.                               PROG 3
           MOVE J-PAY TO E-J.                                           PROG 3
           MOVE CON-TIME TO ETIME.                                      PROG 3
           MOVE EXCEP-REC TO DETAIL-REC.                                PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
                                                                        PROG 3
                                                                        PROG 3
       EXCEPT.                                                          PROG 3
           MOVE SOP TO EOP.                                             PROG 3
           MOVE STIME TO ETIME.                                         PROG 3
           MOVE ' ' TO NS-FLAG.                                         PROG 3
           IF SCD = 'CL' MOVE 7 TO E-I GO TO EX-LOOP.                   PROG 3
           IF SCD = 'TF' MOVE 9 TO E-I GO TO EX-LOOP.                   PROG 3
           IF SCD = 'TJ' MOVE 10 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'TB' MOVE 11 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'LA' MOVE 12 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'LS' MOVE 13 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'LH' MOVE 14 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'LE' MOVE 15 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'CT' MOVE 16 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'HK' MOVE 17 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'HV' MOVE 18 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = 'RM' MOVE 19 TO E-I GO TO EX-LOOP.                  PROG 3
           IF SCD = ' ' MOVE 21 TO E-I                                  PROG 3
               IF SPTYP = 'NS' MOVE '*' TO NS-FLAG.                     PROG 3
       EX-LOOP.                                                         PROG 3
           MOVE SPTYP TO ARG-PAY.                                       PROG 3
           PERFORM PAY-TYPE THRU PT-EXIT.                               PROG 3
           MOVE J-PAY TO E-J.                                           PROG 3
           MOVE EXCEP-REC TO DETAIL-REC.                                PROG 3
           RELEASE DETAIL-REC.                                          PROG 3
       EX-EXIT.  EXIT.                                                  PROG 3
                                                                        PROG 3
       BACKLOG.                                                         PROG 3
           MOVE BLPROC TO ARG-PROC.                                     PROG 3
           PERFORM SEARCH-RTN THRU SR-EXIT.                             PROG 3
           IF MUACSCD (I) = 'D' MOVE 3 TO M-I ELSE                      PROG 3
           IF MUACSCD (I) = 'E' MOVE 1 TO M-I ELSE MOVE 2 TO M-I.       PROG 3
           MOVE BLVOL TO M-VOL.                                         PROG 3
           IF BLCD = 'V' ADD 3 TO M-I.                                  PROG 3
           MOVE MUACS-BL TO DETAIL-REC.                                 PROG 3
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    RELEASE DETAIL-REC.

SEARCH-RTN.
    MOVE 2 TO LOW.
    IF ARG-PROC < PROC (LOW) OR > PROC (HIGH) MOVE 1 TO I
       GO TO SR-EXIT.
    IF ARG-PROC = PROC (LOW) MOVE LOW TO I GO TO SR-EXIT.
    IF ARG-PROC = PROC (HIGH) MOVE HIGH TO I GO TO SR-EXIT.
S-LOOP.
    SUBTRACT LOW FROM HIGH GIVING TEST.
    IF TEST = 1 MOVE 1 TO I GO TO SR-EXIT.
    COMPUTE MID = (LOW + HIGH) / 2.
    IF ARG-PROC = PROC (MID) MOVE MID TO I GO TO SR-EXIT.
    IF ARG-PROC < PROC (MID) MOVE MID TO HIGH ELSE MOVE MID
       TO LOW.
    GO TO S-LOOP.
SR-EXIT.  EXIT.

PAY-TYPE.
    IF ARG-PAY = '  ' MOVE 1 TO J-PAY GO TO PT-EXIT.
    IF ARG-PAY = 'ND' MOVE 2 TO J-PAY GO TO PT-EXIT.
    IF ARG-PAY = 'NS' MOVE 2 TO J-PAY GO TO PT-EXIT.
    IF ARG-PAY = 'OT' MOVE 3 TO J-PAY GO TO PT-EXIT.
    IF ARG-PAY = 'CE' MOVE 4 TO J-PAY GO TO PT-EXIT.
    IF ARG-PAY = 'HP' MOVE 5 TO J-PAY GO TO PT-EXIT.
    MOVE 1 TO J-PAY.
PT-EXIT. EXIT.

TIME-CONVERSION.
    MOVE BTIME (3) TO STIME-CON.
    MOVE BTIME (7) TO ETIME-CON.
    MOVE 1 TO FIRST-PASS.
TC-LOOP.
    IF EHOURS < SHOURS ADD 24 TO EHOURS.
    SUBTRACT SHOURS FROM EHOURS GIVING CHOURS.
    MOVE EMIN TO EXP-MIN.
    IF EMIN < SMIN ADD 60 TO EXP-MIN SUBTRACT 1 FROM CHOURS.
    COMPUTE EXP-TENS ROUNDED = (EXP-MIN - SMIN) / 6.
    IF EXP-TENS = 10 ADD 1 TO CHOURS MOVE ZERO TO EXP-TENS.
    MOVE EXP-TENS TO CTENTHS.
    IF FIRST-PASS = 0 GO TO TC-EXIT.
    MOVE CON-TIME TO ETIMEE.
    MOVE 0 TO FIRST-PASS.
    MOVE BTIME (4) TO STIME-CON.
    MOVE BTIME (8) TO ETIME-CON.
    GO TO TC-LOOP.
TC-EXIT. EXIT.
DS-EXIT.
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```
       MOVE 1 TO FIRST-PASS.                                          PROG 3
       CLOSE IN-REC.                                                  PROG 3
                                                                      PROG 3
                                                                      PROG 3
   REPORT-OUTPUT SECTION.                                             PROG 3
       OPEN OUTPUT OUT-PUT.                                           PROG 3
       PERFORM HOUSEKEEPING.                                          PROG 3
       MOVE ZERO TO SHIFT-BLOCK (1), SHIFT-BLOCK (2),                 PROG 3
          SHIFT-BLOCK (3), SHIFT-BLOCK (4).                           PROG 3
       PERFORM ZERO-MC VARYING I FROM 1 BY 1 UNTIL I > 8.             PROG 3
       PERFORM ZERO-MB VARYING I FROM 1 BY 1 UNTIL I > 6.             PROG 3
                                                                      PROG 3
   RETURN-LOOP.                                                       PROG 3
       RETURN DETAILS    AT END GO TO REPORT-EXIT.                    PROG 3
   RL.                                                                PROG 3
       IF SMUACMP                                                     PROG 3
          MOVE DETAIL-REC TO MUACS-BL                                 PROG 3
          ADD M-VOL TO MUACS-C (M-I)                                  PROG 3
          GO TO RETURN-LOOP.                                          PROG 3
       IF SMUACBL                                                     PROG
          MOVE DETAIL-REC TO MUACS-BL                                 PROG 3
          ADD M-VOL TO MUACS-B  (M-I)                                 PROG 3
          GO TO RETURN-LOOP.                                          PROG 3
   DUMP-RETURN.                                                       PROG 3
       IF SORT-OP-NR NOT = OPER-NUM THEN                              PROG 3
          IF FIRST-PASS = 1 MOVE ZERO TO FIRST-PASS                   PROG 3
             MOVE SORT-OP-NR TO OPER-NUM ELSE GO TO DUMP.             PROG 3
       IF SPROD                                                       PROG 3
          MOVE DETAIL-REC TO PROD-REC                                 PROG 3
          ADD PTIME TO PE-GRID (P-I, P-J)                             PROG 3
          ADD PTIME TO TIME-ALLOWED                                   PROG 3
          GO TO RETURN-LOOP.                                          PROG 3
       IF SEXCEP                                                      PROG 3
          MOVE DETAIL-REC TO EXCEP-REC                                PROG 3
          ADD ETIME TO GHOURS (E-I, E-J)                              PROG 3
          IF E-J = 1 OR E-J = 2 ADD ETIME TO HOURS-EXCEP              PROG 3
          IF NS-FLAG = '*' ADD ETIME TO TIME-AVAIL                    PROG 3
          GO TO RETURN-LOOP.                                          PROG 3
       IF SERRATE                                                     PROG 3
          MOVE DETAIL-REC TO ERROR-RATE                               PROG 3
          ADD ERRS TO JO-ERR                                          PROG 3
          ADD ERVOL TO JO-VOL                                         PROG 3
          GO TO RETURN-LOOP.                                          PROG 3
       IF SOPERTR                                                     PROG 3
          MOVE DETAIL-REC TO OP-DATA                                  PROG 3
          GO TO RETURN-LOOP.                                          PROG 3
       GO TO RETURN-LOOP.                                             PROG 3
                                                                      PROG 3
```

```
DUMP.                                                                PROG 3
    MOVE 'INDIVIDUAL' TO H1-O.                                       PROG 3
    WRITE PRINT-LINE FROM H1 AFTER 0.                                PROG 3
    MOVE OOP-NR TO L1-2.                                             PROG 3
    MOVE OSHIFT TO L1-3.                                             PROG 3
    MOVE OGRADE TO L1-4.                                             PROG 3
    MOVE OSTEP TO L1-5.                                              PROG 3
    MOVE ONAME TO L1-1.                                              PROG 3
    WRITE PRINT-LINE FROM L1 AFTER 3.                                PROG 3
    WRITE PRINT-LINE FROM L2 AFTER 3.                                PROG 3
    WRITE PRINT-LINE FROM L3 AFTER 1.                                PROG 3
    WRITE PRINT-LINE FROM L4 AFTER 1.                                PROG 3
    IF HOURS-EXCEP > HOURS-AVAIL                                     PROG 3
       THEN MOVE ZERO TO TIME-AVAIL                                  PROG 3
       ELSE COMPUTE TIME-AVAIL =                                     PROG 3
            TIME-AVAIL + HOURS-AVAIL - HOURS-EXCEP                   PROG 3
         MOVE TIME-AVAIL TO L5-1.                                    PROG 3
    ADD TIME-AVAIL TO ITAV (OSHIFT).                                 PROG 3
    MOVE TIME-ALLOWED TO L5-2.                                       PROG 3
    ADD TIME-ALLOWED TO ITAL (OSHIFT).                               PROG 3
    IF JO-VOL = 0 MOVE 0 TO ERR-PCNT GO TO D1.                       PROG 3
    COMPUTE ERR-PCNT ROUNDED = (JO-ERR / JO-VOL) * 100.               PROG 3
D1.                                                                  PROG 3
    MOVE ERR-PCNT TO L5-3.                                           PROG 3
    ADD ERR-PCNT TO KPERR (OSHIFT).                                  PROG 3
    ADD 1 TO KPCOUNT (OSHIFT).                                       PROG 3
    IF TIME-AVAIL = 0 MOVE 0 TO PE GO TO D2.                         PROG 3
    COMPUTE PE ROUNDED = (TIME-ALLOWED / TIME-AVAIL) * 100.          PROG 3
D2.                                                                  PROG 3
    MOVE PE TO L5-4.                                                 PROG 3
    ADD PE TO PER (OSHIFT).                                          PROG 3
    IF PE < 100 MOVE 0 TO INCT-HRS GO TO D21.                        PROG 3
    COMPUTE INCT-HRS ROUNDED = TIME-AVAIL * ((PE - 100) / 200).      PROG 3
D21.                                                                 PROG 3
    MOVE INCT-HRS TO L5-5.                                           PROG 3
    ADD INCT-HRS TO IHE (OSHIFT).                                    PROG 3
    IF HOURS-AVAIL = 0 MOVE 0 TO PE GO TO D3.                        PROG 3
    COMPUTE PE ROUNDED = (TIME-AVAIL / HOURS-AVAIL) * 100.           PROG 3
D3.                                                                  PROG 3
    MOVE PE TO L5-6.                                                 PROG 3
    ADD PE TO EUR (OSHIFT).                                          PROG 3
    WRITE PRINT-LINE FROM L5 AFTER 2.                                PROG 3
    WRITE PRINT-LINE FROM L6 AFTER 3.                                PROG 3
    WRITE PRINT-LINE FROM L7 AFTER 1.                                PROG 3
    WRITE PRINT-LINE FROM L8 AFTER 1.                                PROG 3
    PERFORM DUMP-GRID THRU DG-EXIT VARYING I FROM 1 BY 1             PROG 3
       UNTIL I > 20.                                                 PROG 3
    MOVE SORT-OP-NR TO OPER-NUM.                                     PROG 3
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       PERFORM HOUSEKEEPING.                                                PROG 3
       GO TO RL.                                                            PROG 3
                                                                            PROG 3
   HOUSEKEEPING.                                                            PROG 3
       MOVE ZERO TO TIME-ALLOWED, HOURS-EXCEP,                              PROG 3
           JO-ERR, JO-VOL, TIME-AVAIL.                                      PROG 3
       PERFORM ZERO-TABLE THRU ZT-EXIT.                                     PROG 3
                                                                            PROG 3
                                                                            PROG 3
   DUMP-GRID.                                                               PROG 3
       PERFORM XFER-A VARYING I FROM 1 BY 1 UNTIL I > 6.                    PROG 3
       PERFORM BALANCE VARYING J FROM 1 BY 1 UNTIL J > 5.                   PROG 3
       COMPUTE GHOURS (7, 1) =                                              PROG 3
           GHOURS (7, 1) + (HOURS-AVAIL - GHOURS (20, 1)).                  PROG 3
       MOVE HOURS-AVAIL TO GHOURS (20, 1).                                  PROG 3
       PERFORM CROSS-TOTAL VARYING I FROM 1 BY 1 UNTIL I > 20.              PROG 3
       MOVE SPACES TO PRINT-LINE.                                           PROG 3
       WRITE PRINT-LINE AFTER 1.                                            PROG 3
       MOVE 1 TO J, K.                                                      PROG 3
       PERFORM PRINT-GRID VARYING I FROM 1 BY 1 UNTIL I > 20.               PROG 3
   DG-EXIT.  EXIT.                                                          PROG 3
                                                                            PROG 3
   XFER-A.                                                                  PROG 3
       PERFORM XFER-B THRU XB VARYING J FROM 1 BY 1 UNTIL J > 5.            PROG 3
   XFER-B.                                                                  PROG 3
       IF PE = 0 MOVE 0 TO GHOURS (I, J) ELSE COMPUTE GHOURS (I, J)         PROG 3
           ROUNDED = PE-GRID (I, J) * (100.0 / PE).                         PROG 3
   XB.   EXIT.                                                              PROG 3
                                                                            PROG 3
   BALANCE.  PERFORM BAL-COL VARYING I FROM 1 BY 1 UNTIL I > 19.            PROG 3
   BAL-COL.  ADD GHOURS (I, J) TO GHOURS (20, J).                           PROG 3
                                                                            PROG 3
   ZERO-BAL.  COMPUTE GHOURS (7, J) ROUNDED =                               PROG 3
       GHOURS (7, J) + GHOURS (20, J) - GHOURS (21, J).                     PROG 3
   CROSS-TOTAL.  PERFORM CROSTOT VARYING J FROM 1 BY 1 UNTIL J > 5.         PROG 3
   CROSTOT.  ADD GHOURS (I, J) TO GHOURS (I, 6).                            PROG 3
   PRINT-GRID.                                                              PROG 3
       IF GFLAGS (I) = 1 PERFORM PRINT-HEAD.                                PROG 3
       IF I = 20 MOVE SPACES TO L10-1                                       PROG 3
                 WRITE PRINT-LINE FROM L10 AFTER 1.                         PROG 3
       MOVE P-TAB (I) TO L9-1.                                              PROG 3
       MOVE J-TAB (I) TO L9-2.                                              PROG 3
       MOVE GHOURS (I, 1) TO L9-3.                                          PROG 3
       MOVE GHOURS (I, 2) TO L9-4.                                          PROG 3
       MOVE GHOURS (I, 3) TO L9-5.                                          PROG 3
       MOVE GHOURS (I, 4) TO L9-6.                                          PROG 3
       MOVE GHOURS (I, 5) TO L9-7.                                          PROG 3
       MOVE GHOURS (I, 6) TO L9-8.                                          PROG 3
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       WRITE PRINT-LINE FROM L9 AFTER 1.                                PROG 3
   PRINT-HEAD.                                                          PROG 3
       MOVE PH-TAB (K) TO L10-1.                                        PROG 3
       WRITE PRINT-LINE FROM L10 AFTER 1.                               PROG 3
       ADD 1 TO K.                                                      PROG 3
   ZERO-TABLE.                                                          PROG 3
       PERFORM ZPGRID  VARYING I FROM 1 BY 1 UNTIL I > 6.               PROG 3
       PERFORM ZJGRID  VARYING I FROM 1 BY 1 UNTIL I > 21.              PROG 3
   ZT-EXIT.  EXIT.                                                      PROG 3
   ZERO-MC.  MOVE ZERO TO MUACS-C (I).                                  PROG 3
   ZERO-MB.  MOVE ZERO TO MUACS-B (I).                                  PROG 3
   ZPGRID.                                                              PROG 3
       PERFORM ZP-GRID VARYING J FROM 1 BY 1 UNTIL J > 5.               PROG 3
   ZP-GRID.  MOVE ZERO TO PE-GRID (I, J).                               PROG 3
   ZJGRID.                                                              PROG 3
       IF I = 1 OR 7 OR 12 OR 17 OR 19 MOVE 1 TO GFLAGS (I)             PROG 3
          ELSE MOVE 0 TO GFLAGS (I).                                    PROG 3
       PERFORM ZJ-GRID VARYING J FROM 1 BY 1 UNTIL J > 6.               PROG 3
   ZJ-GRID.  MOVE ZERO TO JO-GRID (I, J).                               PROG 3
   REPORT-EXIT.                                                         PROG 3
       EXIT.                                                            PROG 3
   TOTALS-DUMP SECTION.                                                 PROG 3
       WRITE PRINT-LINE FROM M1 AFTER 0.                                PROG 3
       WRITE PRINT-LINE FROM M11 AFTER 3.                               PROG 3
       MOVE PH-TAB (1) TO L10-1.                                        PROG 3
       WRITE PRINT-LINE FROM L10 AFTER 3.                               PROG 3
       PERFORM M-DUMP VARYING I FROM 1 BY 1 UNTIL I > 6.                PROG 3
       MOVE PH-TAB (4) TO L10-1.                                        PROG 3
       WRITE PRINT-LINE FROM L10 AFTER 3.                               PROG 3
       MOVE P-TAB (17) TO M2-1.                                         PROG 3
       MOVE J-TAB (17) TO M2-2.                                         PROG 3
       MOVE MUACS-C (7) TO M2-3.                                        PROG 3
       MOVE 0 TO M2-4.                                                  PROG 3
       WRITE PRINT-LINE FROM M2 AFTER 2.                                PROG 3
       MOVE P-TAB (18) TO M2-1.                                         PROG 3
       MOVE J-TAB (18) TO M2-2.                                         PROG 3
       MOVE MUACS-C (8) TO M2-3.                                        PROG 3
       WRITE PRINT-LINE FROM M2 AFTER 2.                                PROG 3
       GO TO NEXT-REPORT.                                               PROG 3
   M-DUMP.                                                              PROG 3
       MOVE P-TAB (I) TO M2-1.                                          PROG 3
       MOVE J-TAB (I) TO M2-2.                                          PROG 3
       MOVE MUACS-C (I) TO M2-3.                                        PROG 3
       MOVE MUACS-B (I) TO M2-4.                                        PROG 3
       WRITE PRINT-LINE FROM M2 AFTER 2.                                PROG 3
   NEXT-REPORT.                                                         PROG 3
       MOVE 'INSTALLATION' TO H1-0.                                     PROG 3
       WRITE PRINT-LINE FROM H1 AFTER 0.                                PROG 3
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       WRITE PRINT-LINE FROM L2 AFTER 3.                               PROG 3
       WRITE PRINT-LINE FROM L3 AFTER 1.                               PROG 3
       WRITE PRINT-LINE FROM L4 AFTER 1.                               PROG 3
       MOVE 'FIRST SHIFT ' TO A.                                       PROG 3
       MOVE SPACES TO B, H1-0, H1-1.                                   PROG 3
       WRITE PRINT-LINE FROM H1 AFTER 3.                               PROG 3
       MOVE 1 TO I.                                                    PROG 3
       PERFORM DUP-INST THRU DI-EXIT.                                  PROG 3
       MOVE 'SECOND SHIFT' TO A.                                       PROG 3
       WRITE PRINT-LINE FROM H1 AFTER 3.                               PROG 3
       MOVE 2 TO I.                                                    PROG 3
       PERFORM DUP-INST THRU DI-EXIT.                                  PROG 3
       MOVE 'THIRD SHIFT ' TO A.                                       PROG 3
       WRITE PRINT-LINE FROM H1 AFTER 3.                               PROG 3
       MOVE 3 TO I.                                                    PROG 3
       PERFORM DUP-INST THRU DI-EXIT.                                  PROG 3
       MOVE 'INSTALLATION' TO A.                                       PROG 3
       WRITE PRINT-LINE FROM H1 AFTER 3.                               PROG 3
       MOVE 4 TO I.                                                    PROG 3
   DUP-INST.                                                           PROG 3
       MOVE SPACES TO H1-0.                                            PROG 3
       MOVE ITAV (I) TO L5-1.                                          PROG 3
       MOVE ITAL (I) TO L5-2.                                          PROG 3
       IF KPCOUNT (I) = 0 MOVE 0 TO ERR-PCNT GO TO DI-A.               PROG 3
       COMPUTE ERR-PCNT ROUNDED = KPERR (I) / KPCOUNT (I).             PROG 3
   DI-A.                                                               PROG 3
       MOVE ERR-PCNT TO L5-3.                                          PROG 3
       IF KPCOUNT (I) = 0 MOVE 0 TO PE GO TO DI-B.                     PROG 3
       COMPUTE PE ROUNDED = PER (I) / KPCOUNT (I).                     PROG 3
   DI-B.                                                               PROG 3
       MOVE PE TO L5-4.                                                PROG 3
       MOVE IHE (I) TO L5-5.                                           PROG 3
       IF KPCOUNT (I) = 0 MOVE 0 TO PE GO TO DI-C.                     PROG 3
       COMPUTE PE ROUNDED = EUR (I) / KPCOUNT (I).                     PROG 3
   DI-C.                                                               PROG 3
       MOVE PE TO L5-6.                                                PROG 3
       WRITE PRINT-LINE FROM L5 AFTER 2.                               PROG 3
       IF I = J GO TO DI-EXIT.                                         PROG 3
       ADD CORRESPONDING SHIFT-BLOCK (I) TO SHIFT-BLOCK (4).           PROG 3
   DI-EXIT.  EXIT.                                                     PROG 3
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COMPUTER PROGRAM NUMBER FOUR

UPDATING THE PROCEDURE TIME MODEL

CONTENTS

PROGRAM SYNOPSIS

Program number four updates the Procedure Time Model based on reported production and management override records.

INPUT DESCRIPTION

a. Batch Control Form

b. Management Override

c. Current System File

OUTPUT DESCRIPTION

a. New System File

b. Procedure Time Model Report

KEYPUNCH PROCEDURE REPORT

JANUARY 1972

JOB-NR	M	PROCEDURE NAME	DATE	SIZE	-RATINGS-	DATA ENTRY STROK	PRED	3-MO	2-MO	1-MO	USE1	USE2	VERIFICATION STROK	PRED	3-MO	2-MO	1-MO	USE1	USE2
001000	E	JOB NR. 1000	15 12 72	60	G G E E F	70	500	510	520	500	490	500	60	400	410	425	390	400	400
002000		JOB NR. 2000	15 12 72	60	G G E E F	80	600	610	620	600	580	600	50	500	510	520	490	500	500
003300	E	JOB NR. 3300	15 12 72	60	G G E E F	70	500	510	520	500	490	500	60	400	410	425	390	400	400
005000	E	JOB NR. 5000	15 12 72	80	G E F P G	70	500	520	500	500	500	420	60	400	425	390	400	400	336*
006000		JOB NR. 6000	15 12 72	60	G G E E F	80	600	620	600	333	600	459	50	500	520	490	278	500	381*
007000	D	JOB NR. 7000	15 12 72	75	P P P P F	65	700	720	700	306	700	521	60	600	590	620	263	600	446*
007001		JOB NR. 7001	15 12 72	60	G G E E F	80	600	610	620	600	580	600	50	500	510	520	490	500	500
008000	D	JOB NR. 8000	15 12 72	120	P P F G E	100	900	900	900	900	890	900	95	850	850	850	850	850	850
008300	E	JOB NR. 8300	15 12 72	60	G G E E F	70	500	510	520	500	490	500	60	400	410	425	390	400	400
009000		JOB NR. 9000	15 12 72	60	G G E E F	80	600	610	620	500	580	600	50	500	510	520	490	500	500

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AUTHOR.  LCDR DANFORTH.                                                 PROG 4
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000980 01  EXPANDED-TIME.                                                   PROG 4
000990     02  EXP-MIN               PICTURE 999.                           PROG 4
001000     02  EXP-TENS              PICTURE 99.                            PROG 4
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001030     02  PDATE                 PICTURE X(6).                          PROG 4
001040     02  PPROC                 PICTURE X(6)   VALUE SPACES.           PROG 4
001050     02  FMUACS                PICTURE X.                             PROG 4
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001070         03  PSKP              PICTURE 999.                           PROG 4
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001110         03  MO-1-KP           PICTURE 9999.                          PROG 4
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001210         03  MO-2-VR           PICTURE 9999.                          PROG 4
001220         03  MO-1-VR           PICTURE 9999.                          PROG 4
001230         03  US-VR             PICTURE 9999.                          PROG 4
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001260         03  FILLER            PICTURE XXX.                           PROG 4
001270         03  VRTMU             PICTURE 9999   OCCURS 6 TIMES.         PROG 4
001280     02  FILLER                PICTURE X(10) VALUE SPACES.            PROG 4
001290 01  RPT-LINES.                                                       PROG 4
001300     02  H1.                                                          PROG 4
001310         03  FILLER  PICTURE X(75) VALUE ' KEYPUNCH PROCEDURE REPO    PROG 4
001320-            'RT                                                '.    PROG 4
001330         03  H1-1  PICTURE X(58) VALUE SPACES.                        PROG 4
001340     02  H3.                                                          PROG 4
001350         03  FILLER  PICTURE X(75) VALUE ' JOB-NR  M  PROCEDURE NA    PROG 4
001360-            'ME          * DATE *  SIZE  -RATINGS- STROK PRED 3-MO 2'.    PROG 4
001370         03  FILLER  PICTURE X(58) VALUE '-MO 1-MO  USE1 USE2  STR    PROG 4
001380-            'OK PRED 3-MO 2-MO 1-MO  USE1 USE2 '.                    PROG 4
001390     02  H2.                                                          PROG 4
001400         03  FILLER  PICTURE X(58) VALUE SPACES.                      PROG 4
001410         03  FILLER PICTURE X(75) VALUE  '*------  D A T A  E N T     PROG 4
001420-            'R Y -------*  *---- V E R I F I C A T I O N -----*'.    PROG 4
001430     02  L1.                                                          PROG 4
001440         03  FILLER            PICTURE X      VALUE SPACES.           PROG 4
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           03  L1-1               PICTURE X(6).                            PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-2               PICTURE X.                               PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-3               PICTURE X(20).                           PROG 4
           03  L1-4               PICTURE 99B99B99.                        PROG 4
           03  FILLER             PICTURE XXX     VALUE SPACES.            PROG 4
           03  L1-5               PICTURE ZZ9.                             PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-6               PICTURE XX OCCURS 5 TIMES.               PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-7               PICTURE ZZ9.                             PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-8               PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-9               PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-10              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-11              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-12              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-13              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE XXX     VALUE SPACES.            PROG 4
           03  L1-14              PICTURE ZZ9.                             PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-15              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-16              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-17              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-18              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE XX      VALUE SPACES.            PROG 4
           03  L1-19              PICTURE ZZZ9.                            PROG 4
           03  FILLER             PICTURE X       VALUE SPACES.            PROG 4
           03  L1-20              PICTURE ZZZ9.                            PROG 4
           03  FLAG               PICTURE X       VALUE SPACES.            PROG 4
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                                                                           PROG 4
     OPEN INPUT IN-REC, SYSINP, OUTPUT SYSTEM-OUT, OUT-PUT.                PROG 4
                                                                           PROG 4
 LOOP-A.                                                                   PROG 4
                                                                           PROG 4
     IF XPROC NOT = PAD READ IN-REC AT END MOVE PAD TO XPROC               PROG 4
        GO TO LOOP-C.                                                      PROG 4
     IF ISET-UP MOVE IDATE TO H1-1 PERFORM HEADNG GO TO LOOP-A.            PROG 4
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       IF NOT IBC GO TO LOOP-A.                                          PROG 4
       IF FIRST-PASS = 0 MOVE 5 TO FIRST-PASS GO TO LOOP-B.              PROG 4
       GO TO MATCH-IT.                                                   PROG 4
                                                                         PROG 4
   LOOP-B.                                                               PROG 4
       READ SYSINP AT END GO TO EOJ.                                     PROG 4
       IF SHEAD MOVE HNAME TO L1-3 MOVE HDATE TO L1-4 MOVE HSIZE         PROG 4
         TO L1-5 PERFORM RATE-SHIFT VARYING I FROM 1 BY 1                PROG 4
         UNTIL I > 5.                                                    PROG 4
       IF NOT SPTM WRITE SYSOPT FROM SYSTEM-IN GO TO LOOP-B.             PROG 4
       GO TO MATCH-IT.                                                   PROG 4
   RATE-SHIFT.  MOVE HRATE (I) TO L1-6 (I).                              PROG 4
                                                                         PROG 4
   MATCH-IT.                                                             PROG 4
       IF XPROC = PAD                                                    PROG 4
         MOVE SYSTEM-IN TO NEW-PTM GO TO LOOP-C.                         PROG 4
       IF BPROC < PPROC IN SPTMODEL GO TO LOOP-A.                        PROG 4
       IF BPROC > PPROC IN SPTMODEL                                      PROG 4
         MOVE SYSTEM-IN TO NEW-PTM GO TO LOOP-C.                         PROG 4
       MOVE CORRESPONDING SPTMODEL TO NEW-PTM.                           PROG 4
       MOVE CORRESPONDING SPTMODEL TO KP-TIME-A.                         PROG 4
       MOVE CORRESPONDING SPTMODEL TO VR-TIME-A.                         PROG 4
                                                                         PROG 4
   LOOP-D.                                                               PROG 4
       PERFORM TIME-CONVERSION THRU TC-EXIT.                             PROG 4
       ADD BVOL TO VOL.                                                  PROG 4
   DLOOP.                                                                PROG 4
       IF XPROC NOT = PAD READ IN-REC AT END MOVE PAD TO XPROC           PROG 4
         GO TO LOOP-E.                                                   PROG 4
       IF NOT IBC GO TO DLOOP.                                           PROG 4
       IF BPROC = PPROC IN NEW-PTM GO TO LOOP-D.                         PROG 4
                                                                         PROG 4
   LOOP-E.                                                               PROG 4
       COMPUTE MO-1-KP ROUNDED = (RTIM1 * 100000) / VOL.                 PROG 4
       COMPUTE MO-1-VR ROUNDED = (RTIM2 * 100000) / VOL.                 PROG 4
       COMPUTE CR-KP ROUNDED = (2 * KPTMU (1) + KPTMU (2)                PROG 4
         + KPTMU (3) + KPTMU (4)) / 6.                                   PROG 4
       COMPUTE CR-VR ROUNDED = (2 * VRTMU (1) + VRTMU (2)                PROG 4
         + VRTMU (3) + VRTMU (4)) / 6.                                   PROG 4
       MOVE '*' TO FLAG.                                                 PROG 4
                                                                         PROG 4
   LOOP-C.                                                               PROG 4
       WRITE SYSOPT FROM NEW-PTM.                                        PROG 4
       MOVE PPROC IN NEW-PTM TO L1-1.                                    PROG 4
       MOVE PMUACS IN NEW-PTM TO L1-2.                                   PROG 4
       MOVE PSKP IN NEW-PTM TO L1-7.                                     PROG 4
       MOVE PSVR IN NEW-PTM TO L1-14.                                    PROG 4
       MOVE KPTMU (1) TO L1-8.                                           PROG 4
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           MOVE KPTMU (2) TO L1-9.                                    PROG 4
           MOVE KPTMU (3) TO L1-10.                                   PROG 4
           MOVE KPTMU (4) TO L1-11.                                   PROG 4
           MOVE KPTMU (5) TO L1-12.                                   PROG 4
           MOVE KPTMU (6) TO L1-13.                                   PROG 4
           MOVE VRTMU (1) TO L1-15.                                   PROG 4
           MOVE VRTMU (2) TO L1-16.                                   PROG 4
           MOVE VRTMU (3) TO L1-17.                                   PROG 4
           MOVE VRTMU (4) TO L1-18.                                   PROG 4
           MOVE VRTMU (5) TO L1-19.                                   PROG 4
           MOVE VRTMU (6) TO L1-20.                                   PROG 4
           WRITE PRINT-LINE FROM L1 AFTER 2.                          PROG 4
           ADD 2 TO LINEZ.                                            PROG 4
           IF LINEZ > 54 PERFORM HEADNG.                              PROG 4
           MOVE SPACES TO FLAG.                                       PROG 4
           MOVE 0 TO RTIM1, RTIM2.                                    PROG 4
           GO TO LOOP-B.                                              PROG 4
                                                                      PROG 4
       HEADNG.                                                        PROG 4
           MOVE 0 TO LINEZ.                                           PROG 4
           WRITE PRINT-LINE FROM H1 AFTER 0.                          PROG 4
           WRITE PRINT-LINE FROM H2 AFTER 2.                          PROG 4
           WRITE PRINT-LINE FROM H3 AFTER 1.                          PROG 4
                                                                      PROG 4
       TIME-CONVERSION.                                               PROG 4
           MOVE BTIME (1) TO STIME-CON.                               PROG 4
           MOVE BTIME (5) TO ETIME-CON.                               PROG 4
           MOVE 1 TO FIRST-PASS.                                      PROG 4
       TC-LOOP.                                                       PROG 4
           IF EHOURS < SHOURS ADD 24 TO EHOURS.                       PROG 4
           SUBTRACT SHOURS FROM EHOURS GIVING CHOURS.                 PROG 4
           MOVE EMIN TO EXP-MIN.                                      PROG 4
           IF EMIN < SMIN ADD 60 TO EXP-MIN SUBTRACT 1 FROM CHOURS.   PROG 4
           COMPUTE EXP-TENS ROUNDED = (EXP-MIN - SMIN) / 6.           PROG 4
           IF EXP-TENS = 10 ADD 1 TO CHOURS MOVE ZERO TO EXP-TENS.    PROG 4
           MOVE EXP-TENS TO CTENTHS.                                  PROG 4
           IF FIRST-PASS = 2 GO TO TC-EXIT.                           PROG 4
           ADD RTIME TO RTIM1.                                        PROG 4
           MOVE 2 TO FIRST-PASS.                                      PROG 4
           MOVE BTIME (2) TO STIME-CON.                               PROG 4
           MOVE BTIME (6) TO ETIME-CON.                               PROG 4
           GO TO TC-LOOP.                                             PROG 4
       TC-EXIT.                                                       PROG 4
           ADD RTIME TO RTIM2.                                        PROG 4
                                                                      PROG 4
       EOJ.                                                           PROG 4
           CLOSE IN-REC, SYSINP, SYSTEM-OUT, OUT-PUT.                 PROG 4
           STOP RUN.                                                  PROG 4
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BIBLIOGRAPHY

1. Alrich, J.C., "Keypunch Replacement Equipment," DATAMATION, June 1970, p. 79-89.

2. Arvey, R. D. and Dunnette, M. D., "Task Performance as a Function of Perceived Effort-Performance and Performance-Reward Contigencies," University of Minnesota Center for the Study of Organizational Performance and Human Effectiveness, Report 4003, September 1970.

3. Broadbent, D. E., Perception and Communication, Pergamon, 1958.

4. Business Week, "Job Monotoney Becomes Critical," September 9, 1972, p. 108.

5. Business Week, "Management Itself Holds the Key," September 9, 1972, p. 142-149.

6. Caro, J. M., Incentive Plans as Civilian Employee Motivational Devices in the Department of the Navy, MBA Thesis, George Washington University, Washington, D. C., June 1971.

7. Cary, R. F., "A History of Keyboard Data Entry Equipment," DATAMATION, June 1970, p. 73-76.

8. Cutting, R. A., M. D., "Fatigue," The American Peoples Encyclopedia, Grolier, Inc., 1963, p. 8-349.

9. EDP ANALYZER, "Improvements in Data Entry, Part 1," Vol. 9, No. 9, September 1971.

10. EDP ANALYZER, "Improvements in Data Entry, Part 2," Vol. 9, No. 10, October 1971.

11. English, H. B., and English, C. A., A Comprehensive Dictionary of Psychological and Psychoanalytical Terms, McKay, 1958.

12. Federal Personnel Manual, "Incentives," Chapter 451, U. S. Government.

13. Forward, J. R., "Group Achievement Motivation and Individual Motives to Achieve Success and to Avoid Failure," University of Michigan, Report AF 49(638) 1630, June 1969.

15. Greenblatt, S., "Delete Delays and Dollars with Direct Data Entry," INFOSYSTEMS, September 1972, p. 20-25.

16. Halcomb, C. G., McFarland, B. P., and Denny, N. R., "Monitoring Performance with a Time-Shared Memory Task," Texas Tech University, Report AD721918, April 1971.

17. Herzburg, F., Mausner, B., and Snyderman, B., The Motivation to Work, Wiley, 1959.

18. Hollander, E. P., "Validity of Peer Nomination in Predicting a Distant Performance Criterion," Journal of Applied Psychology, Vol. 49, No. 6, 1965, p. 434-438.

19. Kahn, R. L., "Productivity and Job Satisfaction," Personnel Psychology, Vol. 13, Autumn 1960, p. 275-287.

20. King, A. S., Managerial Relations with Disadvantaged Work Groups: Supervisory Expectations of the Underprivileged Worker, Ph.D. Thesis, Texas Tech University, May 1970.

21. Kittock, K. E., LCDR, SC, USN, "Evaluation of Computer Controlled Source Data Entry Equipment," Naval Supply Center, Newport, Rhode Island, Final Report, April 1971.

22. Landon, J. R., "Data Preparation at Blue Cross," DATAMATION, June 1970, p. 91-92.

23. Malott, Contingency Management, Behaviorbelia, 1972.

24. Martin, J., Design of Real-Time Computer Systems, Prentice-Hall, 1967.

25. Masse, S., "The Questionnaire Survey Technique," The Journal of Navy Civilian Manpower Management, Vol. V, No. 3, Fall 1971, p. 6-11.

26. Myers, M. S., Every Employee a Manager, McGraw-Hill, 1970.

27. Navy Ships Parts Control Center, Central Data Processing Division, Standards and Procedures Manual, "EAM Standards and Procedures," Section 10, Chapter 1, Subjects 1 and 2.

28. Niebel, B. W., Motion and Time Study, Richard D. Irwin, Inc., 1958.

29. Opsahl, R. L. and Dunnette, M. D., "The Role of Financial Compensation in Industrial Motivation," Psychological Bulletin, Vol 66, No. 2, 1966, p. 94-118.

30. Peterson, W. L., Principles of Economics: MICRO, Richard B. Irwin, Inc., 1971.

31. Poock, G. K. and Wiener, E. L., "Music and Other Auditory Backgrounds During Visual Monitoring," The Journal of Industrial Engineering, June 1966, p. 318-323.

32. Porter, L. W., "The Use of Rewards in Motivating Marginal Members of the Work Force," Performance Research Incorporated, Report, February 1970.

33. Porter, L. W. and Lawler, E. E. III, Managerial Attitudes and Performance, Irwin-Dorsey, Limited, 1968.

34. Reese, E. P., The Analysis of Human Operant Behavior, William C. Brown Company, 1966.

35. Rothe, H. F., "Does Higher Pay Bring Higher Productivity?," Personnel, Vol 37, July-August 1960, p. 20-27.

36. Smith, H. C., "Music in Relation to Employee Attitudes, Piecework Production, and Industrial Accidents," Applied Psychology Monographs, No. 14, Stanford University Press, 1947.

37. Stender, R. C., "The Future Role of Keyboards in Data Entry," DATAMATION, June 1970, p. 60-72.

38. Surface, W. D., The Effect of Music on the Metabolic Rate of Workers, M. S. Thesis, Purdue University, June 1951.

39. Sutermeister, R. A., People and Productivity, McGraw-Hill, 1963.

40. Teevan, R. C., "Fear of Failure and General Achievement Behavior," Bucknell University Report AD697001, October, 1969.

41. Trimble, G. R. and Penta, A. J., "Evaluation of Keyboard Data Entry Systems,: DATAMATION, June 1970, p. 93-99.

42. U. S. News & World Report, "The Drive to Make Dull Jobs Interesting," July 17, 1972, p. 50-54.

43. Wallace, J., Psychology: A Social Science, W. B. Saunders Company, 1971.

44. Wassenaar, D. J. and Oestreich, H. H., The Hawthorne Studies: A Summary and Critical Evaluation, Lansford Publishing Company, 1972.

45. Zander, A. F., "Group Aspirations and the Desire for Group Achievement," University of Michigan, Report AF 49(638)-1630, March 1970.