INCENTIVE WAGE PAYMENT PLANS

FOR LIMITED CONTROL OPERATIONS

by

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TABLE OF CONTENTS

		Page
ACKNOWLEDGMENTS		2
LIST OF TABLES		5
LIST OF FIGURES		5
CHAPTER		
I	INTRODUCTION	6
II	PHILOSOPHY AND BACKGROUND	11
	Philosophy of Incentive Payment for Limited Control Operations	11
	Principles Applicable to All Incentive Payment Plans	15
	Statistics on Incentive Plans	19
	Trends	20
	Summary	22
III	ANALYSIS OF EIGHT INCENTIVE PLANS IN CURRENT USE FOR LIMITED CONTROL OPERATIONS	24
	Plan A	28
	Plan B	34
	Plan C	36
	Plan D	42
	Plan E	46
	Plan F	50
	Plan G	54
	Plan H	58
	Summary of the Eight Plans	61

IV GENERAL CONSIDERATIONS 65

Shall There Be an Incentive Payment Plan? 66

Motivation 72

Measurement 81

Economics 95

Summary. 98

V RECOMMENDATIONS FOR SOUND INCENTIVE PLANS FOR LIMITED CONTROL OPERATIONS 99

VI SUMMARY 109

BIBLIOGRAPHY. 114

VITA 118

APPENDIX A 120

Plan A 121

Plan B 127

Plan C 130

Plan D 137

Plan E 146

Plan F 152

Plan G 157

Plan H 162

APPENDIX B 169

LIST OF TABLES

TABLE		Page
1	Comparison of the Eight Plans	63

LIST OF FIGURES

FIGURE		Page
1	Pay Chart - Plan A	30
2	Pay Chart - Plan C	37

I

INTRODUCTION

The purpose of this paper is to show how sound incentive wage payment plans may be applied to operations in which the worker does not have complete control over his output.[1] Such operations have been variously classified as machine-paced, process, or restricted operations. These types of operations have received very little incentive coverage and are widely regarded as being "unmeasurable," or "unprofitable" for incentive payment plans.

All industrial operations can be broken into two general classes, namely, those in which the worker has complete control over his output and those in which he does not have complete control. We shall designate the latter type, about which this paper is written, as "limited control" operations.

Operations over which the worker has complete control are generally manual effort operations in which output is a function of only the manual exertion of the worker coupled with his skill in performing the job. These are called hand-paced operations. Widespread

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[1]Incentive wage payment plans as used here include all payment plans which relate a worker's pay to his performance, thereby creating a monetary "incentive" for the worker to work more effectively. Some references suggest that wage incentives are related only to payment for worker effort; such is not the case here. Other sources prefer to use a term such as "productivity bonus" instead of "incentive." In this paper the nomenclature matters little—the ideas and principles being the important items.

application of incentive payment plans has been made to this type of operation. Though differing greatly in detail, all such plans are fundamentally the same and relate pay to "standard" times for performing manual tasks. These will be referred to as "straight incentive" or "piecework" plans.

The limited control operations discussed herein can be subdivided into four types of operations:

1. The worker performs mostly manual work but does not have complete control over the amount he produces due to restrictions in the flow of work.
2. The worker performs mostly manual work in operating a machine but does not have complete control over the amount he produces due to restrictions in machine capacity.
3. The worker services a machine or group of machines which operate automatically.
4. The worker attends a continuous processing operation.

Factors in these types of operations which are not controllable by the worker include machine speeds, availability of work, and variations in incoming materials. On the other hand, the worker may exert control over factors such as machine idle time and machine adjustment which bear little relationship to manual effort but important relationship to machine output, quality, and operating costs.

As previously stated, the purpose of this paper is to show how sound incentive wage payment plans can be applied to limited control

operations. To show why this subject is important, the following four statements are presented:

1. Due to widespread incentive coverage of completely controlled (hand-paced) operations, sound principles have been established and the subject of incentive payment nearly exhausted. Such is not true of limited control operations for which much study and analysis is needed in order to develop sound incentive principles and plans.
2. The proportion of limited control to complete control operations is increasing due to technological advancements which are resulting in widespread replacement of manual effort by machines.
3. Incentives for limited control operations are not "unprofitable," but rather they may pay off handsomely. A worker with limited control over his operation may still control factors which have a great effect on output. For example, by reducing idle time one minute on a high production machine, a worker may increase output by more than he could with an hour of extra effort on a manual version of the same operation. Conversely, if a hand-paced worker works poorly not too much is lost, but if a machine operator in a limited control situation makes an improper adjustment, thousands of dollars worth of material and machine time may be lost.

4. Limited control operations are measurable in terms of overall worker effectiveness, but they require an approach different from that of hand-paced operations. New concepts and methods of measurement make the task easier. Nevertheless, measurement of worker performance for limited control operations is not as straightforward as measurement of only manual effort.

A few companies have already attacked the problem of incentives for limited control operations and after careful studies and analyses have developed successful payment plans for some limited control operations. Such plans embody new concepts and approaches to the problem of work measurement and incentive payment. Other companies have attempted to modify straight incentive plans and fit them to limited control operations. Still other companies have completely avoided any form of incentive payment for such operations.

The material in this paper should be of value to all three types of companies just described. It seeks to give a comprehensive picture of what has been done and may bring out new or overlooked ideas to the few companies that have themselves brought a fresh outlook to the problem. (Individually, such companies have contributed considerable data for this paper.) To the companies that have attempted to apply old philosophies to limited control operations, it will present a new approach to the problem of incentives. And to companies that have avoided incentives for these operations, it will present an argument for the adoption of incentives as discussed. Furthermore, this paper

is important even for companies which do not wish to have any type of incentive plan; good management and supervision principles demand the type of analysis described here in order to increase effectiveness with or without incentive pay.

To achieve the stated purpose of this paper, the following sequence of presentation will be followed:

II. Philosophy and Background - A general discussion of the subject to get the reader and author on grounds of mutual understanding.

III. Descriptions and analyses of eight incentive plans for limited control operations in actual use today.

IV. General Considerations

A. Shall There Be an Incentive Payment Plan?

B. Motivation

C. Measurement

D. Economics

V. Recommendations for sound incentive plans for limited control operations.

VI. Summary

II

PHILOSOPHY AND BACKGROUND

This section is intended to more fully acquaint the reader with the basic thoughts underlying incentive payment plans for limited control operations. These thoughts are presented under the following subdivisions:

A. Philosophy of Incentive Payment for Limited Control Operations.

B. Principles Applicable to All Incentive Payment Plans.

C. Statistics on Incentive Plans.

D. Trends.

Philosophy of Incentive Payment for Limited Control Operations

Good sound principles of management and supervision demand that supervisory personnel be thoroughly acquainted with the operations under their direction. Supervisors should know what factors are important to the operation, which of these factors are controlled by the workers, and where emphasis should be placed in order to achieve maximum effectiveness. Whether or not an incentive payment plan is devised to help get such improved performance is secondary to a sound application of the above principles.

Let us consider the problem of incentive payment for a fire department operation. Such an operation would classify as a limited control operation. If firemen were paid by a conventional piecework type incentive plan, they would be paid on the basis of manual effort time standards for extinguishing various kinds of fires. Therefore, their pay would increase as the number of fires increased and as the intensity of the kind of fires increased. Under such a system, the firemen would find it profitable to relax fire prevention and fighting procedures. They conceivably could go so far as to employ an arsonist to set more fires for them. This would indeed be a poor payment plan in view of the fact that the primary responsibilities of fire departments are to prevent fires and to extinguish fires in the shortest time possible allowing a minimum of damages and losses.

To develop a more satisfactory incentive payment plan we should analyze the operation and find that the firemen have some control over (1) fire prevention, (2) the time it takes to reach and extinguish a fire, and, therefore, (3) the monetary loss due to a fire. It follows that any payment plan to reward the firemen for increased effectiveness should measure performance with respect, not to manual exertion, but to the controllable factors mentioned above. How to accomplish this is the problem.

The fire department example may appear silly, but there are many similar examples in more common industrial situations. A maintenance worker paid only for manual effort (i.e. the number of repairs made times standard times for each repair) would have more incentive

to do a poor job leading to more and longer repairs than he would to do a good job. If a machine operator paced by his machine is paid for quantity of production only, he is tempted to "fix" his machine to operate at more than the correct or safe speed in order to earn more money. Workers on chemical processing machines which require little manual exertion but constant observation and adjustment of gauges and controls can hardly be given proper incentive to do a good job if pay is geared only to their manual effort.

An approach fundamentally different from that used on straight incentive plans for hand-paced operations is required for limited control operations. Pay must be based on an overall effectiveness of operation including all factors under the worker's control rather than on manual effort alone. Often in limited control operations, the worker who does the least manual work is in reality the most effective worker. Such could be the case in fire department, maintenance, and machine attention operations. "Busy"ness does not mean effectiveness, and a worker relaxing with his feet on a desk <u>may</u> be highly effective. In order to have good incentive plans for limited control operations we must be able to measure this effectiveness.

The basic immediate objective in any good incentive plan is to get increased worker effectiveness which will result in increased quantity and quality of production. To do this the plan must provide ample worker motivation through bonus pay and other factors, and at the same time it must pay off economically. Gains must more than offset costs of establishing and administering the system. A sound plan should accomplish the following:

1. Pay the worker for his overall effectiveness; which should be--
2. A function of actual operating results (productive output); on the basis of --
3. Only those factors of the operation over which the worker exerts control.

The two general classes of factors in limited control operations over which a worker has control are machine idle time and quality. Better machine utilization and, therefore, more productivity is achieved from reduction of idle time by proper maintenance, rapid servicing, and other similar factors. Likewise, the worker can maintain good quality by proper attentiveness and application of his skills in operating his equipment.

In attacking the problem of measurement of operator effectiveness, we might consider the following questions:

1. What are the factors affecting productivity and quality?
2. Which of these factors does the worker control?
3. To what extent does the worker control the factors?
4. What is the relative importance of the factors under the worker's control?
5. How can we relate the worker's pay to his performance in order to give him adequate incentive to do a better job?

When fitting pay to performance, it must be borne in mind that, in a limited control operation, the worker may be able to save (or lose) much more money than he could on a hand-paced job. High investment for machinery and materials per worker which is characteristic of limited control operations makes this possible. In one example which is discussed later a crew of five workers tending a costly high volume production machine can save $50,000 per year simply by getting one minute extra production per shift by reducing machine idle time.

Principles Applicable to All Incentive Payment Plans

The foregoing discussion has been concerned primarily with basic philosophies of incentives for limited control operations. Now let us consider some principles applicable to all incentive plans.

There are several principles which apply to any type of incentive payment plan including plans for limited control operations. These principles have been developed and proven during more than a half century of incentive practice and may be found stated in a multitude of forms in numerous publications.

J. K. Louden gives the following eleven basic requirements of a sound incentive plan:[2]

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[2]J. K. Louden, Wage Incentives, New York, John Wiley and Sons, Inc., 1944, pp. 46-48.

1. The plan should reward the employee in direct proportion to the increased output.
2. The plan should be understandable and easily calculable by the employees.
3. Hourly base rates should be guaranteed.
4. There should be enough spread between the guaranteed base rate and the normal bonus rate to provide incentive to extra effort or sustained effort (25% is recommended).
5. It should provide enough of a guarantee of standards to give the worker a feeling of security.
6. Definite instructions covering policy and methods should be provided.
7. Shop procedure should be standardized.
8. Measured standards must be based on definite quality requirements with proper and direct controls placed over waste.
9. Equitable adjustment for failure to meet the task when the cause of the failure is beyond the employee's control should be provided.
10. Once production is such that bonus is earned, unit costs should be constant.
11. To be effective the plan must be rigidly maintained.

Solomon Barkin, Director of the Textile Workers Union of America, in listing ten requirements[3] agrees closely with Louden except he also recommends that "workers should be compensated equitably for management's failure to provide them the full opportunity to earn incentive pay, either because of lack of volume, bad material, or other causes beyond the worker's control. (Such a practice) would challenge the engineering staff and supervision to eliminate the cause of the deficiency. Temporary rates above the base rate should be provided where workers are given work for which a measure of work effort has not been set, but they should be kept to a minimum."

In outlining an ideal approach to incentive problems, H. B. Maynard[4] gives the following criteria:

1. Enthusiastic cooperation among management, foremen, workers, and the union is necessary.
2. Any successful incentive plan must be backed up by sound methods and standards work.
3. Adequate time must be allowed to do a good job of establishing a sound incentive plan.
4. The plan must be developed on the basis of a thorough understanding of the philosophies, past and present, which underly incentives.

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[3]Solomon Barkin, "Management's Attitude Toward Wage Incentive Systems," Industrial and Labor Relations Review, October, 1951, Ithaca, New York, pp. 92-107.

[4]H. B. Maynard, "Changing Philosophies on Wage Incentives," Mechanical Engineering, April, 1952, New York, pp. 277-279.

5. Understanding of current basic attitudes of workers in a group is necessary.

As a last consideration in this general discussion of principles applicable to all incentive plans let us note the ten evils which cause incentive plans to fail as given by Louden:[5]

1. Failure to have supervision play a major role in the program and failure to train supervisors in the fundamentals of industrial engineering.
2. Failure to enlist cooperation of employees and to gain their full understanding and confidence.
3. Failure to recognize the caliber of men and the competency required to perform this work.
4. Failure to establish standard procedures and policies governing industrial engineering.
5. Failure to realize that industrial engineering consists of more than taking time studies and installing a wage incentive system.
6. Failure to guarantee standards once established against change unless there is a change in method, equipment, or specification.
7. Establishment of a ceiling on incentive earnings above which an employee must not go or the standard will be cut.

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[5] J. K. Louden, op. cit. pp. 4-6.

8. Failure to analyze and establish standards for materials and spoilage.

9. Failure to establish rigid specifications and quality standards.

10. Failure to maintain properly and regularly measured standards and wage incentive installations once they are established.

The bibliography at the end of this paper lists several references which elaborate on the subject of incentives. These are recommended for the reader who wishes to further acquaint himself with the general subject of incentives.

Statistics on Incentive Plans

The general principles of incentive payment just given have been followed in most incentive plans in use today. To show the general status of incentive plans, some statistics pertinent to the overall incentive payment picture are given in the next few paragraphs.

In March 1953, Business Week[6] stated that approximately 50% of all employees in U.S. industry were paid by an incentive plan. It was estimated at that time that 60% would be on incentive by 1962.

In December 1953, Dun's Review and Modern Industry published results of a survey of worker attitudes toward incentive payment

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[6] Business Week, March 7, 1953, pp. 112-114.

plans.[7] The results summarized here help to fill out our current picture of incentives:

1. Of those on incentive, 60% strongly like incentives and 10% oppose them.
2. Of those on incentive, 75% want to stay on incentive.
3. A majority of those on incentive have some complaints about the system.
4. Most workers on incentive prefer individual incentive payment to group incentive payment.
5. Most workers on daywork (non-incentive) prefer to stay that way.
6. The best liked incentive plans are found in companies which have good employee relations and are liked by the workers.
7. The better the foremen, the better the performance results under incentive plans.

It is not sufficient just to consider past principles of incentive payment along with cold statistics in attacking the problem of incentives for limited control operations. Current trends that may influence future incentive plans should also be considered.

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[7] A. G. Larke, "Worker Attitude on Incentives," Dun's Review and Modern Industry, December, 1953, pp. 61-63.

Trends

The problem of incentive wage payment is dynamic. Changes in industry and its people during the past half century have caused gradual changes in incentive payment philosophies and procedures. Obviously, such changes will continue. Some of the more significant trends that should influence incentive practices are:

1. Technological advances resulting in replacement of men by machines (commonly called "automation") are causing an increase in the number of limited control operations.
2. Increased investment in machinery and materials per worker is increasing the financial responsibility of workers.
3. A need for more technically trained machine operators is created by technological advances.
4. A rise in the overall skill and education level of industrial workers, especially those not engaged in manual operations, is a by-product of technological advancement.
5. A general rise in the standard of living of industrial workers is occurring.
6. New techniques for work measurement and standard setting based on statistical theory are being developed.
7. Improved electronic computers which can be used for problem solving, planning, and data processing are being developed.

Summary

The foregoing discussions of the philosophy of limited control incentives, general principles of incentive payment, statistics on incentive plans, and current trends should have acquainted the reader with the problem at hand.

It is the opinion of the author that thinking in the development and administration of incentive payment plans has lagged far behind the changes in industrial conditions where limited control operations are involved.

During the past half century many good incentive plans have been developed for manual work. Early difficulties have been largely overcome by following sound principles based on experience. In companies where incentive plans exist, virtually all hand-paced operations are covered by conventional incentive payment plans. The field of hand-paced operations has been almost "milked dry" with very few opportunities for extended incentive coverage remaining.

On the other hand, the field of limited control operations offers unlimited opportunity for incentive coverage. However, it is extremely important that payment plans for limited control operations be well planned, set up, and administered in order to obtain maximum benefits with a minimum of trouble. A sound approach demands a careful analysis of each situation leading to a tailor-made plan based on sound principles for each operation.

A fresh viewpoint is necessary in order to effectively measure a worker's performance on a limited control operation. Worker effectiveness is primarily a function of the worker's control of machine idle time (and thereby, productivity), quality, and operating costs. Incentive bonus must be paid to a worker on the basis of his overall effectiveness which should be a function of actual operating results on the basis of only those factors of the operation over which the operator exerts control.

There are a few companies which have devised incentive payment plans for limited control operations with varying degrees of success. Eight of the plans are described in the next section of this paper.

III

ANALYSIS OF EIGHT INCENTIVE PLANS IN CURRENT USE FOR LIMITED CONTROL OPERATIONS

The eight plans analyzed here represent attempts by companies to fit incentive payment plans to limited control operations. All of the plans have been successful, but they all have distinct disadvantages or limitations.

Study and analysis of these plans by the reader should give him an insight into (1) how incentive plans have been applied to various types of limited control operations, (2) some of the difficulties which may be encountered in such plans, and (3) some of the sound techniques of measurement and payment which may be applied to other plans.

The particular operations involved and the mechanics of the payment plans are only summarily described in this section of this paper. Complete descriptions are given in appendix A. For easier understanding, the plans have been simplified in the descriptions without loss of significant details.

One or more of the plans A through H were designed for each of the four types of limited control operations described earlier:

Type I - The worker performs mostly manual work but does not have complete control over the amount he produces due to restrictions in the flow of work. Applicable plan - A.

Type 2 - The worker performs mostly manual work in operating a machine but does not have complete control over the amount he produces due to restrictions in machine capacity. Applicable plans - B and C.

Type 3 - The worker services a machine or group of machines which operate automatically. Applicable plans - C, D, E, F, and G.

Type 4 - The worker attends a continuous processing operation. Applicable plan - H.

Several terms which may be unfamiliar to the reader appear in the analyses which follow. For convenience, these terms are defined here:

1. Downtime - In machine operations, all time that a machine is not operating (producing product) is called downtime. Usual reasons for downtime occurrences are machine adjustments, cleanup, maintenance, product change, and operator negligence.
2. Standard time - There are many definitions of "standard," but for simplicity the following is used here: The time required for a task to be performed by qualified operators working at a normal pace, plus allowances for personal time (rest and delay). Normal pace is the maximum pace a worker can be expected to maintain over a period of several hours without undue fatigue. This is

generally referred to as 100% effort in rating for leveling of time study data. Standard times as used here are 100% of so-called high task standards.[8]

3. Percent busy - This is a descriptive term used to indicate the amount of manual effort required in limited control operations, and it is based on the standard time concept described above. If a worker is on the job for eight hours and the standard times for all the manual tasks he does total six hours, then he is said to be "75% busy" meaning that his job required him to work at 100% manual effectiveness for only 75% of the time he was on the job. He may actually work faster or slower than 100% at times depending on the nature of his job.

4. Group and Individual Incentive - In individual incentive payment, incentive bonus percent (or pay percent) is calculated individually for each worker based only on his performance. In group incentive payment, an incentive bonus percent (or pay percent) is calculated for a group of workers based on their collective performance. Group incentive is generally used either when the operation requires teamwork from a group of workers

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[8]For a more detailed discussion of standard times see R. M. Barnes, Motion and Time Study, Third Edition, New York, John Wiley and Sons, Inc., 1949.

or when the operation is of such a nature that it is impossible or not feasible to measure the performance effectiveness of individual workers.

5. Daywork rate - This is the hourly rate paid to a qualified worker on a job not on incentive and is also known as the base rate or job rate. For convenience in comparing the plans described here, a daywork rate of $2.00 is used.

6. Incentive bonus or premium - This is all payment made to a worker in excess of the daywork rate for the job being performed. In some cases where merit rating plans are used for workers, a worker may receive an individual rate based on merit rating when he does not work on incentive. In these instances incentive bonus or premium is actually all payment made in excess of the individual rate of the worker. For simplicity of comparison, only daywork rates are used as a basis for illustrations in this paper unless noted otherwise.

Plan A

Plan A is designed for a type 1 situation in which the worker performs mostly manual work but does not have complete control over the amount he produces due to restrictions in the flow of work.

Description

A current application of plan A is to a laboratory operation in which a worker performs a chemical analysis of product samples. The workload varies to require from one half man to one and a half men (working at 100% effectiveness) for a given shift. One man is required to be in the lab at all times regardless of how low the workload gets. Additional help can be secured if necessary when the workload is high.

Incentive premium is based on manual effort in order to encourage the worker to do as much work as possible without using additional help. Standard times based on production are established for all operations performed by the worker. The plan differs from straight piecework plans because adjustments are made to reflect true worker effectiveness (which differs from production effectiveness) earned from the standards and low effectiveness due to low workload which is not the worker's fault.

True manual effectiveness changes 8% for a 10% change in production effectiveness which is calculated from standard hours earned divided by actual hours worked. True manual effectiveness equals production effectiveness at 100%. The true manual effectiveness would

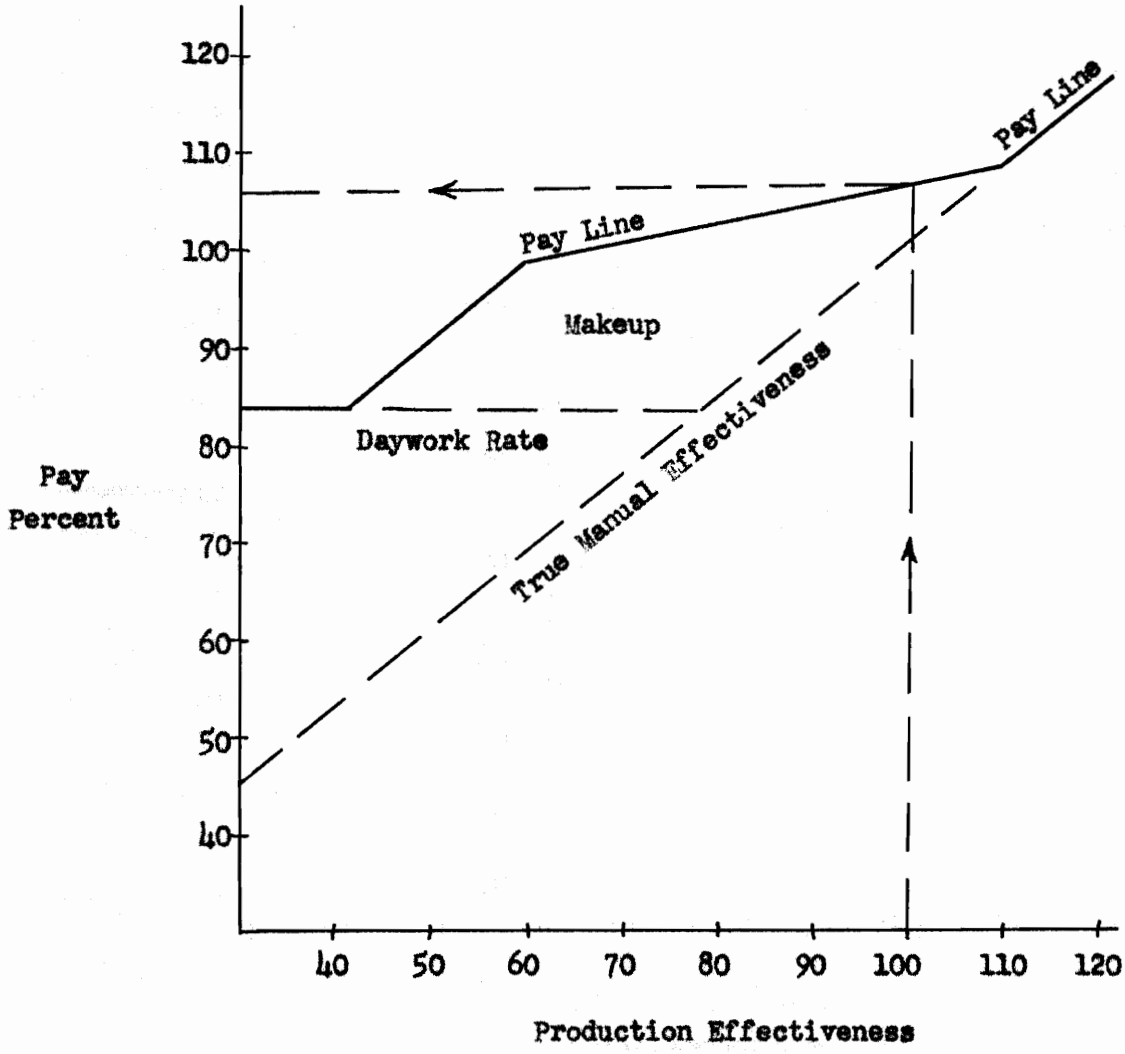
be the ideal percent to pay the worker if no restrictions existed in the workload.

A makeup allowance is added to true manual effectiveness in calculating the pay percent. This is done in order to compensate the worker for low workloads and to assure him the opportunity to average 27% premium above his daywork rate if he works at a true 100% pace.

The two adjustments mentioned are combined in the chart shown in figure 1, page 30. Production effectiveness is read into the chart to find the pay percent. Pay is equal to pay percent times 120% of the daywork rate times the actual hours worked.

Analysis

Plan A provides a method of paying incentive premium on operations which may be alternately hand-paced or limited control with insufficient work available to keep the worker 100% busy. The best solution in such situations is to assign filler jobs to the worker to be done for additional premium during would-be idle time. However, this cannot always be done as was the case here. When situations such as described for this plan arise, it is generally advantageous to have incentive payment, especially since there is abundant work at times. It is not feasible, though, to let the operator's earnings suffer excessively when work is scarce. Hence the makeup allowance is used in this plan. The makeup allowance chart is revised periodically as workload changes to keep average earnings for a worker working at a 100% pace at 106% of the incentive rate (127% x



1. Read production effectiveness into the horizontal axis.

2. Go up to the pay line.

3. Go left and read pay percent from the vertical axis.

Example: 100% production effectiveness = 106% pay.

FIGURE 1: Pay Chart - Plan A

Daywork rate). When average workloads can be built up sufficiently, the makeup will disappear.

Another significant feature of this plan is the adjustment made to arrive at a true manual effectiveness. Studies showed that when the worker turned out 10% more production for a given amount of time, his manual output only increased 8%. This was due to the fact that he could work more effectively at higher workloads.

No attempt was made to evaluate operator effectiveness in terms other than manual effort, such as the quality of his work, and the speed with which he renders the service of reporting the results of his analysis of a sample.

Advantages

1. Makeup is calculated with the pay percent and posted separately to indicate clearly to the worker that it is a makeup allowance and subject to change.
2. Makeup is based on average workloads, is revised periodically, and gets smaller as workloads get greater to the point that it may be eliminated.
3. Makeup is used to guarantee a 27% bonus as long as the worker maintains a 100% pace.
4. The worker is on straight incentive above 108% true effectiveness.
5. Makeup becomes constant below 83% true effectiveness to discourage workers from taking advantage of it.

6. In the makeup portion of the pay line between 83% and 108% true effectiveness incentive is weak, but there is some incentive to reach the straight incentive above 108%.

Disadvantages

1. A worker working at 100% true effectiveness on this plan gets more pay (106%) than a worker at 100% true effectiveness on a conventional straight incentive plan.
2. Workers may understand the plan and feel it is fair after proper explanation, but nevertheless they may be discouraged whenever increased workload causes a reduction in makeup allowance. (The big argument against this is that makeup is a gift and they should be happy with whatever they do get).
3. Workers may take advantage of the makeup portion of the pay curve to do poor work with little penalty in pay. From 83% to 108% true effectiveness percent a 1% decrease in true worker effectiveness would result in only a 0.2% decrease in pay.

Summary

This plan has merit for the restricted case to which it applies. The glaring makeup allowances should stimulate supervision to build the job up to a fully hand-paced level. An alternative plan in such cases is to use a straight piecework type plan and let earnings fall below 100% if the workers will accept such conditions. Straight daywork payment is poor because the worker probably would call in

additional help when workloads rise; under incentive he probably would work harder and increase his earnings. Clearly indicating the degree of makeup and periodically revising it are good ideas although they may cause minor difficulties. The study to determine worker true effectiveness with respect to production effectiveness is interesting and may be applicable to many other operations. The principle is somewhat new and needs further study.

Many variations can be considered for this plan such as making the average earnings lower than 27% premium over the daywork rate, changing the slope of the makeup curve, etc. (In this case 27% premium was necessary to meet average earnings from a previous incentive plan.)

A possible way of strengthening the measure of performance would be to include factors such as effectiveness of the service rendered by the worker and quality of his work.

Plan B

Plan B applies to type 2 operations in which the worker performs mostly manual work in operating a machine with restricted production capacity.

Description

This plan was designed for a plastic molding machine operation in which the worker performs manual work in operating the machine but is limited in maximum output by a restriction in machine cycle time. The worker cannot better the set machine cycle time of 30 seconds, but, if he is slow, he may exceed the cycle time thereby causing productive output to fall short of the machine's capacity. To keep the machine operating at maximum capacity the worker needs to work at a normal 100% pace for only 22 seconds of the 30 second cycle. Product quality is not controlled by the operator.

Pay is based on a percent effectiveness which is equal to actual production divided by maximum possible production. Pay percent is the percent effectiveness plus 5%. Therefore, if the worker maintains the 30 second cycle time throughout a shift, achieving maximum possible production, his pay percent will be 105%. Pay is equal to pay percent times hours worked times 120% of the daywork rate.

Analysis

This plan is well suited for the situation in which the worker is paced by his machine which has an easy to meet cycle time but requires constant operator presence and attention. Maximum pay percent of 105% is earned when the worker gets 100% utilization of the machine's capacity. This is equal to a maximum incentive bonus of 26% above the daywork rate. Lunch and mandatory personal breaks are paid for at the pay percent earned while the worker is actually operating the machine. Some companies would pay for such times at 100% pay percent or even at the daywork rate. Such changes could be easily made in the plan without altering its basic philosophy.

Advantages

1. Pay is based on the degree to which the worker maintains the machine cycle time which is the only important factor over which he has control.
2. The plan is simple and easy to administer.

Disadvantage

The worker may feel he deserves the opportunity to earn a higher pay percent than his job or the payment plan permits.

Summary

This plan has good incentive value combined with simplicity, ease of administration, and ease of measurement. It is adequate for the type of situation to which it applies.

Plan C

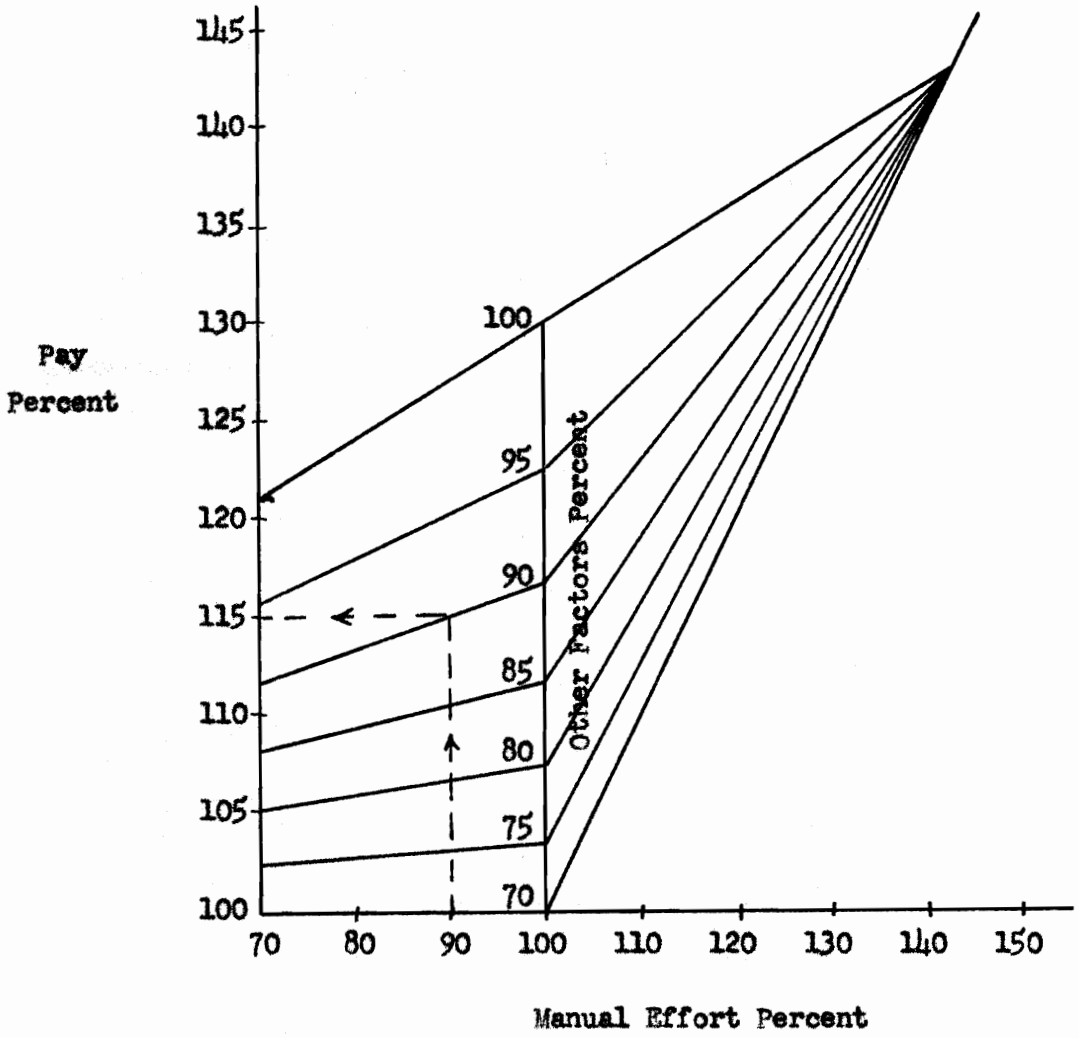
Plan C is best suited for type 2 operations in which the worker performs manual work in operating a machine with restricted production capacity and type 3 operations in which the worker services a machine or group of machines which operate automatically.

Description

In jobs normally covered by this plan, the worker can best serve his company (1) by increasing production by good machine operation and reduction of downtime and waste, (2) by improving quality, and (3) by reducing operating costs.

The payment plan is geared to (1) manual effort and (2) "other factors" performance. Standard times are set for all manual operations. Studies of "other factors" are made to determine the factors such as downtime and quality that are controlled by the worker, the extent to which he controls each factor, and the financial importance of his control over each factor. From one to three such factors are measured for incentive pay purposes. Standards of performance can be calculated. Total "other factors" performance is a weighted average of performance on the individual factors. Manual effort percent and "other factors" performance percent are read into the chart shown in figure 2, page 37.

No incentive premium is earned for performance under 70% on either manual effort or other factors. Premium becomes progressively



1. Read manual effort percent into the horizontal axis.

2. Go up to the proper line for other factors percent effectiveness.

3. Go left and read pay percent from the vertical axis.

Example: 90% manual effort and 90% other factors effectiveness = 115% pay.

FIGURE 2: Pay Chart - Plan C

greater as other factors percent effectiveness increases since improvements become more difficult to achieve as effectiveness increases.

Analysis

The logical approach of this plan makes it an excellent incentive framework for almost any operation in which manual effort requirements exceed 70%. A sound approach is used to the problem of measurement of a worker's contribution to the company and payment of incentive premium in relation to the contribution.

The plan has been very successful in actual operation on a wide variety of operations covering over 1,000 workers. The workers are satisfied with the plan and their incentive pay; the company is satisfied with its large cost savings due to the plan.

Noteworthy Characteristics

1. The use of factors other than manual effort for premium pay is based on careful analysis of each situation to determine the relative values of all factors and their standard values.
2. Machines and processes are always run at capacity and the standards are based on these rated capacities. When production requirements are low, machines and processes are still run at capacity but for shorter periods of time.
3. Maintenance men are being included under the plan and although they may not be 70% busy they are all given pay for 100% manual effectiveness plus premium for "other factors."

4. The plan is constantly audited, upgraded, and modified to insure continued satisfactory results.

Advantages

1. All significant factors under the worker's control are included in the pay calculation according to weighted importance based on studies.
2. All standards are based on careful study and analysis.
3. The worker has increasing incentive to improve performance on other factors as manual effort gets higher (up to 100%).
4. For any given manual effort percent the incentive to improve performance on other factors increases as the other factors performance effectiveness rises (greater pay gain for going from 95% to 100% than from 80% to 85%) due to the fact that improved performance becomes more difficult at higher levels.
5. The plan, although somewhat complex, is understood and liked by the workers.

Disadvantages

1. A gap exists between workers at 69% and 70% manual effort. The 69% worker can earn no premium but the 70% worker can earn around 20% premium for 100% effectiveness on other factors. This borderline case is avoided in all but a few cases by building up jobs appreciably above 70% manual effort.
2. Occasionally, a worker exceeds 100% other factors percent effectiveness by better than standard output (usually due to a method

improvement by the worker). For this he still receives only 100% toward premium and the standard can be revised to include the better method. This obviously discourages superior operator performance. It may be supplemented by a method improvement incentive award in the future.

3. The analysis and study required to set standards and administer the plan is costly.
4. Occasionally some workers have difficulty understanding why in some cases a 10% manual effort increase may net only a 3% pay increase (other factors percent effectiveness being constant).
5. In some situations, manual effort may not be a significant measure of the worker's contribution to the company.

Summary

This is an excellent plan and definitely the best of the eight plans discussed from the standpoint of thoroughness and soundness of measure and broadness of scope of applicability. It has proven itself by years of very successful operation resulting in increased wages to the workers and large savings to the company. Although it can hardly be called a perfect plan or panacea for incentives it nevertheless is an established framework of fundamentals within which good incentive plans can be constructed for almost any job. Furthermore, the measurement approach is sound and comprehensive in that all factors are studied and the plan based on the factors which are significant and controllable by the operator. However, the listed disadvantages must not be overlooked, one of the most

important being the lack of application for operations with less than 70% manual effort requirements. Also, manual effort is a prime unit of measure but may not actually be a factor in worker effectiveness for all cases. High cost of study and administration requires that such a plan justify its existence by large savings.

Plan D

Plan D covers type 3 operations in which a group of workers services an automatic machine.

Description

This plan was designed especially for a particular operation in which the workers' function is to service an automatic machine and see that it operates at maximum effectiveness. The operation consists of a number of machines, each operated by a crew of about five men. Each machine operates automatically except for various downtimes. Crew members can increase output only by (1) minimizing downtime by better than standard performance of manual tasks during downtimes and by (2) keeping the machine adjusted properly so no waste will occur. Manual effort is expended mostly for handling the product and for performing downtime tasks. The workers are between 50% and 75% busy.

The payment procedure utilizes a measure of machine effectiveness and of manual effort. Machine effectiveness increases as the amount of waste which is the crew's fault decreases and as performance against downtime standards improves. Manual effort is measured on an empirical basis by the number of cans of product handled and the number of downtimes encountered. Average cans and downtimes yields an incentive bonus pay percent which is adjusted periodically to always average 5% with a range of 0% to 10%. Pay percent is the total of machine effectiveness which averages about 99% and manual

effort pay percent which averages 5%. Pay is equal to pay percent times hours worked times 120% of the daywork rate. Pay is calculated each shift for each machine. All crew members of a machine earn the same pay percent.

Analysis

This plan functions very well in the particular situation to which it applies, namely a machine operation in which the operating crew has no control over machine speed but does control to some extent quality and downtime. A rough cost estimate indicates that a one minute reduction in downtime each shift (1074 shifts per year) would result in increased production which would yield extra profit of $50,000 per year. This is certainly ample justification for some sort of incentive to "squeeze" extra production through reduction in downtime. It can be done on this job by good performance without impairing product quality. (Savings as shown here are not uncommon for high production machinery in which investment in equipment and material far exceeds labor cost per operating minute.)

A noteworthy characteristic of the plan is the distinction made between waste product attributable to the crew and to other sources. The crew is paid for waste product over which they had no control as if it were good product. If the source of waste is doubtful, a mild penalty is assessed against the crew by giving only 0.9 instead of 1.0 standard hours per machine hour.

Advantages

1. Pay is based on factors under the crew's control with the exception of relative activity which is based on production schedules set by supervision.
2. The relative activity chart is easy to maintain.
3. Downtime standards are the only part of the plan which calls for detailed time study.

Disadvantages

1. The plan exercises no control over crew labor hours. Supervisors assign crew sizes.
2. Decisions must be made by supervision regarding fault for all non-standard product (this is good in part in that it forces supervision to locate causes).
3. Administration is semi-complex and some operators have difficulty understanding the plan.
4. Earning opportunity is limited due to the relatively small percent of total time over which the operator can exercise control (i.e. downtimes). This may not give enough monetary incentive to get better performance. For example, for saving a valuable one minute downtime on a shift a worker's extra earnings would be only 4¢ for the eight hour shift. Or, in other words, to raise pay by 1% (19.2¢ per shift) 4.8 minutes of downtime must be saved.

Summary

This plan embodies a sound approach to the problem at hand and has proven satisfactory. The complexity of the plan is to be expected in this type situation and is not a major factor. Limitations which could cause difficulty are the plan's lack of control over labor hours and the small monetary gain for improved performance.

Plan E

Plan E was designed for type 3 operations in which crews of workers service automatic machines which operate nearly continuously.

Description

Plan E applies to crews operating a special type of continuous automatic processing equipment. Each crew consists of from two to four men as determined by supervision and operates one or two machines. The machines produce continuous strips of a plastic which must be handled by the workers. Machine speed is not controlled by the workers. Good and alert worker performance is necessary to minimize waste by keeping the machines properly adjusted. The process is complex and requires frequent attention from the crew members who are 50% busy on the average.

Fixed pay equal to 105% times the daywork rate times hours worked on incentive is guaranteed to the workers. Premium pay equal to 20% of the daywork rate is added to the fixed pay for each hour good product is produced. Additional premium pay is given when authorized waste is produced.

Authorized waste consists of a small percent of standard allowed waste and waste which is produced purposely according to supervisory instructions. All other waste is unauthorized. The standard allowed waste is based on the previous six months unauthorized waste average. The purposely produced waste is economically feasible to run during

operations such as product change and minor cleanups since it is very costly to shut-down and start-up a machine.

In other words, premium is paid for all time on incentive except time during which unauthorized waste is produced. Pay is calculated each shift. Each crew is regarded as a group for incentive pay purposes.

Analysis

This plan incorporates a sound basic philosophy of paying incentive premium for all good product or authorized waste which is produced. The incentive, therefore, is to minimize unauthorized waste regardless of the cause.

Noteworthy Characteristics

1. By paying 105% of the daywork rate for all hours on incentive a guarantee is established. For all premium hours (hours producing good product or authorized waste) 20% of the daywork is paid as premium. As premium hours rises from 0 to 8.00 or from 0% to 100% premium, pay will only rise 20%. Since pay is only 20% variable with respect to production as shown here, a 5% increase in good product produced will result in only a 1% increase in pay. This dilutes the strength of the incentive payment considerably.
2. On the other hand, by paying some premium for all good production, a serious disadvantage of a previous plan for this operation is eliminated. Under the older plan, workers were guaranteed the daywork rate and premium was 100% variable with respect to

production. Whenever premium hours earned dropped below 6.65 per eight hour shift, no premium could be earned. Therefore, once a crew had experienced over 8.00-6.65 = 1.35 hours of unauthorized waste in a shift they had no incentive, payment wise, to try to get the machine adjusted and producing standard product.

3. A crew under this plan always can earn some premium regardless of the trouble they experience. The same is true for a crew taking over a machine producing waste from a previous shift.
4. A standard waste allowance is allowed based on average unauthorized waste for each machine for the previous six months.

Advantages

1. The workers always have some incentive to earn extra premium by producing good product.
2. The plan is simple enough to be understood and administered easily.
3. Machine speed is not a factor. Premium is paid only for good product plus authorized waste.

Disadvantages

1. The plan exercises no control over crew labor hours. Supervision establishes crew sizes and makes machine assignments.
2. No determination is made as to responsibility for unauthorized waste. For example, if one crew gets a machine into waste

trouble by poor performance and the crew taking over the machine on the next shift inherits the condition, the new crew must get out of the trouble before they can earn premium. However, the new crew does have the opportunity to adjust the machine and start earning premium. Another example would consist of waste caused by mechanical troubles. No determination is made as to whether or not they are the fault of the crew. The argument is advanced that incentive premium should not be paid for unauthorized waste whatever the cause.

3. There are no time standards set for the duration of running authorized waste during scheduled waste hours. The actual time taken is allowed.
4. Monetary gain from incentive premium is small for increased production. One hour extra of good product results in only a 2.5% pay gain. Thus the strength of the financial incentive is doubtful.
5. The periodic adjustment of the standard allowed waste means that the workers are working against themselves in attempting to earn extra premium by bettering past waste performance.

Summary

The plan is performing satisfactorily in the situation described here. However, the incentive is weak and measurement is not thorough. Although the simplicity here is advantageous, a more sensitive measurement and incentive procedure should make the plan better for this type of situation.

Plan F

Plan F applies to type 3 operations in which a worker services automatic machines.

Description

This general payment plan is suitable for a wide variety of operations. In the operations normally covered by this plan, workers servicing automatic machines may increase output by maintaining quality, by keeping the machines properly adjusted and operating correctly, and by reducing downtime.

Incentive pay is related to the manual effort requirements of the operation with adjustments being made for quality and utilization of the machine's capacity to produce. Time standards are established for all manual work done while the machines are operating. These standards are expressed in man hours per machine hour and assist in assigning machines to men as well as being a basis for payment. The actual standard hours allowed for pay purposes is calculated by adjusting the manual time standards by multiplying them by quality performance and machine production effectiveness (actual production divided by standard production capacity). Other time standards are set for downtimes such as cleanup and product change and give an opportunity to earn more pay by reducing downtimes.

Incentive bonus pay is 50% variable with respect to overall effectiveness and starts at 67% overall effectiveness. Thus, for

every 2% overall effectiveness increase above 67%, pay will increase 1%. Overall effectiveness of 100% would earn pay equal to 116.5% of the daywork rate. The daywork rate is guaranteed to each worker. Pay is calculated each shift.

Analysis

One of the outstanding features of this plan is the wide variety of operations to which it can be applied. It is a fairly simple plan to set up and administer although time standards are required for operator effort on all operations. Essentially it is similar to the Halsey 50-50[9] type of incentive plan for hand-paced operations in which incentive pay is 50% variable with respect to effectiveness and begins at 67% effectiveness. The most significant feature of the plan as far as pay calculation is concerned is the adjustment of manual effectiveness with quality and machine production effectiveness factors. The plan has proven very effective in actual use on a number of different operations.

Advantages

1. Time standards for manual work aid in assigning balanced workloads to operators.
2. The plan can be applied to a wide variety of operations.

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[9]For a description of the Halsey Plan, see L. P. Alford, J. P. Bangs, Production Handbook, New York, Ronald Press, 1950, pp. 1201-1203.

3. The plan is fairly simple and easy for the workers to understand.
4. The busiest and best operators receive the most pay.
5. Machine production effectiveness and quality performance are measured and play an important part in the pay calculation.

Disadvantages

1. Time standards may be difficult or costly to establish for some jobs.
2. Operations requiring low physical effort have little or no chance to earn incentive bonus regardless of performance in controlling quality, production effectiveness, and downtime.
3. Equal emphasis is placed on quality and production effectiveness which may not always be a sound relationship. In addition, there may be other significant factors under the worker's control which are not measured by the plan.
4. Manual effort may not be a significant measure of the contribution of the worker to the company.

Summary

This is a good simple general plan. Probably its weakest point is the fact that production effectiveness and quality performance are picked as measured factors and given equal weight on a blanket type coverage. More flexibility providing for detailed analysis as to what factors should be included (and to what extent) may correct the weakness. The plan is equitable to all operators, and, since

it pays more for the heavier manual effort jobs, supervisors are stimulated to assign work to operators on as near equal a basis as possible. The limited variability of pay of 50% dulls the monetary incentive. There is no way provided to pay incentive premium for operations requiring manual effort below about 67%. Although supervision should be stimulated to eliminate such jobs, there are times that it may be worthwhile to pay incentive based completely on factors other than manual effort.

Plan G

Plan G covers a type 3 operation in which crews of workers service automatic machines.

Description

Plan G is a group payment plan for loom fixers in a weaving operation. Loom fixers are workers whose job consists of keeping a number of looms operating and in adjustment. In other words, their job is to minimize downtime. Three loom fixers may service 100 looms. In this operation, perfect loom production effectiveness is 100%. Average loom productive effectiveness before installing this incentive plan was 90%.

Loom fixers are given an incentive bonus amounting to 1.8 times the percent by which their actual effectiveness exceeds the 90% pre-incentive average. Therefore, a crew achieving 95% loom productive effectiveness would earn a bonus of 9%. Pay is equal to 100% plus the bonus percent (total) times hours worked times 120% of the daywork rate. All members of a crew of loom fixers (usually three men) earn the same bonus as a group. Pay is calculated weekly.

The plan measures basically the extent to which the loom fixers minimize downtime. However, allowances are given for downtimes not the fault of the fixers in order to prevent a loss of bonus pay.

Analysis

This plan has been successful for the loom fixers and might be applicable to many machine tending operations in which a worker or crew of workers is charged with getting full utilization from a group of machines by minimizing downtime only.

The sole basis for payment in this plan is the control of downtime. Neither manual effort nor other factors which may be controlled by the workers are considered by the plan.

No control is exercised over downtimes which are not chargeable to the loom fixers. Possibly such downtimes could be controlled by another incentive plan for the workers concerned.

Using past production data to establish a standard of performance, as was done here with the 90% pre-incentive average, is generally regarded as an unsound practice. However, the danger of runaway rates due to poor standards is minimized in this case by the fact that maximum effectiveness is limited to 100%.

Experience with the plan in operation has shown that the loom fixers realize that hastily made adjustments cause longer downtimes later and, therefore, they do good work. The fact that pay is calculated weekly helps to encourage them to avoid sloppy work.

Advantages

1. The payment plan is geared to machine effectiveness rather than manual effort since machine effectiveness is the best single measure of worker performance.

2. A strong incentive is offered by paying 1.8% extra premium for every 1% increase in effectiveness.
3. The plan is simple to administer and easy for the workers to understand.
4. Average loom productive effectiveness has increased from 90% to 95% since the plan was installed.

Disadvantages

1. When effectiveness falls below 90%, no bonus is earned and no monetary incentive remains to keep effectiveness as high as possible. Therefore, one bad day could destroy incentive for a week.
2. Pay is calculated weekly instead of on a shift basis. The reason for this is to encourage workers to do good work which will result in maximum effectiveness over long periods. Nevertheless, daily pay calculations are still desirable to let the workers know where they stand.
3. No sound system is established to aid in determining whether or not unscheduled downtimes are the fault of the loom fixers.

Summary

This plan has been successful in the particular application described here. Its strong points are measurement based on the most important factor of downtime control, high pay return for improved effectiveness, and simplicity. Potential weaknesses are failure to consider other factors of performance which may be

important, and loss of incentive below 90% effectiveness. The plan would be applicable to a wider range of jobs if it were made more analytical and thorough.

Plan H

Plan H covers a type 4 operation in which workers attend the machinery and equipment in a continuous processing operation.

Description

This plan is designed for a continuous chemical refining operation requiring a crew of 12 workers. The workers have little to do when the process is operating satisfactorily except to record instrument readings every two hours. They are less than 50% busy on the average. When troubles do occur, however, they are expected to be able to quickly make the adjustments necessary to resume proper operation. Major losses due to faulty operation rarely occur. Production output averages 60% of capacity and varies considerably about that figure. Output is set by supervision. The only significant factor controlled by the workers (other than correcting troubles that occur) is the amount of steam used. Good operation can appreciably reduce the $600,000 annual cost of steam which is the largest single expense of production.

Pay is based on production output, steam economy, and actual crew labor hours used. For average conditions of production output (equal to 60% of capacity), actual steam useage (2.50 pounds steam per pound of product), and 2016 (12 men times 21 eight hour shifts per week) actual crew labor hours used, pay is equal to 125% times the daywork rate. For all practical purposes, labor hours are fixed at 2016. For a 10% increase in production output (from 60% to 66%

of capacity) pay will increase 0.3%. For a 10% increase in steam economy performance (2.50 pounds to 2.27 pounds) pay will increase only 0.2%. Pay is calculated weekly and all 12 crew members earn the same pay percent.

Analysis

This plan relates pay to production output which is not under operator control except when trouble occurs and to steam economy which is under operator control. To keep pay from fluctuating too much when extreme variations in production output occur, pay was fixed to vary only 3% per 100% change in production output and 2% per 100% change in steam economy performance. As a result it is more of a pegged payment plan than an incentive plan. Monetary incentive is negligible. Better results might be had if pay were made more sensitive to changes in steam economy and worker effectiveness in preventing and eliminating troubles.

Advantages

1. Some control is maintained over crew size by setting a standard crew size and not paying premium for hours in excess of standard.
2. Steam economy is recognized and measured as a factor in the payment plan.
3. Standards are easy to set and maintain.

Disadvantages

1. Monetary incentive to improve steam economy is very small.

2. Monetary incentive to correct production difficulties in order to increase production output is very small.
3. There is no measured relationship between production output and manual effort. Premium increases as production increases as a more or less token recognition of worker effort.
4. Pay is calculated weekly instead of each shift. This is due to the difficulty of measuring production over short periods.

Summary

As an incentive plan, plan H is very weak because there is no significant premium for good performance or penalty for poor performance. It is more a method of paying high wages than an incentive plan. Too much emphasis is placed on relating pay to production output which is not even under the worker's control. The incentive value of the plan could best be increased by placing much more emphasis on premium pay for steam economy and trouble correction and prevention.

Summary of the Eight Plans

A few general comments are needed to supplement the individual analyses made of each of the payment plans just described.

In all of the plans some attempt is made to relate incentive premiums to factors under the worker's control which affect output, quality, and cost. Plan A is an exception in that no consideration is given to the quality and promptness of the service performed by the lab worker. The plans vary widely in the thoroughness with which the factors are studied for measurement purposes. There is also considerable variance in the weight the factors have in the pay computation.

Manual effort is not considered in measuring performance in plans B, E, G, and H. In plan A manual effort is the sole basis of measurement. Plans C and F use manual effort as a foundation to be altered by performance on other controllable factors. Relative manual activity is the consideration in plan D.

The extent to which the workers utilize the productive capacity of their machine is a major factor measured in all plans except A.

Incentive premium above the daywork rate averages between 17% and 31% for the eight plans. Increase in premium percent for a 1% increase in overall effectiveness varies from 0.05% to 2.00%. No plan, except C, makes any attempt to relate incentive premium to the actual cost savings which are attributable to the worker. In plan C, no policy is established for distributing a portion of the

savings to the worker, but when the empirical standards are set for "other factors" performance, more premium opportunity and weight is given where potential savings are large.

All of the companies involved with the plans described here took particular pains to insure that these new payment plans were thoroughly explained to the workers. This was particularly true for the more complex plans such as C and D. General opinion holds that it is very important that the worker have a complete understanding of (1) how his payment plan works, (2) why it is as it is, (3) what management expects of him, (4) what he can expect of management, and (5) how both he and the company benefit from his good performance.

Although all of the plans had some limitations or weak spots, they give us indications of how the problem of incentive payment for limited control operations can be logically approached. Many of the principles to be presented later will be formulated from ideas in these plans.

A brief tabular summary of the eight plans is presented in table 1 on pages 63 and 64 to facilitate comparisons with regard to the measures of performance and the incentive bonus.

Table 1

Comparison of the Eight Plans

Plan	Measures of Performance	Average bonus earned above daywork rate
A	Manual effort	27%
B	Machine utilization	25%
C	Manual effort Other factors (machine utilization, quality, etc.)	25%
D	Machine utilization Waste product Relative manual activity	25%
E	Machine utilization Waste product	25%
F	Manual effort Machine utilization Quality	17%
G	Machine utilization	31%
H	Machine utilization Steam economy	25%

Table 1 (Continued)

Comparison of the Eight Plans

Plan	Maximum possible bonus earnings above daywork rate	Approximate increase in pay above daywork rate for a 1% increase in overall effectiveness (from average performance to 1% above average)
A	Unlimited	0.24%
B	26%	1.20%
C	Unlimited	1.20% to 2.00% (depends on position on the chart)
D	Approx. 35%	1.00%
E	25% to 30% (depends on waste allowance)	0.20%
F	Unlimited	0.50%
G	42%	2.16%
H	30%	0.05%

IV

GENERAL CONSIDERATIONS

The foregoing section described and discussed eight current incentive plans for limited control operations. All of the plans are being successfully used today although we might suspect that the degree of success of several of them could be raised by further study and application of sounder principles of measurement and payment.

At this point the reader should be well acquainted with the types of operations included under limited control operations, some methods by which incentive payment plans can be applied to these operations, and some of the problems which are encountered.

Before attempting to advance more definite ideas and principles for incentive payment on limited control operations, several general problems must be considered. In order, they are:

Shall There Be An Incentive Payment Plan?

Motivation

Measurement

Economics

Shall There Be an Incentive Payment Plan?

The consideration of whether or not incentive payment plans should be used will be viewed from two standpoints. First, there must be general company decisions and policies regarding incentive plans as a whole. Secondly, there must be considerations concerning plans for specific individual operations. The following discussion is not an attempt to answer the question "incentive payment or not?" The intent is to highlight some of the factors which must be studied and analyzed in order to help individual organizations answer the question for themselves.

There are numerous examples of companies that have been very successful without incentive plans and companies that have used incentive plans to great advantage. Some companies have experienced marked improvement by installing incentives while with others improvement has resulted from abandoning an incentive system. In general, organizations that have good management and enjoy satisfactory worker morale are able to successfully use incentive plans. It must be emphasized that incentive payment plans are not a substitute for good management but rather a tool to help management do a better job. Seemingly, wholehearted support and conscientious management can make almost any plan work.

Through incentive plans we attempt to motivate a worker to improve his performance with resultant gains to the worker in pay and to the company in savings and increased productivity.

The following list includes the main advantages to be gained from good incentive payment plans:

1. Workers are paid in relation to their performance with the better workers getting the most money.
2. Production increases result in lower unit costs by more effective utilization of the worker, machinery, and other factors of production.
3. Improved methods result from studies used to set up the plan.
4. Management has a yardstick by which it can more accurately measure the effectiveness of operation in its plant and spot weak areas.
5. Standards aid in planning, scheduling, and predicting future costs.
6. Supervision is stimulated to do its job better.

On the other hand, these disadvantages may be encountered:

1. The cost of setting standards and administering incentive plans is high.
2. Accurate standards cannot be set due to limitations in performance rating (leveling).
3. Divergent interests of the worker and the company occur. The worker's main incentive becomes to "beat the system" rather than to help the company.
4. Grievances and personnel problems increase where incentive plans exist.

5. Creeping changes occur which cause standards to get out of line. It is difficult to correct such situations after they occur.
6. Workers may purposely perform poorly and try to force easier standards.
7. Workers may establish self imposed ceilings on productivity in fear that standards will be reduced if they perform too well.
8. Large pay differentials between incentive and daywork workers cause friction and personnel problems.
9. Most savings claimed for incentive plans can be had without incentives if supervision is good.

The pros and cons listed here apply to incentive plans for both hand-paced and limited control operations. However, we must recognize that incentive plans can be applied to some operations easier than to others.

Most hand-paced operations may be easily placed on incentive by use of sound conventional time study and straight incentive plans.

Several characteristics of limited control operations make the problems of measurement and payment more difficult than those for hand-paced operations:

1. Standard methods are difficult to establish due to lack of a set operational pattern.
2. Determination must be made of the worker's control of the operation.

3. Performance must be measured by considering some factors other than manual effort.
4. Cost savings attributable to the worker are difficult to calculate especially when it is hard to measure the extent of worker control.

The increased difficulty of measurement and payment of limited control operations results in increased costs of study and administration. In most cases savings more than offset the cost but there may be considerable doubt as to the validity of the saving data and the worker's performance measurement unless the plan is based on thorough and accurate studies.

It follows that there will exist some limited control operations which cannot be put on incentive and yield savings that will offset the cost of study and administration. (The same is true for some hand-paced operations.) Here a very real problem rises with regard to precedent setting.

Looking into any company at random we would find examples of hand-paced, limited control, and clerical type operations. Analysis would probably indicate that some of the operations could be easily and profitably placed on incentive. Some operations would yield fair savings on incentive while others could not be economically placed on incentive at all.

A threefold problem now exists of (1) should any incentive plans be installed? (2) if so, on which jobs? and (3) will a precedent be set for extended incentive coverage at a later date?

Suppose that initially only the operations which yield large savings are put on incentive and later less profitable operations are covered. The daywork workers on jobs uneconomical for incentives but closely associated with the incentive operations may clamor for the opportunity to earn high incentive bonuses the same as their neighbors on incentive.

Should these operations be put on incentive at a loss for morale reasons, or should the management be firm and explain that incentives are uneconomical in their case? The latter choice seems most logical.

However, there are numerous examples of companies that have succumbed to pressure for various reasons and installed token "incentive" plans at a loss to preserve good employee relations. (There is considerable doubt here as to whether such practices really maintain good relations from an overall standpoint.) The most popular reason for paying such "unearned" incentive premiums is that "everyone else in the department was on incentive." It is surprisingly difficult to be able to draw a line and say that, "this is where we stop extending incentive coverage for economic reasons."

When considering installation of incentive plans for a department or an entire company, the long range precedent setting problem must be considered along with the immediate problems.

The ultimate decision of whether or not to have incentive plans and to what extent rests with the management of the organization concerned. The decision should be based on sound judgment

after a thorough analysis of the situation. Once a decision has been made to have incentive plans, two requirements should be fulfilled before further action is taken:

1. Management must be completely sold on the idea and convey their enthusiasm throughout the organization or departments involved.
2. Qualified industrial engineers must be available who, through sound work measurement practices, may establish sound measures of worker effectiveness, and subsequently establish good sound incentive plans and gain worker acceptance.

The considerations of motivation, measurement, and economics which follow are all related closely with the problem just discussed. They are taken up separately here because each is of sufficient importance to warrant individual attention.

Motivation

No incentive payment plan, simple or elaborate, will be effective unless it motivates workers to improve their performance.

To cover the subject of human motivation in detail would far exceed the scope of this paper, but some points which are pertinent to the problem of incentive plans for limited control operations will be discussed.

Several excellent publications are available which deal with motivation of the industrial worker. The best and most comprehensive study can be found in Money and Motivation by William F. Whyte.[10] This book is highly recommended to anyone who is concerned with incentive payment plans.

The following discussions will deal with money as a motivating factor and leave the art of leadership untouched. It has been said many times that good leadership or supervision is the best incentive to motivate a person to perform better. This may be accepted as true, but nevertheless a good financial incentive tool in the hands of a good supervisor can give even greater incentive and financially recognize the better workers.

Since we are interested primarily in limited control operations, let us first consider the type of person who works on such operations.

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[10] W. F. Whyte, Money and Motivation, New York, Harper and Brothers, 1955.

Normally, limited control operations employ a higher skilled worker than hand-paced operations. This results from the increased expenditure for machinery and equipment and the highly technical nature of some of the operations. We may consider in general that the workers we discuss are (1) more highly skilled and trained, (2) more intelligent, (3) of some higher social order, and (4) more highly paid than workers on conventional handwork operations. As the present trend toward automation and high equipment investment continues, we can expect the relative status of workers on these operations to rise even higher. They will be technicians rather than laborers.

Consider also the fact that rising standards of living in this country have raised the income and living standards of all workers in general. Most companies have many fringe benefits covering retirement, job security, insurance, and the like.

In short, very few workers on limited control operations have any genuine worry about sufficient income or security. A brief examination of a theory of human motivation will help to relate the subject of worker motivation by incentive plans to the foregoing discussion of changes in the financial and social status of workers.

The Maslow-Air Force Theory[11] is a dynamic theory of human motivation. This theory presents human needs in the following

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[11] See notes by Alpheus Smith which are reproduced in appendix B. Also, Principles of Leadership and Management, Air Science IV, Vol. II, Air University, Maxwell Air Force Base, Montgomery, Alabama, 1954, pp. 48-60, 82-93, and 94-107.

order of priority:

1. Survival Needs - basic biological needs essential to life.
2. Security Needs - safety needs; to lessen worry about the future.
3. Belongingness and Love Needs - needs for acceptance and approval by others.
4. Esteem Needs - more complex needs involving recognition for accomplishments.
5. Self-realization Needs - the highest needs of utilizing ones full potential; seldom reached.

Briefly stated, this theory says that an individual has minimum needs in each of the five classes. Until his minimum needs are fulfilled in one class, he cannot be motivated by appealing to his needs in a higher class. For example, until minimum survival needs are fulfilled, the person cannot be motivated by appealing to his security needs. The theory also states that, at any given time, one of the five classes of needs is dominant in an individual. This dominant need changes as the environment of the individual changes.

Certainly basic survival needs are fulfilled for all workers we are considering. Security needs are fulfilled to a large extent. Years ago the extra income brought by incentive payment plans was highly desirable to help satisfy security needs. Today, the workers with which we are concerned are secure. Most have satisfactory

wages, a home of their own, a car, a television set, numerous appliances, and other items characteristic of good living. Their employer furnishes security fringe benefits such as pension plans, sickness and health insurance, and life insurance.

It follows that incentive plans intended to motivate these workers to perform better should be directed at the "belongingness and love needs" and possibly the "esteem needs."

It is logical to assume that today's worker with his higher standard of living will still work harder for more money, but the marginal value of that money will be less to him than if he needed it to satisfy survival or security needs. Therefore, we assume that the average man needs a greater, or perhaps different, inducement to motivate him to achieve greater effectiveness than he would have needed ten years ago. This, of course, applies to the average worker. The miserly type will continue to pinch pennies, and the carefree type still will not want to work harder for any amount.

It would be interesting if we could have statistics showing marginal values of added income for the past 50 or more years. A 5% raise years ago meant that essential food and clothing could be bought, later it came to mean that an automobile might be had, and finally it may now mean the possibility of a second car, purchase of a sailboat, country club membership, or some similar luxury. Surely the incentive urge or motivation to earn that 5% extra was greater in the past than now. A worker should eventually reach the point of zero marginal value of extra work for extra income

at which he wants to feel fresh and able to enjoy his prosperity after work rather than to tire himself on the job to earn money he will not enjoy.

Some workers under several of the eight payment plans described earlier have admitted that they will not exert themselves to achieve better performance for the amount of premium pay involved. In these cases pay increased less than 1% for a 1% increase in worker performance, and we might expect that higher premium would partially remedy the situation. This case is obviously one involving the marginal value of added incentive premium.

Some general thought should be directed at the effect of industry's increasing paternalism and the spread of security fringe benefits. It has already been shown how rising living standards and increased security may have dulled the motivating effect of money or at least decreased the marginal value of added income. There is an old saying that "the good fighter is the hungry fighter." This is not an argument that workers should be supressed and not given a high standard of living. It is an argument for finding out what will increase the appetite. Certainly, initially, industry's security practices resulted in increased productivity by freeing the workers from security worries, making them generally happier, and reducing labor turnover.

However, the question is posed, "will workers become too secure and complacent with resultant losses in productivity?" The overall idea of social and economic gains created by industry for its

workers is good, but a penetrating appraisal of the subject should be continually made lest this good thing of high wages and security be carried too far and undermine the great industrial system which fostered it.

Thus far, motivation has been treated on an individual worker basis. Since incentive plans may be designed to pay workers on a group basis as well as an individual basis, some problems are discussed here concerning group motivation for incentive payment purposes.

It is generally accepted that individual payment plans are superior to group incentives except where teamwork is mandatory or where individual measures cannot be established. However, many advocates of profit sharing "incentive" plans believe strongly in collective group effort for the mutual good of the worker and the company.

Profit sharing is a sound method of incentive payment in principle because it recognizes the contribution of the workers to a company's overall success. But, profit sharing is often put on a company-wide basis and becomes merely a method of increasing pay. In a small group an individual may have the feeling that he can raise overall performance through his efforts, but in a company-wide application individuals may not see how they can make an appreciable contribution to profit and "let John do it" attitudes may develop.

It follows that profit sharing would be more effective if administered on the basis of small departments, groups, or individuals, in which bonus is paid in relation to performance against standards of operation including a budget. Ideally everyone would earn on a basis of what they actually contributed to company effectiveness or profit. The Scanlon plan[12] is perhaps the best current example of a profit-sharing approach.

The worker must be motivated to really care how well he performs. He should feel that it is up to him to sink or swim. Small self-sufficient working units often prove very effective in achieving this. Compare the situation of a small town in which many people work and behave well because everyone else knows what they are doing and a big city in which few care what others do. Likewise small plant managers can run plants successfully "by the seat of their pants" treating each worker as an individual whereas large companies find complicated systems necessary to administer their business.

People are all different. Therefore, no single incentive will motivate all equally. In large companies, unfortunately, general plans must be used which will give optimum motivation for all concerned. Some people stoop to pick up a penny from the gutter;

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[12]See W. F. Whyte, op. cit., pp. 166-188; and G. K. Krulee, "The Scanlon Plan: Cooperation Through Participation," The Journal of Business, April 1955, Chicago, The University of Chicago Press, pp. 100-113.

others will not. In considering the motivating power of money, the question must be posed as to how much money must be offered in order to get a worker to perform better.

In several of the eight plans discussed a substantial increase in overall effectiveness, say 10%, results in only about a 2% pay increase, or around $0.40 per day. Will a worker expend the effort, skill, and attentive time necessary to earn that sum, or will he relax at work with only a small financial loss to him and a large loss to the company? Personal experience indicates that the success of many such incentive payment plans is based on personal pride, social pressure among workers, or fear of poor merit rating and loss of promotion opportunities rather than on the immediate money involved.

Oftentimes the success or failure of a payment plan, as far as productivity is concerned, lies in the general atmosphere of the department. Desire of the majority to see who can do the best creates a healthy atmosphere which elevates the performance of all including the poor workers. Conversely, a poor atmosphere may develop in which the worker who attempts to perform well is branded as eager or a "rate buster" and becomes a social outcast of his group.

The thoughts given here have only scratched the surface of the motivation problem. Where actual incentive plans are being considered, the case at hand must govern to a large extent the decisions which are made. One of the mystifying dilemmas of motivation is the fact that a plan may be successful in one place and a failure in another seemingly identical situation with no apparent explanation.

No ready answer can be given to the problem of what it takes to motivate a worker to do his job better. We do know through experience that money is a motivating factor, but we also recognize that there are other more intangible factors which tend to motivate workers.

Perhaps sound non-financial motivation techniques, applicable to industrial situations, will be perfected someday. Continued study of such motivation is definitely needed in the light of the aforementioned changes in the social and financial status of workers on limited control operations.

Although we do know that money is a motivating factor, it is difficult to say exactly how much money in the form of an incentive premium is necessary to motivate a worker to improve his performance. Considerations such as the marginal value of added income are important.

Generally speaking, incentive premium should be as high as economically possible depending on savings which result from improved performance, but care must be taken to keep all payment plans equitable and to avoid extremely lucrative jobs which cause jealousy by workers on less lucrative jobs. A suggested guide for incentive payment on limited control operations is to give <u>at least</u> a 1% increase in pay for a 1% increase in overall effectiveness due to the worker's performance.

Measurement

Measurement of worker performance for limited control operations is considerably more difficult and complex than for hand-paced operations. By the term worker performance, we are referring to the overall contribution of the worker to the company in terms of increased production, improved quality, and reduced operating costs.

For the typical hand-paced operations, standard times are established for all operations performed by the worker. The worker's performance for pay purposes is simply a reflection of how fast he works relative to the standards. This is a measure of only manual performance. Occasionally quality is included as a measured factor.

In the previous discussions in this paper the idea has been brought out that, in limited control operations, manual performance is not the sole factor affecting a worker's contribution to the company. Other factors such as machine utilization, elimination of downtime, quality, steam economy, and waste, have been considered. The very nature of the operations we are discussing here, as the name limited control implies, restricts the worker's control over the factors involved in production, quality, and cost. To logically tie incentive pay to worker performance we must follow the five step approach which was suggested in the section on philosophy and background:

1. Determine the factors which affect productivity, quality, and cost of operation.
2. Determine which factors are controlled in any manner by the worker.
3. Determine the extent to which the worker controls each factor.
4. Determine the economic importance of the worker's control over each of the factors with respect to value of increased productivity, improved quality, and savings in operating costs.
5. Relate the pay of the worker to his overall performance based on the controlled factors in such a manner that he will have adequate incentive to increase his performance level.

Clearly, many measurement problems are involved in the successful application of this five step approach. It was mentioned in the introduction that limited control operations have been widely regarded as "unmeasurable." Actually, very few operations can be truly classified as unmeasurable. The measurement problems faced here are not as awesome as one might suppose. Limited control operations vary from those which are very easy to measure to those which are very difficult to measure with the cost of measurement increasing as the difficulty increases. The question of applicability for incentive payment is not one of, "is the operation measurable?" but rather one of "can we economically measure it?" The economic question must be settled for each

individual case. The remainder of this section will be devoted only to problems of measurement since economic considerations will be discussed later.

The remaining discussion deals with some of the techniques and problems of measurement in applying the five step approach to establish sound incentive plans. Space limitations restrict the amount of description given to various techniques. The reader will find the listed references very useful for further investigation. Considerable study and development is needed to provide more and better work measurement techniques for limited control operations.

The eight plans discussed earlier included examples of plans which use manual effort as a basis for payment and those which do not. In several cases incentive payment was given for manual effort which had no influence on the worker's overall performance. The following concept is tentatively suggested with regard to manual effort and incentive payment:

1. Manual effort should not be a basis for incentive premium except when that effort results in increased productivity, improved quality, or reduced operating costs. An example in which manual effort would thus be measured is a downtime which can be reduced by increased manual performance with a resultant increase in production.
2. When it is desirable to have different levels of pay for workers at different levels of manual effort merely as a recognition of physical exertion, when such effort

is not related to overall performance, the recognition should be made in base rates through job evaluation and not in the incentive portion of the pay plan.

As a prerequisite to the actual measurement of worker performance, the best method of performing the work must be established and recorded in some form of written standard practice (job conditions). The problem of methods study is not considered here. Written standard practices may be supplemented by photographs, movies, and references to the operating procedures and records maintained by the production department concerned.

Recording of methods is difficult in some limited control operations. This is particularly true in machine servicing or maintenance jobs for which frequency and type of work cannot always be predicted. Nevertheless, good standard practices must be maintained since they are in a sense part of the agreement between the worker and the company regarding what is expected of him for a given remuneration.

Measurement of worker performance necessitates the establishment of performance standards against which the actual performance of the worker can be compared. The two basic types of performance standards are time standards and standards for other factors. Time standards are used for factors in which time is the measure of performance such as manual requirements, machine capacity, and machine cycle time. Standards for other factors measure all other factors controlled by the operator such as quality and material useage.

Time standards are established by use of stopwatch time study, predetermined times, and work sampling.

Several good texts are available which discuss stopwatch time study. Two well known texts are Barnes' Motion and Time Study,[13] and Abruzzi's Work Measurement.[14] A Trade Union Analysis of Time Study by William Gomberg[15] is highly recommended also.

Stopwatch studies are widely used for hand-paced operations and are the basis for most piecework standards. They are useful in phases of limited control operations such as downtime standards in which the standard is expressed in units of time per occurrence. Watch studies are good for repetitive short cycle operations. They may be impractical for the long cycle or non-repetitive operations common to many limited control situations.

One major disadvantage of stopwatch study is the necessity for performance rating (leveling) in setting standards for manual operations. At best leveling is a matter of educated guesswork. However, in many limited control operations the "normal" worker concept may be overlooked. For example, on service or maintenance operations, manual effort is not required for sustained periods of time. When downtime is extremely costly, the standard for performing a downtime

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[13] R. M. Barnes, op. cit.

[14] Adam Abruzzi, Work Measurement, New York, Columbia University Press, 1952.

[15] William Gomberg, A Trade Union Analysis of Time Study, Second edition, New York, Prentice Hall, Inc., 1955.

task may call for effort in excess of "normal." When such maximum effort is required adequate incentive premium must be offered.

Predetermined times fall into two categories, universal systems and standard data developed by individual companies. The purpose of both is to enable setting of standard times without having to time study the operation. A popular universal system is Methods-Time Measurement (MTM).[16]

Work sampling has only recently been accepted as an excellent method of setting time standards on long cycle or non-repetitive operations. Work Sampling by Barnes[17] describes the method and several applications.

Work sampling uses random spot observations of an operation to build a picture of the entire operation. In addition to furnishing data for setting time standards, it can furnish additional useable data. Such data might pertain to machine interference (the condition of more than one machine requiring a worker's attention simultaneously), average percent busy of the workers, frequency of machine downtime, and work flow. Since it is based on statistical probability theory, sampling gives results with calculable accuracy in terms of limits of possible error and probability of correctness.

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[16] H. B. Maynard, G. J. Stegmerten, and J. L. Schwab, Methods-Time Measurement, New York, McGraw-Hill Book Co. Inc., 1948.

[17] R. M. Barnes, Work Sampling, Dubuque, Iowa, Wm. C. Brown Company, 1956.

Much time can be saved by use of work sampling on long cycle or non-repetitive operations. Many operations which are costly to measure by stopwatch study can be economically measured with work sampling. Time lapse movie cameras which expose single frames of film at preset intervals can record data for sampling studies, and they do not need an observer to tend them. Handling of data in sampling studies can be "automated" by recording observations on mark sensed IBM cards and processing the cards by machine.

Bernard Roth[18] describes an application of sampling which satisfies the following requirements as a study:

1. Economical
2. Accuracy is calculable
3. Gives a model or picture of the entire operation
4. Furnishes standard data for predetermined standards
5. Impregnable against criticism by scientific or irresponsible persons
6. Eliminates "crystal ball" type guesswork

Standards for factors other than those covered by time standards may be established on an empirical basis by utilizing past production data or on a more precise basis by setting "ideal" performance levels through laboratory or other similar tests. In either case the problem is to determine a standard performance for

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[18] B. N. Roth, "Automation and Time Standards," The Journal of Industrial Engineering, March-April, 1957, pp. 95-98.

each worker-controlled factor and establish incentive pay levels for other degrees of performance.

A few typical factors which may be measured in the above manner are product quality, steam economy, amount of useful by-product, weight of product, color of product, material useage, quantity of product, care of equipment, and waste produced. In plan C, laboratory tests were used to set standards of ideal performance for waste in a centrifuging operation. Plans D, E, G, and H, used past performance data to set standards for various factors. In the Scanlon plan, a bonus is distributed on the basis of the ratio of labor costs to sales value of products produced.

The problem of measuring performance with regard to the type of factors mentioned in the previous paragraph must be approached from a logical common sense viewpoint. Ingenuity and creative thinking are useful in uncovering methods of measuring some of these "unmeasurable" factors. Where laboratory or scientific methods cannot be used to set standards, previous performance data must be collected and standards set by careful analysis and judgment.

Quality type standards can frequently be arrived at through laboratory tests. Decisions as to what incentive pay should be given for each degree of quality must then be made on the basis of the difficulty and the value involved.

When past performance data is used to set standards, care must be taken to ascertain the methods and conditions upon which the data

is based. Such empirical standards offer a considerable challenge to the standard setter.

There are several statistical techniques which may be used as aids in setting standards. These are tests of significance, analysis of variance, and regression and correlation.[19] A simple example of the use of each is given here:

1. Tests of significance can be used to determine if a change in a result of a particular operation is significantly affected by a change in worker performance.
2. Analysis of variance is a broader application of the significance test. When a battery of like machines and a group of workers are involved it may be advantageous to determine if different workers cause different results or if the differences occur normally in the operation of the machines. For example, maybe it is desired to see if machine breakdowns are significantly related to the performances of the maintenance workers. Analysis of variance techniques can test for such relationships.
3. Regression and correlation may be used to (a) determine the correlation between worker performance and results

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[19]Recommended references for these techniques are: W. J. Dixon and F. J. Massey, Jr., Introduction to Statistical Analysis, New York, McGraw-Hill Book Co., Inc., 1951.

A. H. Bowker and G. J. Lieberman, Handbook of Industrial Statistics, Englewood Cliffs, New Jersey, Prentice-Hall, 1955.

and (b) fit the best possible curve to a set of points representing performance plotted against results.

These statistical techniques have been used very little as an aid to standard setting. Certainly, more use should be made of these techniques in order to develop better standard setting methods.

The general approach for setting empirical standards should include these steps:

1. Collect data of (a) worker performance and (b) operating results for as many factors and differant levels of operation as practical.
2. Show worker performance and results in tabular or graphical form.
3. Analyze the data using judgment and statistical techniques.
4. Determine maximum and minimum levels of acceptable results.
5. Determine how costs are affected by changes in results.
6. Determine how incentive premium should vary with respect to the worker performance and operating results.
7. Set the standards.

Empirical type standards may also be necessary for some manual effort operations. In plan A, studies indicated that true manual performance only varied 80% with respect to productivity (which was actually being measured by the standards). The payment procedure was adjusted to compensate for the difference.

Two other techniques of measurement for incentive purposes are the use of relative activity standards and methods improvement incentives. Relative activity standards are standards which are periodically revised so that the current standard is based on performance over the previous period (e.g. the previous six months' quality level becomes standard for the next six months). The worker is in effect continually working against himself in this case. Relative activity standards are a substitute for good measurement and should be avoided except in special situations. Relative activity standards may be used for new operations which have not settled down to the point that they are routine and measurable. Such standards have the effect of hastening the development of a good operation and also giving the workers incentive opportunity for the break-in period.

Methods improvement incentives may sometimes be integrated with an incentive plan to encourage workers to devise and report improved methods. The improvement reward should be large enough to overcome the disadvantage to the worker of having standards adjusted to the new method. Suggestion systems are a form of methods improvement incentive.

Relation of worker performance to pay is the final consideration of measurement. Incentive premium must be sufficient to motivate the worker to improve his performance. A dilemma arises in deciding whether to relate premium directly to savings on a percentage basis or to give all workers equal earning opportunity.

If premium is a fixed percent of the savings attributable to the worker, some workers will receive much greater premium than others. Compare, for example, the case of the crews which can save $50,000 per year by reducing downtime one minute per shift with crews that have little or no opportunity to save large sums. On the other hand, if all workers had the same premium earning potential, pay would not be related to the value of the men to the company. A general solution is to strike a happy medium between these two alternatives, thus insuring that the workers saving the most earn the most premium.

We have discussed measurement only from the standpoint of incentive performance. Let us now consider the measure made by job evaluation to establish the base rates for all jobs.[20] Factors such as skill, education, training, working conditions, manual effort, and maybe responsibility are considered in establishing base rates. If job evaluation, in fact the entire wage and salary administration function, is not integrated with the incentive payment plan, pay may not be related accurately to performance. For example, if skill requirements are based on one skill level for job evaluation and another for incentive pay standards, the overall measure will be inaccurate.

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[20]An excellent reference on the subject of wage structure is: G. W. Taylor, F. C. Pierson, New Concepts in Wage Determination, New York, McGraw-Hill Book Company, Inc., 1957. See Chapter 6, "The Internal Wage Structure," by E. R. Livernash, pp. 140-172

Integration of wage and salary administration with incentive planning will also help to minimize the problem of base rates for non-incentive operations being padded and raised merely to reduce the pay differential between incentive and non-incentive operations.

Where incentive and wage administration functions cannot be physically combined, close cooperation is mandatory.

The measurement for incentive payment must be based on the whole operation and the whole payment foundation. Installing incentive payment plans without integrating the incentive payment portion with the basic wage administration is similar to building castles on clouds.

It would seem logical that all requirements of the worker which are fixed by the operation on which he works should be recognized payment-wise in his base rate. (This was suggested in handling manual effort earlier in this section.) Incentive payment, then, should only recognize "variable" performance factors and pay premium for performance over and above basic standard performance. The standard of performance implied by the base rate should be clearly defined.

The important thing in measurement of worker performance is to insure that all measures are as accurate as possible. With this in mind, the measurement function for limited control operations may be summarized as follows:

1. Measurement for limited control operations is more difficult than that for hand-paced operations and should

consider all factors relative to amount of production, quality, and operating costs.

2. Good written standard practices are necessary.
3. A five step approach should be used to arrive at how worker controlled factors should be used to measure worker performance.
4. Manual effort should be a basis for incentive pay only when it affects productivity, quality, or cost.
5. Time standards can be established by stopwatch, predetermined times, or work sampling.
6. Standards should be established for other factors such as quality on the basis of scientific tests or past performance.
7. Statistical techniques such as analysis of variance are useful in setting standards and testing the validity of standards.
8. Pay must be related to worker performance and should reflect to some degree the cost savings attributable to him.
9. The wage and salary administration measurements must be integrated with the incentive payment measurements.

Economics

From the economic standpoint, incentive payment plans should be treated similarly to investments in equipment or buildings and analyzed accordingly. The expenditures involved in establishing and administering incentive plans should be justified by substantial cost savings.

The fact that incentive payment plans affect the workers' pocketbooks creates personnel considerations which may not be found in economic studies for equipment. However, a sound study on the advisability of incentive plans would consider personnel factors along with the more tangible expenses and savings. A good economy study weighs intangible as well as tangible factors.

Good cost data is needed to determine what savings are resulting from an incentive installation in addition to being needed to relate incentive pay to worker performance as mentioned in the discussion of measurement.

A major problem arises in determining what expenses will be attributed to the incentive plan. Expenses which could be charged to the incentive plan include all costs of methods study and improvements, measurement and standard setting, and administration of the system. If all of these costs were charged to an incentive plan, very large savings would be needed to justify the plan.

The fact must be recognized that many of the requirements of a sound incentive plan are also requirements for sound plant

operation even when no incentive plans exist. These include methods improvement studies, standards of performance needed for production planning and worker evaluation, and periodic checks on worker and equipment performance. The degree to which these requirements will be accomplished varies where incentive plans do not exist. For example, measures of worker performance may be made through casual observation by the foreman or by an elaborate measured daywork installation.

We can look at an incentive operation in this manner: Some basic study and measurement is done to make the operation satisfactory and profitable without incentive payment; by a higher degree of study and measurement plus a system of administration, an incentive plan can be established which will bring in even greater profits (savings).

For economic purposes, only the differential expenses which the company deems attributable to the incentive plan should be included in the analysis of feasibility of the plan. These will normally include costs of refined measurement and of administration of the plan. Likewise, only the savings which are attributable to improved worker performance resulting from the incentive plan should be credited to the plan.

Another consideration is referred to as the "honeymoon period" by Dean Robert Roy of Johns Hopkins in an article entitled "Do Wage Incentives Reduce Costs?"[21] The period immediately following

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[21] R. H. Roy, "Do Wage Incentives Reduce Costs?" Industrial and Labor Relations Review, January, 1952, pp. 195-208.

installation of an incentive plan may be very rosy with workers and management profiting. However, after this period, the worker frequently begins to regard incentive premium as a "right" and not as a bonus for above average performance, and he begins to clamor for looser standards and other concessions. One by one small concessions may be granted with an eventual high cumulative cost in both direct incentive payments and administration. The general practice is that rates may be raised but never cut. These considerations are pertinent to the economic problem and also are a reminder of some of the difficulties which may be minimized by sound planning and forethought.

From the overall economic standpoint there are many limited control operations which can be placed on incentive at large rates of return. As equipment costs per worker increase we can expect an increase in the number of limited control operations which can be put on incentive. Even though the degree of worker control is getting smaller as we "automate," the net potential savings from the worker-controlled portion of the operation are increasing.

Summary

The considerations of shall there be an incentive payment plan? motivation, measurement, and economics round out the discussions of significant points about incentive payment plans for limited control operations.

The next section takes the ideas that have been brought out and formulates them into principles and recommendations for development of incentive payment plans for limited control operations.

V

RECOMMENDATIONS FOR SOUND INCENTIVE PLANS FOR LIMITED CONTROL OPERATIONS

A list of recommendations for sound incentive plans for limited control operations is given here. These recommendations are based on the material presented in the preceding sections of this paper, and they apply specifically to limited control operations.

Additional general principles and recommendations which apply to all types of incentive plans were given on pages 15-19. These additional principles were not questioned or discussed in this paper unless they needed modification or expansion to fit them to the limited control situation. Experience has proven them to be sound principles.

The recommendations which follow are for an ideal type of incentive payment plan. It is recognized that there will be some cases in which the ideal plan will be difficult to achieve. However, sound incentive plans can still be developed for such cases if a sound and logical approach is followed. The recommendations listed here should serve as a guide or checklist for establishing and measuring the effectiveness of incentive payment plans for limited control operations.

Recommendations

1. Decide whether or not to have incentives on the basis of economic feasibility. Make certain that the following points are included in the analysis:
   a. Consider the present, the future, and the problem of precedent setting.
   b. Weigh personnel and human relations factors carefully.
   c. Charge to the cost of the incentive plan only those costs which are over and above costs of methods and standards studies which would be incurred without incentives. Treat savings similarly.
2. Management must wholeheartedly and enthusiastically support any incentive plans that may be undertaken.
3. Good industrial engineers who are capable of devising, installing, and administering good sound incentive plans must be available.
4. Have a single basic framework for all incentive payment in the company, plant, or department concerned. A single basic plan helps keep incentive plans equitable among the different operations. Equitable plans are a necessity. Tailor-make each incentive plan to the individual operation to which it applies, staying within the established framework.
5. Incentive premium should be paid only for results which benefit the company and are attributable to the performance

of the worker. The company benefits through:

a. Increased productivity resulting from increased machine or equipment utilization.

b. Improved quality.

c. Decreased operating costs resulting from better utilization of materials, power, or supplies and from care of equipment and machinery.

6. Substantial incentive premium must be paid for above standard performance in order to motivate a worker to perform better.

   a. The worker's pay should be increased <u>at least</u> 1% for every 1% increase in his overall performance.

   b. Premium may be related directly to savings attributable to the worker, or all workers may be given equal opportunity to earn premium. A solution between the two extremes is recommended.

   c. Premium should get progressively higher as worker performance increases to high levels because of the increasing difficulty of improving performance.

7. Try to motivate workers by non-financial means also. Appeal to needs of belongingness and esteem.

8. The wage and salary administration function of rate setting should be integrated (or, at least, closely coordinated) with the incentive payment function.

   a. Base rates should be based on the fixed requirements of a job.

b. Incentive premium should recognize those variable components of a job which, when performed better, will result in savings or gain to the company.

c. Base rates and incentive premium must be complementary and not overlap. Together they pay a worker for his total worth to the company.

9. Measurement to determine standards for worker performance should follow the five step approach:

a. Determine the factors which affect productivity, quality, and cost.

b. Determine which of the above factors are controlled by the worker.

c. Determine the extent to which the worker controls each factor.

d. Determine the economic importance of the worker's control over each factor.

e. Relate incentive premium pay to the worker's overall performance based on the weighted importance of the controlled factors.

10. Sound measurement techniques must be employed. A few suggestions are:

a. Make good use of work sampling in addition to stopwatch studies and MTM in setting "time" standards for manual work and machine operation times.

b. Careful study and analysis is necessary to set sound standards for other factors such as quality and economy of operation. Such standards will be based on past performance or on laboratory type studies.

c. Statistical tests of significance, analysis of variance, and regression and correlation can be used to help determine the extent of worker control, set standards, and check on the validity of the standards.

d. Relative activity standards which are periodically readjusted on the basis of previous performance may be useful in some situations such as break-in periods of new operations.

e. Methods improvement incentives may be successfully integrated into the basic measurement plan.

11. Make sure that true worker performance is measured accurately in order to prevent paying unwarranted incentive premium.

12. Educate all workers to think in terms of overall effectiveness based on productivity, quality, and operating cost. Stress the fact that a high degree of manual effort or "busy"ness does not necessarily mean good overall performance.

13. Carefully explain the incentive payment plan to each worker affected. Make sure that the worker understands how his pay is calculated, how standards were arrived at, what is expected of him, and what his incentive premium will be. Emphasize that what is good for the company is good for him.

14. Incentive premium should be posted and clearly labled as premium in order to emphasize the fact that premium is not a right but is earned only by good performance.
15. Payment plans should be constantly audited, reviewed, and improved in order to keep them well maintained and functioning effectively.
16. Creative and imaginative thinking is essential in developing and administering sound incentive payment plans for limited control operations due to the relative newness of such an approach to incentives.
17. Worker opinion should be weighed heavily in appraising a plan regardless of how good management thinks the plan is. No incentive payment is fully effective unless the workers think it is a good and a fair plan.

The recommendations given here present a formidable task for development and administration of sound incentive payment plans for limited control operations. Nevertheless, they do not suggest the impossible.

It is recognized that there will be cases in which the principles cannot be followed. That does not mean that incentive payment plans are impractical in these situations. Successful plans can be devised even when some of the recommendations are disregarded or compromised.

The important thing is that the recommendations and ideas presented here be carefully studied and analyzed as to their merit

in individual situations. Once a person has developed a clear concept of the problem at hand and the fundamentals of incentive payment, motivation, measurement, and economics, he is capable of devising and judging incentive plans himself.

Some comments on incentive payment plans for each of the four types of limited control operations previously described are given in the next few paragraphs.

Type 1 - The worker performs mostly manual work but does not have complete control over the amount he produces due to restrictions in the flow of work.

Plan A shows how some premium can be paid in a type 1 situation by use of "makeup" when the workload is low. Thus the worker is assured of reasonable earnings and he can always earn more premium if he improves his performance.

Some companies may desire to pay for type 1 operations on a straight piecework basis, letting earnings fall as the workload falls, until the guaranteed rate is reached. Whether this type of straight piecework plan or a plan with makeup should be adopted depends on the desires of individual companies. Worker acceptance may be easy to secure in some cases, difficult in others.

Although manual effort is a basic unit of measure for type 1 operations, some consideration should be given to the possibility of measuring additional factors such as quality of work and promptness in doing available work.

Type 2 - The worker performs mostly manual work in operating a machine but does not have complete control over the amount he produces due to restrictions in machine capacity.

Plan B is a simple and adequate payment plan for a particular operation of this type in which machine utilization was the only basis of measure.

Other type 2 operations may require measures of quality, amount of wasted materials, and worker effectiveness in caring for equipment or machinery.

A ceiling on opportunity is implied by the nature of the operation. Premium should be sufficient to motivate the worker to attain the maximum possible effectiveness.

Type 3 - The worker services a machine or group of machines which operate automatically.

The basic measure in this type of operation is control of machine productivity by controlling downtime. A common additional measure is quality. The primary objective is to get maximum machine utilization in producing good product.

Some consideration should be given to the care which the workers take of the machinery and equipment. They should not be permitted to squeeze extra production out of the machine which might cause the machine to break down later.

Manual effort is normally of no importance to the overall effectiveness of this type of operation except when manual work is done during downtimes.

In some situations it may be desired that manual effort be tied into the premium payment simply to recognize the level of worker activity. If the recommendations were strictly followed, recognition of the manual effort requirements would be made in the base rate. However, at the present time, it may not be feasible to make the necessary changes in the wage structure. Also, the workers may not fully appreciate the concept that overall effectiveness rather than manual effort is important. Although the reasons given are not particularly sound, they do emphasize the need to do what is best now. Changes may be made gradually and less painfully later. On the other hand, this may set a precedent which can be expensive to correct. Plans C and F use manual effort as a basis and also consider other factors, C being a more comprehensive plan than F.

Plans E and G do not consider manual effort at all in measuring worker effectiveness.

Type 3 operations include many of the automatic or automated operations in industry today. In these operations the limited control of the worker may be very important economically since idleness of this highly productive equipment is generally very costly. Whether the worker performs maintenance when stoppages occur, replenishes the material when exhausted, or makes inspections and machine adjustments, he is controlling a valuable part of the total operation.

Type 3 operations will probably be the "bread and butter" operations for application of limited control incentive plans. The

general discussions in this paper have been aimed at this type of operation although the principles apply to all the types of operations.

Type 4 - The worker attends a continuous processing machine.

This is the most difficult type of operation from the standpoint of measuring worker effectiveness. Normally workers on such operations merely observe the operation and are needed mainly in case of equipment breakdown. As a result, it is often difficult or unfeasible to place some of these operations on incentive.

Plan H attempted to provide incentive on a type 4 operation but succeeded mainly in paying a nearly constant premium. One good measure, steam economy, was devised, but it had a negligible effect on pay.

Incentive plans should be applied to type 4 operations only when sound measures of performance which will pay off economically can be found.

VI

SUMMARY

Incentive payment plans which will result in substantial gains to both the company and its workers can be devised for limited control operations. The underlying philosophy of such plans must be to pay the worker incentive premium based on only those factors of the operation over which he has control and which will result in gains to the company. The reward must be sufficient to motivate the worker to improve his performance.

Actual examples of successful incentive plans for limited control operations are proof that plans can be developed on both simple and complex foundations.

Regardless of the type of payment plan that is developed, there are principles which should be followed in order for the plan to be sound and successful. These principles (recommendations) may be summarized briefly as follows:

1. Determine the extent of incentive coverage by careful study and analysis of present and future considerations, both economic and otherwise.
2. Do not attempt to have incentive payment plans unless good management and supervision already exist. Wholehearted support and understanding must be developed by the workers, supervisors, management, and union.

3. Observe good worker motivation practices especially in offering sufficient incentive premium to stimulate improved performance.
4. Measure worker performance by actual contribution to the company in terms of productivity, quality, and operating costs rather than by manual effort alone.
5. Integrate or closely coordinate the functions of wage and salary administration and incentive payment.
6. Have an overall incentive framework within which equitable payment plans for individual operations can be tailor-made to suit the situation.

The development of sound incentive payment plans for limited control operations, due to the relative newness of the subject, offers a considerable challenge. There are no model plans available to solve all problems of incentive payment. However, good plans can be developed on a logical basis if (1) the problem and the nature of limited control operations are understood and (2) a sound grasp is had of the principles and techniques that are presented in this paper.

Much additional study is needed to help develop limited control incentive plans to a much higher degree than exists today. This paper has barely scratched the surface on some topics and has only presented food for thought rather than concrete solutions for others.

Some suggested subjects for further study are:

1. A study of motivation by both financial and non-financial means. Determination of the amount of premium which must be offered to get a worker to improve his performance. Investigation of the marginal value of added income as worker living standards rise.
2. Development of new measurement techniques for worker controlled factors other than manual effort or machine time. Increasing the use of statistical techniques in measurement.
3. Development of a complete integrated measurement of the whole job of a worker including base rate measures and incentive premium measures.

The economic importance of incentives for limited control operations is due to the high investment in the equipment operated or serviced by a worker. In one case, a one minute reduction of machine downtime each shift would save $50,000 per year. Even though the amount of control exerted over the operation by the worker may be limited, the dollar value of that control is generally greater than that of a comparable hand-paced operation. Therefore, little changes in worker performance cause large gains or losses to the company. For these reasons it is desirable to have incentive payment plans which will deter the worker from poor performance and motivate him to greater effectiveness.

We can expect to have more and more limited control operations in the future due to technological advancement.

There will always be operations which cannot be economically put on incentive because of high costs of measurement and administration and/or low gains to the company. Before arbitrarily drawing a conclusion that incentive payment is impractical, a thorough analysis should be made of the operation in question. The only reason workers are put on a job is because they are needed to contribute to the overall operation.

No company should undertake incentive payment plans for limited control operations as a substitute for good management and administration. Incentive plans are a tool to be used as a supplement to help secure increased effectiveness. No plan can be better than the people who develop and administer it. Experience has shown that the companies which enjoy the greatest success with incentive plans are those which have good employee relations and good management at all levels of supervision.

The purpose of this paper has been to show how sound incentive payment plans can be applied to limited control operations with resultant gains to both the company and the workers. Emphasis has been placed on the philosophy that such payment plans must be developed by measuring overall worker performance on the factors of production controlled by the worker rather than by measuring manual effort or "busy"ness alone. Several examples of current plans were given to clarify the problem and present some approaches to it. A general

discussion (whether or not to have incentives, motivation, measurement, and economics) presented ideas, techniques, and problems of incentive payment for limited control operations. Finally a list of recommendations was given.

The author sincerely hopes that the material presented here has been effective in (1) convincing the reader of the importance and feasibility of incentives for limited control operations, (2) presenting techniques and ideas which will be helpful in developing such plans, and (3) stimulating creative thought which will result in better ideas, techniques, and incentive plans for the future.

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VITA

Biographical Sketch

Birthplace——————————————Richmond, Virginia, June 3, 1931.

Early Education———Lawrenceville Public Schools, Lawrenceville, Virginia.

Undergraduate Work—Virginia Polytechnic Institute, Blacksburg, Virginia; B. S. in Industrial Engineering, 1952.

Military Service———U. S. Air Force, two years, 1952-1954, First Lieutenant, Manpower Management Officer. Special training: Associate Infantry Company Officer's Course, Fort Benning, Georgia; Manpower Management Officer's Course, Scott AFB, Illinois.

Work Experience———Eastman Kodak Company, Rochester, New York, one and a half years, 1952-1956 (interrupted by military service and graduate studies). Position: Industrial Engineer, Work Measurement Department. Duties: Development of incentive payment plans; standard setting for incentive payment.

Present Employment: Virginia Polytechnic Institute, Blacksburg, Virginia, one and two thirds years, 1956-1957. Position: Instructor of Industrial Engineering.

Enrolled in graduate school, Virginia Polytechnic Institute, January, 1956.

Married to Margaret Ann Irland, no children.

J. Landon Short
August, 1957

APPENDIX A

Plan A

Description of the Operation

Plan A is especially designed for manual effort operations which may be alternately hand-paced or schedule-paced (limited control) due to uncertainty of the availability of work. It is being applied to a laboratory operation in which a worker performs a chemical analysis on product samples. This is normally a one man job, but the workload may vary to require a high of one and a half men or a low of only one half man (working at 100% effectiveness) for a given shift. When the workload is low (less than a one man job) it is still necessary to keep a man in the lab because samples arrive randomly and must be handled quickly. There are no other jobs which can be given the worker in the lab to fill the remainder of his time. When the workload is high (more than a one man job) additional help may be secured for the lab worker.

Philosophy of the Payment Plan

Manual effort is the fundamental basis for incentive payment in this plan. Incentive premium is paid to encourage the worker to handle as much work as possible without using additional help. In this respect it is similar to straight piecework plans. However, consideration is made of the facts that workload is often too low to keep the worker 100% busy and that true manual effort is not always equal to production effectiveness.

Conventional standard times are set on a per occurrence basis for all operations performed by the worker assuming that there is enough work available for him to be 100% busy. By dividing standard hours earned by actual hours worked a production effectiveness is calculated.

Two adjustments are made to convert the production effectiveness to pay percent.

The first adjustment converts production effectiveness to true manual effectiveness. Studies have shown that, because the worker can organize his work in larger units and, therefore, work more effectively as the workload increases, true manual effectiveness is only 80% variable with respect to production effectiveness calculated from the standards. True manual effectiveness is the percent that ideally would be paid if the operation were completely hand-paced.

The second adjustment adds a makeup percent to the true manual effectiveness in order to get the pay percent. This is done to compensate the worker when "true manual effectiveness" is low due to lack of work which is not the worker's fault. Thus the company's desire is fulfilled that the worker have an opportunity to earn 27% premium above his daywork rate for average workload conditions if he works at a true 100% pace (equaling average earnings under a previous plan). When makeup is applied, pay percent is only 20% variable with respect to production effectiveness. No makeup is given above 110% production effectiveness. Every six months, makeup

is revised to meet average workload conditions. Therefore, makeup gets smaller as the operation approaches becoming completely hand-paced with no workload restrictions.

Description of the Payment Plan

I. Measure of Performance - Manual effort is the basic measure of performance. Standard times are set on a per occurrence basis for all operations performed by the worker. These standards reflect production output and are adjusted to show true manual effectiveness. Studies show that, when the worker earns 100% production effectiveness from the standards, he is actually performing at 100% true manual effectiveness. However, when 110% production effectiveness is earned, true manual effectiveness is only 108%. Likewise, 90% production effectiveness requires 92% true manual effectiveness. The explanation for this is given under "Philosophy of the Payment Plan."

II. Payment Procedure - Pay is calculated each shift as follows: (Makeup has been determined based on an average workload of 100% production effectiveness for the past six months and is shown on the chart used in the calculations.)

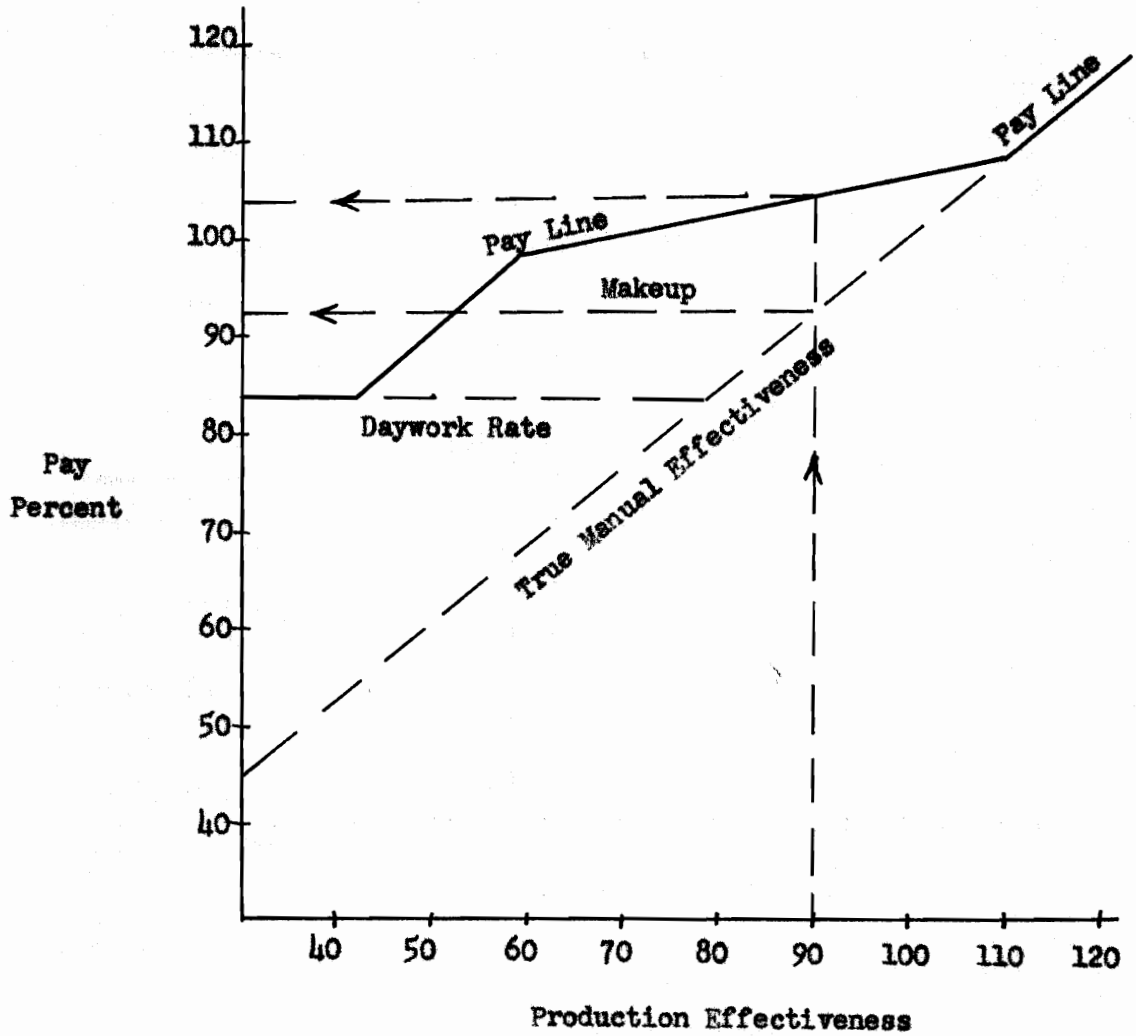
A. Calculate production effectiveness:

1. Standard hours = Production x Standards

2. Production effectiveness = $\frac{\text{Standard hours}}{\text{Actual hours}}$

B. Find pay percent (= true manual effectiveness + makeup) from the chart on page 125.

1. Read production effectiveness into the horizontal axis of the chart.
2. Go up to the pay line.
3. Go left and read pay percent from the vertical axis. (Notice that true manual effectiveness can be read from the vertical axis by going up to the true manual effectiveness line and left to the vertical axis. Make-up is equal to pay percent minus true manual effectiveness. When posting worker earnings, the makeup is posted also to impress the worker with the fact that he is receiving makeup.)



Pay Chart - Plan A

III. Example of Pay Calculation

A. Data:

1. Standard hours earned = 7.20
2. Actual hours = 8.00
3. Daywork rate = $2.00
4. Incentive rate = 120% x $2.00 = $2.40

B. Calculations:

1. Production effectiveness = $\frac{\text{7.20 Standard hours}}{\text{8.00 Actual hours}}$ = 90%
2. From chart:

   Pay percent = 104%

   True manual effectiveness = 92%

   Makeup = 12%
3. Pay = 104% x $2.40 x 8.00 = $19.97

Plan B

Description of the Operation

Plan B is an individual incentive plan for operators of a group of plastic molding machines. Each worker operates a single molding machine which has a cycle time of thirty seconds. The cycle time is broken down as follows:

9 seconds - Machine opens, worker removes molding with tongs and inserts plastic preform for next molding, machine closes. A worker working at a normal 100% pace can perform the manual work in seven seconds.

21 seconds - Machine operation time. During this time the worker cuts sprues and flash from previous molding, puts the molding in a container, and gets ready to remove next molding and insert the preform when the machine opens. A worker working at a normal 100% pace can perform the manual work in 15 seconds.

The machine cycle time is fixed and cannot be shortened. If the worker is slow and gets behind he may keep the machine open in excess of nine seconds by a foot operated control. The worker has no control over product quality.

The worker is at work eight hours each shift, but he must take two mandatory 10 minute personal breaks and a mandatory 30 minute lunch break at specified times. Therefore, seven hours and 10 minutes (430 minutes) are available for machine operation.

Philosophy of the Payment Plan

Obviously, in this case, the maximum productive output of the worker is limited by the machine capacity. The only control exerted by the worker is his manual effort in maintaining the machine cycle. Plan B is designed to give monetary incentive to the worker to get maximum utilization from the machine by measuring his actual performance against the maximum possible performance.

Description of the Payment Plan

I. Measure of performance - Effectiveness of performance of the worker is measured by dividing actual production by maximum possible production. Thus, the worker is working at 100% effectiveness when he maintains the machine cycle throughout the shift. In this case maximum production is 860 moldings per shift. (430 work minutes ÷ 1/2 minute cycle time = 860)

II. Payment procedure - Pay is calculated for each shift as follows (assume the worker works a full eight hour shift):

A. Calculate percent effectiveness by dividing actual production by 860.

B. Determine pay percent by adding 5% to the percent effectiveness.

C. Pay = Pay percent x Actual hours x Incentive rate

Where: Pay percent is described above.

Actual hours is the number of hours the worker is at work.

Incentive rate is 120% x Daywork rate for the job.

III. Example of Pay Calculation

A. Data:

1. Actual production = 851 moldings
2. Daywork rate = $2.00
3. Incentive rate = $2.00 x 120% = $2.40
4. Actual hours = 8 (430 minutes on the job plus 30 minute lunch plus 20 minutes personal)

B. Calculations:

1. Percent effectiveness = $\frac{851}{860} \times 100 = 99\%$
2. Pay percent = 99% + 5% = 104%
3. Pay = 104% x 8 hours x $2.40 = $19.97

Plan C

Description of the Operation

Plan C is suitable as a group or individual plan for almost any operation but is best for situations in which the worker services a machine or group of machines which operate automatically and in which the worker performs mostly manual work in operating a machine having production restricted by the machine's capacity. In these operations, manual effort is of some importance, but other factors controlled by the worker such as quality and downtime may be more important in increasing the output of good product.

A typical application of this plan will be used for illustrative purposes. Consider a centrifuge used for refining a liquid product to separate a basic product from oily waste. The worker is about 85% busy with manual work. In operating the centrifuge he controls process output and refining losses. Process output is the amount of good product turned out of the centrifuge. It may be increased by proper machine operation and reduction of downtime. Refining losses are losses of good product which is drawn off with the oily waste. Good worker performance results in high process output and low refining losses.

Philosophy of the Payment Plan

Incentive pay varies with respect to manual effort and control of other factors by the worker such as downtime and quality. Each

operation to be placed on incentive is carefully studied to determine manual effort requirements, worker controlled factors of importance, and the relative importance of these worker controlled factors. A payment plan is then set up which will pay incentive for manual effort and other important factors in relation to the importance of the factors.

No operations requiring less than 70% manual effort on the average are put on incentive. The company reasons that any worker who is less than 70% busy should get satisfactory results on all factors without added incentive. Jobs are generally established with manual requirements significantly over 70% in order to get a full day's work and to avoid borderline over-under 70% cases.

For performance on factors other than manual effort, more incentive premium is paid for increasing from 95% to 100% effectiveness than from 75% to 80% effectiveness, etc. As performance improves it becomes more difficult to make further improvements and, therefore, more premium is offered. No premium is paid for performance below 70% effectiveness on these factors.

Above 143% manual effort effectiveness, no premium is paid for effectiveness in controlling other factors because it is felt that, at such a level, the worker is too busy manually to handle other matters.

Equipment is always operated at its rated capacity even when production requirements are low. In such cases, operation is for

shorter periods of time. Thus the worker never loses premium because of machine restrictions as long as he can be assigned to a machine on incentive.

Description of the Payment Plan

I. Measures of performance - Performance is measured on the basis of (A) manual effort and (B) "other factors" such as quality and machine effectiveness.

A. Standard times are set for all manual work performed by the worker for both machine operation time and downtime on a per occurrence basis. (These standard times are a sort of low task standard being more liberal than the standard time defined in the text of this paper. It is estimated that 100% performance on these standards is equal to about 85% performance on high task standards.)

In the centrifuge example used here, manual effort requirements for a routine day are 6.80 standard hours or 6.80 ÷ 8.00 = 85% manual effort effectiveness.

B. "Other factors" are measured on the basis of ideal performance being 100%. Selection of other factors is made after studies and analysis to determine (1) what factors does the worker control? (2) to what extent does he control these factors? and (3) what is the relative importance of the worker controlled portion of the factors in terms of cost savings? Typical factors measured include machine productive

efficiency, steam useage, percent scrap, level of quality, percent of useful by-product, density, color, etc. Studies are used to determine the ideal or 100% performance levels and to empirically designate percent effectiveness measures for other levels of performance. (In some cases the worker can better the 100% level of performance, but he cannot "earn" over 100% for that particular factor.) When more than one factor is measured for payment purposes, these factors are weighted as to their importance so that a single "other factors percent effectiveness" can be calculated to use with the manual effort percent in determining pay.

Two factors are measured in the centrifuge operation, namely, process output and refining losses.

1. Process output is based on the maximum output capacity of the centrifuge. 650 pounds per hour equals 100%. Process output effectiveness is actual output divided by 650 pounds per hour.
2. Ideal refining losses are determined by running laboratory centrifuging tests. 100% effectiveness is earned by equaling the ideal loss which is 0.30% of the good product. For every 0.01% that actual losses exceed ideal loss, effectiveness is reduced 1%.
3. Studies show the following savings for increases in effectiveness per 1,000 pounds of product:

1% increase in process output effectiveness saves $0.80.

1% increase in refining losses effectiveness saves $2.50.

Therefore, the weighting of the factors for pay purposes

is $\frac{\$0.80}{\$2.50 + \$0.80}$ = 24% for process output

and $\frac{\$2.50}{\$2.50 + \$0.80}$ = 76% for refining losses.

II. Payment Procedure - Pay for the worker is calculated each shift as follows:

A. Determine manual effort percent.

B. Determine the effectiveness percent for all "other factors."

C. Calculate the weighted average or "other factors percent effectiveness" for effectiveness percents of the other factors.

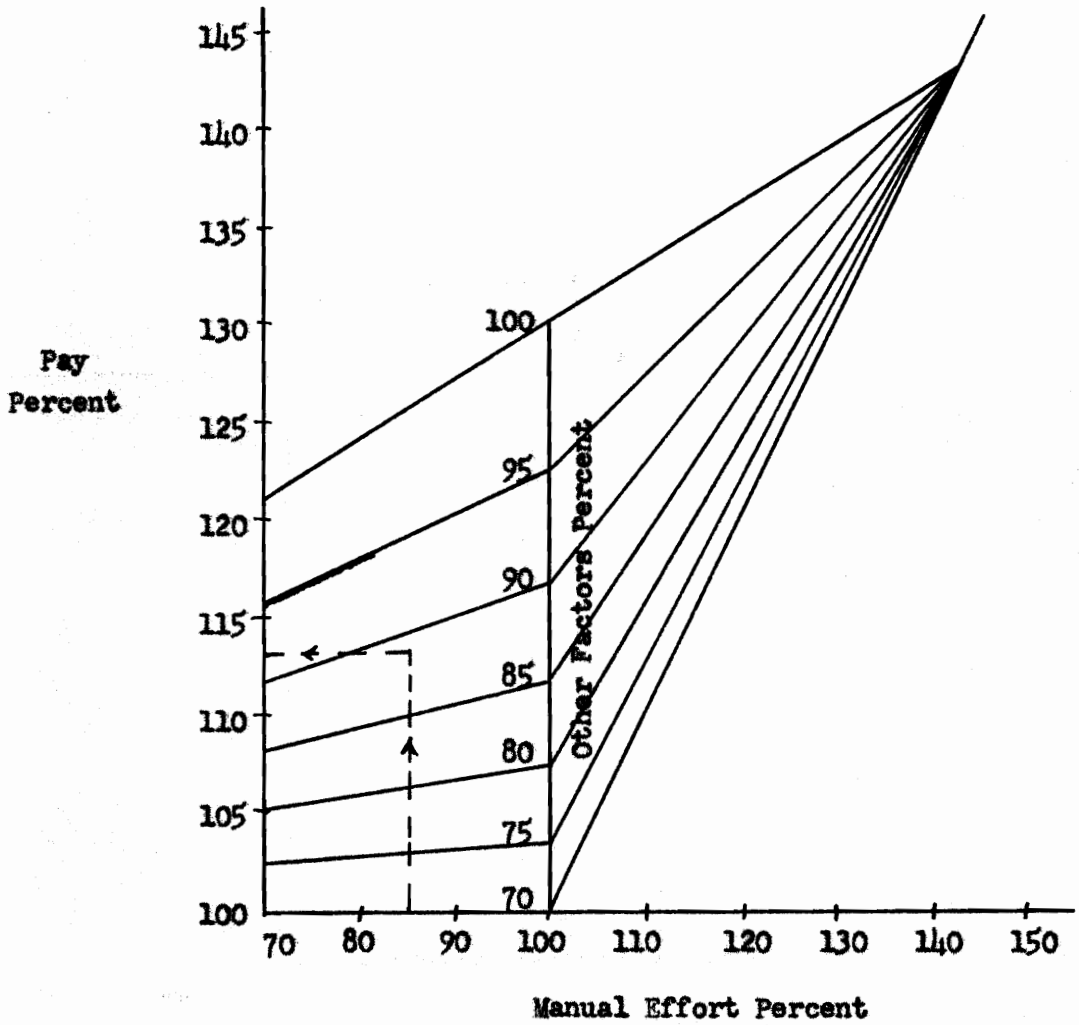
D. Determine "Pay percent" from the chart on page 135 which applies to all operations covered by this plan.

1. Locate the actual "manual effort percent" on the horizontal axis.

2. Go straight up until the line representing actual "other factors percent effectiveness" is reached.

3. Go horizontally to the left and read the "pay percent" on the vertical axis.

E. Pay = Pay percent x Daywork rate x Actual hours.



Pay Chart - Plan C

III. Example of Pay Calculation

A. Data:

1. Standard hours for manual work = 6.80
2. Process output: Standard = 650 pounds per hour

   Actual = 600 pounds per hour
3. Refining losses: Standard = 0.30%

   Actual = 0.42%
4. Weighting of other factors: Process output - 24%

   Refining losses - 76%
5. Actual worker hours = 8.00
6. Daywork rate = $2.00

B. Calculations:

1. Manual effort percent = $\frac{\text{6.80 std. hrs.}}{\text{8.00 actual hrs.}}$ = 85%

2. Process output effectiveness = $\frac{\text{600 actual lbs./hr.}}{\text{650 standard lbs./hr.}}$ = 92%

   Refining losses effectiveness =

$$100\% - \frac{(0.42\% \text{ actual} - 0.30\% \text{ standard})}{.01\%} = 88\%$$

3. Other factors percent effectiveness (weighted average)

   = 24% x 92% process output + 76% x 88% refining losses = 89%.

4. From the chart, 85% manual effort percent and 89% other factors percent effectiveness gives 113% pay percent.

5. Pay = 113% x $2.00 x 8.00 = $18.08

Plan D

Description of the Operation

This group incentive plan was designed for crews operating a special type of automatic processing equipment. The operation consists of a battery of machines each of which processes several variations of a liquid product. Usually a crew of five men operates each machine. Crew sizes are set by supervision. Men may be added or taken away when necessary. Finished product is placed in cans of 200 pounds gross weight each. Full and empty cans are handled by hoists and are transported on four-wheeled dollies which are pushed by hand. The speed at which the machine operates is determined by a product supervisor and is not under the crew's control. From three to 30 cans of product are produced in an eight hour shift.

Operation of the machine is automatic but close observation or attention by the crew is necessary because frequent control adjustments are needed to maintain satisfactory quality. The machine operates continuously except for scheduled stoppages for product change, cleanup, machine adjustments, and minor maintenance. Standard times for these downtimes range from four to 60 minutes each; the number of downtimes ranges from none to 12 per shift. Longer downtimes for major maintenance or cleaning may be scheduled periodically.

The product produced by the machine is classified as standard or waste. Waste product may or may not be the crew's fault. For

example, failure to keep the machine adjusted properly would be the crew's fault, but inferior raw materials would not.

Manual work is largely confined to the handling of the cans and the work done during the downtimes. The workers average being between 50% and 75% busy. They eat lunch and take personal breaks one at a time when they can be spared without affecting the machine's operation.

Philosophy of the Payment Plan

The aim of the plan is to give monetary incentive to the crew to increase the output of good product by minimizing downtime and waste and at the same time to have pay vary as manual effort varies.

Incentive bonus is earned for output in two ways: Bonus is paid for all time the machine runs standard product, and bonus is paid for performing downtime operations in less time than the allotted standard time for the downtime. In this manner pay increases as the effectiveness of operation of the machine increases.

Since manual effort for this operation is extremely difficult to measure, and since it was known that manual effort varies directly as the number of cans filled and downtimes encountered, a relative activity type of payment was devised for manual effort. In this plan the crew with the most cans and downtimes receives the most bonus for manual effort. The bonus is periodically adjusted to average five percent. The adjustment serves to keep pay from going out of control if the average number of cans and downtimes increases over a long period of time. It was desirable to have this control since no real

measurement was made to establish manual effort standards. This measure does recognize relative differences in manual effort among crews on the same shift and for the same crew on different shifts.

Crew labor hours do not enter into the calculation of pay. When crew size varies, the pay percent still is calculated the same for all crew members.

Description of the Payment Plan

I. Measures of performance - Performance of each crew is measured on the basis of (A) machine effectiveness, and (B) relative activity.

A. Machine effectiveness

1. For every hour the machine runs "run time standard hours" are earned in accordance with the following table:

1.0 Std. hr. - Standard product

1.0 Std. hr. - Waste, crew not responsible

0.9 Std. hr. - Waste, responsibility undertain

0.0 Std. hr. - Waste, crew responsible

These classifications are made by the production supervisor. The crew can appeal any decision, but the burden of proof lies with the crew. (Disputes rarely occur, since the product supervisor carefully investigates the causes of all waste.)

2. Standards based on time studies (leveled but with no allowances added) are set for all types of routine

downtimes. When a downtime occurs, "downtime standard hours" are earned equal to the standard for that particular downtime. For example, if a downtime standard is 0.4 hours then 0.4 standard hours are earned every time that downtime occurs.

3. "Machine time on incentive" is all time except time the machine is used for experimental work plus time the machine is idle for any reason except scheduled downtimes for which standards exist.

4. Machine effectiveness is calculated from the following formula:

$$\text{Machine eff.} = \frac{\text{Run time std. hrs.} + \text{Downtime std. hrs.}}{\text{Machine time on incentive}}$$

B. Relative activity

1. The average number of cans filled per machine hour on incentive and the average number of standard downtimes per machine hour on incentive are calculated for all machines combined.

2. A table (table #2, page 145) is maintained which indicates a 5% bonus for the average number of cans and downtimes and bonuses ranging from 0 to 10% for other combinations.

3. The table is adjusted every six months to keep the average bonus at 5%.

II. Payment procedure - Pay is calculated for each crew member for each shift as follows:

A. Find "machine pay percent" by calculating machine effectiveness and reading it into table #1 (page 144). The formula for machine effectiveness was given earlier.

B. Find "relative activity pay percent" by calculating actual cans per hour and standard downtimes per hour and reading them into table #2 (page 145). For example, if 20 cans were filled and machine time on incentive was six hours, actual cans per hour = 20/6 = 3.33.

C. Find "Pay percent" which is the sum of "machine pay percent" and "relative activity pay percent." All members of a crew receive the same "pay percent."

D. Pay = Pay percent x Actual hours on incentive x Incentive rate

Where: Pay percent is described above

Actual hours on incentive is the number of hours the crew member was assigned to the machine while the machine was on incentive.

Incentive rate is 120% x the daywork rate for the job being performed by the crew member.

III. Examples of Pay Calculation

Example #1

A. Data:

1. Machine run time standard hours = 7.07

(The machine operated 7.07 hours and produced all standard product.)

2. Downtime standard hours = 1.00

   (One product change, standard = 1.00 hour, was performed in 0.93 actual hours.)

3. Machine time on incentive = 8.00 hours

   (7.07 operating hours + 0.93 downtime hours.)

4. For activity chart (table #2)

   19 cans filled = 19/8 = 2.4 cans per hour

   1 downtime = 1/8 = 0.1 downtime per hour

5. Daywork rate = $2.00

6. Incentive rate = $2.00 x 120% = $2.40

7. Actual crew member hours on incentive = 8

B. Calculations:

1. Machine effectiveness = $\frac{7.07 + 1.00}{8.00}$ = 1.01

   From table #1: Machine pay percent = 101%

2. From table #2: Relative activity pay percent for 2.4 cans per hour and 0.1 downtime per hour = 4%.

3. Pay percent = 101% and 4% = 105%.

4. Pay = 105% x 8.0 hours x $2.40 = $20.16

<u>Example #2</u>

A. Data:

1. Machine run time standard hours = 6.47

2. Std. product produced for 5.23 hrs. = 5.23 std. hrs.

3. Waste: Crew not responsible; produced for 0.34 hours = 0.34 std. hrs.

4. Waste: Responsibility uncertain; produced for 1.00 hrs. = 0.90 std. hrs.

5. Waste: Crew responsible; produced for 0.85 hrs. = 0.00 std. hrs.

Totals: 7.42 machine operation hrs.; 6.47 std. hrs.

6. Downtime standard hours = 0.38

One speed change, std. = 0.20 hrs., performed in 0.20 actual hours.

One washup, std. = 0.18 hrs., performed in 0.38 actual hrs.

Totals: 0.58 actual hrs.; 0.38 std. hrs.

7. Machine time on incentive = 8.00 hours

(7.42 operating hours + 0.58 downtime hours)

8. For activity chart (table #2)

15 cans filled = 15/8.0 = 1.9 cans per hour

2 downtimes = 2/8.0 = 0.3 downtimes per hour

9. Daywork rate = $2.00

10. Incentive rate = $2.00 x 120% = $2.40

11. Actual crew member hours on incentive = 8.0

B. Calculations:

1. Machine effectiveness = $\frac{6.47 + 0.38}{8.00}$ = 0.86

From table #1: Machine pay percent = 91%

2. From table #2: Relative activity pay percent for 1.9 cans per hour and 0.3 downtimes per hour = 4%

3. Pay percent = 91% + 4% = 95%

4. Pay = 95% x 8.0 hours x $2.40 = $18.24

Table #1

Machine Pay Percent

Machine Effectiveness	Machine Pay Percent
.00 - .25	83
.26 - .45	84
.46 - .60	85
.61 - .70	86
.71 - .75	87
.76 - .79	88
.80 - .82	89
.83 - .85	90
.86 - .87	91
.88 - .89	92
.90 - .91	93
.92 - .93	94
.94 - .95	95
.96	96
..97	97
.98	98
.99	99
1.00	100
1.01	101
1.02	102
1.03	103
1.04	104
1.05	105
1.06	106
1.07	107

Table #2

Relative Activity Pay Percent

Downtimes per hour	Cans per hour						
	0.5	1.0	1.5	2.0	2.5	3.0	3.5
0.0	1	2	2	3	3	4	4
0.1	1	2	3	3	4	4	5
0.2	2	2	3	4	4	5	5
0.3	2	3	3	4	5	5	6
0.4	3	3	4	4	5	6	6
0.5	3	3	4	5	5	6	7
0.6	3	4	4	5	6	6	7
0.7	4	4	5	5	6	7	7
0.8	4	4	5	6	6	7	8
	Relative Activity Pay Percent						

Notes: 1. For simplicity some values are omitted.

2. For past six months:

Average cans per machine hour on incentive = 2.5

Average standard downtimes per machine hour on incentive = 0.4

Plan E

Description of the Operation

Plan E is a group incentive plan for crews operating a special type of continuous automatic processing equipment. The operation consists of a number of large machines which extrude continuous strips of a plastic product at a constant speed of 40 feet per minute. Finished product is wound onto large reels in lengths of 3,000 feet and gross weight of about 350 pounds each. Reels are handled manually with hoists and monorails.

The speed at which the machine operates is established by supervision and is not controlled by the workers. Main duties of the crew members are to constantly observe the operation of the machine, to make necessary adjustments to keep it operating properly, to handle the product, to perform miscellaneous clerical duties, and to perform scheduled operations such as minor cleanup, size change, etc. Normal crew size is two to four men, and either one or two machines is assigned to each crew. Crew size and machine assignments are determined by supervision. The crew members average being about 50% busy.

The complexity of the machine and process leads to frequent troubles resulting in non-standard or waste product being produced. Alert crew performance can prevent some of these troubles but not all of them. Also, good crew performance can reduce waste by hastening corrections when troubles do occur.

Due to the difficulty of machine start-up which requires a skilled crew several hours to get the product running satisfactorily, it is normally an economical practice to run waste product (which can be reclaimed) while troubles are being located and corrections made. Only in cases of major difficulty is a machine shut down.

Philosophy of the Payment Plan

This plan is designed to pay some incentive bonus for all time that good product is being produced. Pay equal to 105% times the daywork rate is guaranteed while on incentive. For every hour which good product is produced an incentive premium of 20% of the daywork rate is paid. Thus a maximum premium of 20% of daywork rate is possible for production alone. In addition, waste allowance standards are established on the basis of previous performance which, if bettered, may result in some extra premium. Some waste is run intentionally according to instructions from supervision for which full premium is paid. Other operational waste normally earns no premium payment regardless of whether or not the workers cause it. Thus, workers earn incentive premium by preventing waste through alert operation and by correcting troubles which occur as quickly and efficiently as possible. Waste which is run intentionally per supervisory instructions plus an amount of waste equal to that allowed by waste allowance standards is called authorized or allowed waste and earns premium. All other waste is unauthorized and earns no premium.

Description of the Payment Plan

I. Measures of performance - The following factors are used in measuring performance: (A) Total hours on production, (B) hours during which good product is produced, (C) waste allowance, (D) standard hours of scheduled waste, and (E) authorized waste hours.

A. Total hours on production is the total time the crew is assigned to operate a machine or machines.

B. Hours during which good product is produced is determined from production records. (Total hours on production-- waste hours = hours of good product.)

C. A standard waste allowance is established for each machine based on the average percent of unscheduled and unauthorized waste for the previous six months. Standard waste allowances are revised every six months. To insure that workers always have an opportunity to better the standard waste allowance, no allowances may be less than 1%. Standard hours for the waste allowance are calculated as follows: Std. waste allowance hours = Std. waste allowance percent x actual hours on production.

D. Standard waste hours are standard hours earned for waste which is run while scheduled operations such as minor cleanup, size change, etc. are being performed. Time standards are set for these types of operations. If a

cleanup standard is one hour, one standard hour of scheduled waste is earned regardless of the time taken by the workers to perform the cleanup.

E. Scheduled waste hours are standard hours earned to compensate for waste which is run during occurrences such as product change, defective raw material, and experimental work. There are no time standards for these operations, and one standard hour is earned for every actual hour taken.

II. Payment procedure - Pay is calculated for each crew member for each shift as follows:

A. Calculate the fixed guaranteed pay from the formula:

Fixed pay = 105% x Daywork rate x Actual hours

B. Calculate premium hours for each machine assigned as follows:

Premium hours = Hours of good product + Standard waste allowance hours + Standard waste hours + Scheduled waste hours.

C. Calculate average premium hours earned for the machines operated.

D. Calculate premium pay using the formula:

Premium pay = 20% x Daywork rate x Average premium hrs.

E. Pay = Fixed pay + Premium pay

III. Example of Pay Calculation

A. Data:

1. A crew of three men is assigned to operate two machines, A and B.

2. Machine A

Actual hours on production = 8.00

Hours of good product = 7.97

Standard waste allowance = 1.00%

No standard waste hours or scheduled waste hours

3. Machine B

Actual hours on production = 8.00

Hours of good product = 4.25

Standard waste allowance = 1.87%

Minor cleanup: Standard waste hours = 0.12

Defective materials caused 0.28 hours of waste:

Scheduled waste hours = 0.28

Each crew member works 8.00 hours.

Daywork rate = $2.00

B. Calculations

1. Fixed pay = 105% x $2.00 x 8.00 = $16.80

2. Premium hours:

Machine A

Hours of good product	= 7.97
Std. waste allowance hrs. = 1.00% x 8.00 hrs.	= 0.08
Machine A premium hrs.	= 8.05

Machine B

Hours of good product	= 4.25
Std. waste allowance hours = 1.87% x 8.00 hrs.	= 0.15
Std. waste hours	= 0.12
Scheduled waste hours	= 0.28
Machine B premium hrs.	= 4.80

3. Average premium hrs. $= \frac{8.05 + 4.80}{2} = 6.43$

4. Premium pay = 20% x \$2.00 x 6.43 = \$2.57

5. Pay = Fixed pay + Premium pay = \$16.80 + \$2.57 = \$19.37

IV. Notes on the Payment Plan

A. Average conditions of production at which unscheduled and unauthorized waste is equal to the standard waste allowance result in earnings of 25% above the daywork rate.

B. Since 105% of the daywork is fixed and guaranteed, only the premium may vary. No premium is earned (except for the waste allowance) when nothing but waste is produced, and 20% premium is earned when no waste occurs (again excluding the waste allowance). Therefore, pay is only 20% variable with respect to production. A 5% increase in good product is needed to earn a 1% increase in pay.

Plan F

Description of the Operation

This plan is applicable to almost any operation but is especially designed and suited for "automated" or mechanized operations in which the worker services a machine or group of machines which operate automatically.

For illustrative purposes we shall consider this plan in a typical application in which a single worker services two automatic machines which package a dry food product in small paper boxes. The worker's duties include observing machine operation and material flow making necessary minor adjustments, recording production, and weighing samples of the packaged product. He is about 90% busy servicing three machines.

The worker controls the quality of output with respect to weight and condition of the package but not with respect to the food product itself. Machine speeds are fixed and constant, but the worker controls production output to some extent by his effectiveness in adjusting and servicing the machines.

Philosophy of the Payment Plan

The fundamental idea behind this plan is to measure worker productivity rather than machine productivity.

Pay is related primarily to manual effort of the worker, but adjustments are made for quality and for production effectiveness (actual production divided by standard production at machine

capacity). If a job is worth 7.00 standard hours of manual effort, and if actual production effectiveness is only 90% of machine capacity, then 7.00 x 90% = 6.30 standard hours will be used in the pay calculation. If the worker worked 8.00 hours, his effectiveness would be 6.30 ÷ 8.00 or 79%. Quality adjustments are made in a like manner.

Incentive pay is based on the percent effectiveness. For 67% effectiveness, 100% of the daywork rate is paid; and, for every 2% increase in percent effectiveness above 67%, a 1% incentive bonus is earned. Incentive bonus (based on the measure of manual effort) is earned by maintaining quality, by keeping the machine operating at standard production, and by reducing downtime.

Description of the Payment Plan

I. Measures of performance - Measures consist of (A) time standards for the worker's manual work, (B) production effectiveness of the machine, and (C) quality performance.

A. Standard times are set for all work done by the operator on a per occurrence basis including both physical effort and machine watching work.

1. Machine operation standards of standard man hours per machine hour are established for each machine based on the time standards. These standards include all operator work such as observing, adjusting, recording, and sampling. They are useful in determining the number of machines a single operator can tend and in

balancing workloads among operators. For example, if a machine operation standard is 0.03 man hours per machine hour, three such machines could be assigned to a single operator. Standards may exceed 1.00 standard man hours per actual hour for some assignments. In these cases the worker can increase his pace to above 100%, giving him a high earning potential.

2. Downtime standards for operations such as clean-up and product change are set and expressed as standard hours per occurrence.

B. Production effectiveness percent is calculated from the formula: $\frac{\text{Actual production per machine hour}}{\text{Standard production per machine hour}}$

Standard production per machine hour is based on studies and machine capacity. If the machine's standard production is 100 boxes per hour, and the worker only produces 90 boxes per hour on the machine, the production effectiveness is $\frac{90}{100} = 90\%$.

II. Payment Procedure - Pay for the worker is calculated each shift as follows:

A. Calculate the production effectiveness percent for each machine being operated using the formula given previously.

B. Calculate standard man hours allowed for each machine's operation as follows:

Machine operating hours x Standard man hours per machine hour x Production effectiveness x Quality performance.

C. Find total standard man hours allowed as follows:

Standard man hours allowed for machine operation + Downtime standard hours.

D. Determine percent effectiveness:

$$\frac{\text{Total standard man hours allowed}}{\text{Actual hours on incentive}}$$

E. $$\text{Pay} = \left(100\% + \frac{\text{Percent Eff.} - 67\%}{2}\right) \times \text{Daywork rate} \times \text{Actual hrs.}$$

(100% x Daywork rate is guaranteed)

III. Example of Pay Calculation

A. Data:

1. Worker services three machines, 1, 2, and 3.
2. Standard man hours per machine operating hour = 0.30 for each machine.
3. Quality performance is 100%.
4. Standard production is:

   100 boxes per hour on machine 1

   100 boxes per hour on machine 2

   120 boxes per hour on machine 3

5. Actual production for eight hours is:

   700 boxes on machine 1 (87.5 boxes per hour)

   720 boxes on machine 2 (90.0 boxes per hour)

   860 boxes on machine 3 (107.5 boxes per hour)

6. All three machines operate 7.00 hours.

7. All three machines have a product change;

   standard = 0.50 standard hours per occurrence

8. All three machines have a cleanup;

   standard = 0.25 standard hours per occurrence

9. Daywork rate = $2.00

10. Actual hours worked = 8.00

B. Calculations:

1. Production effectiveness percent:

   Machine 1: $87.5 \div 100 = 87.5\%$

   Machine 2: $90.0 \div 100 = 90.0\%$

   Machine 3: $107.5 \div 120 = 89.6\%$

2. Standard man hours allowed for machine operation:

   Machine 1: $7.00 \times 0.30 \times 87.5\% \times 100\% = 1.84$

   Machine 2: $7.00 \times 0.30 \times 90.0\% \times 100\% = 1.89$

   Machine 3: $7.00 \times 0.30 \times 89.6\% \times 100\% = 1.88$

   Total $= 5.61$

3. Total standard man hours allowed

   $5.61 + (3 \times 0.50) + (3 \times 0.25) = 7.86$

4. Percent effectiveness:

   $7.86 \div 8.00 = 98\%$

5. Pay $= (100\% + \frac{98\% - 67\%}{2}) \times \$2.00 \times 8.00 = 115.5\% \times \$2.00 \times 8.00$

   $= \$18.48$

Plan G

Description of the Operation

This is a group incentive plan for loom fixers in a weaving operation. A loom fixer is a worker who is responsible for keeping a number of looms operating and in adjustment. He is a machine tender or "downtime eliminator" rather than a machine operator or maintenance repairman. Crew size is established by supervision and is based on the number of looms assigned to the crew. Usually there are three loom fixers per 100 looms. Each crew is a group for incentive pay purposes.

A loom fixer may minimize downtime by making adjustments rapidly and by making adjustments properly so that fewer adjustments will be needed later. The loom fixers are well trained and experienced and realize that hasty but poor present adjustments may cause excessive downtime later.

The product produced in this case is a cloth woven of heavy twisted paper which will be used to make bags for packaging citrus fruits. All looms are of the same type and run at a constant speed of 160 picks per minute (a pick is a loom unit of production).

Machine operators, the direct labor in this case, are covered by another incentive plan.

Philosophy of the Payment Plan

This plan is designed to give strong monetary incentive to the loom fixers to minimize downtime by performing their jobs quickly and properly. Theoretically, perfect performance would result in no downtime or 100% loom productive effectiveness. Performance is measured on the basis of actual loom productive effectiveness achieved by the fixers. Pay is based on the extent to which actual performance exceeds average performance prior to the introduction of this incentive plan. When certain downtimes occur which are not the fault of the fixers, allowances are made to prevent a loss of incentive bonus. Pay is calculated on a weekly basis in order to encourage the loom fixers to make good adjustments instead of hasty ones.

Description of the Payment Plan

I. Measure of performance - Effectiveness of performance of a crew of loom fixers is determined by dividing actual loom production by theoretical loom production. The amount by which effectiveness of performance exceeds a base effectiveness established by previous performance is the basis for calculation of the incentive bonus.

Effectiveness of performance is calculated weekly from the following formula: $\frac{\text{Total actual picks produced} + \text{Allowances}}{\text{Loom hours} \times 9600}$

Where: Total actual picks produced comes from production records.

160 picks are produced every minute the loom is running.

Allowances cover time lost for scheduled downtimes and other downtimes not the fault of the loom fixers. Allowances are expressed in picks at the rate of 160 picks per minute times the base effectiveness. Therefore, a 30 minute scheduled downtime would result in an allowance of 30 minutes x 160 picks per minute x 90% base effectiveness = 4320 picks. (Base effectiveness is described below.)

Loom hours is the number of hours the looms serviced by the crew of fixers were in production. This includes all downtimes and actual running time.

9600 is the maximum number of picks which can be produced in an hour of loom operation at the rate of 160 picks per minute. (160 picks per minute x 60 minutes per hour = 9600 picks per hour)

Base effectiveness is the actual effectiveness of performance earned on all looms combined for the six months immediately preceding installation of this payment plan. The base effectiveness in this case is 90% effectiveness of performance. If crew sizes vary or if the number of looms assigned to a crew varies from the usual three fixers per 100 looms, effectiveness of performance could be expected to vary accordingly. Therefore, management reserves the right to adjust the base effectiveness if the number of looms or crew size varies due to assignment changes.

II. Payment Procedure - Pay is calculated weekly as follows:

A. Base effectiveness is determined in advance. The usual base effectiveness is 90% for a three man crew tending 100 looms.

B. Calculate the crew's effectiveness of performance for the entire week using the formula given under measure of performance.

C. Calculate the bonus pay percent using this formula:

Bonus pay percent = 1.8 (Eff. of perf.—Base eff.)

D. Pay = (100% + Bonus pay percent) x Actual hrs. x Incentive rate

Where: Bonus pay percent is described above

Actual hours is the number of hours the worker is at work

Incentive rate is 120% x the daywork rate for the job

III. Example of Pay Calculation

A. Data:

1. Total actual picks produced = 35,928,000

(3742.5 running hours at 9600 picks per hour)

2. Loom hours = 4,000 (100 looms for 40 hours each)

3. Base effectiveness = 90%

4. Allowances

52 loom hours lost due to scheduled downtimes.

Allowance = 52 hours x 160 picks per minute x 60

minutes per hour x 90% base effectiveness = 449,280 picks.

10 loom hours lost due to unscheduled downtimes not the fault of the loom fixers. Allowance = 10 hours x 160 picks per minute x 60 minutes per hour x 90% base effectiveness = 86,400 picks.

Total allowances = 449,280 + 86,400 = 535,680 picks.

5. Daywork rate = $2.00

6. Incentive rate = $2.00 x 120% = $2.40

7. Actual worker hours = 40

B. Calculations:

1. Effectiveness of performance = $\dfrac{35{,}928{,}000 \text{ picks produced} + 535{,}680 \text{ picks allowance}}{4{,}000 \text{ loom hours} \times 9{,}600 \text{ picks per hour}}$

= 95.0%

2. Bonus pay percent = 1.8 (95.0% — 90.0%) = 9.0%

3. Pay = (100% + 9%) x 40 x $2.40

Pay = $104.64 for the week

Pay = $104.64 ÷ 5 = $20.93 per day

Plan H

Description of the Operation

Plan H was devised as a group incentive plan for workers tending equipment in a large continuous chemical refining operation producing a liquid product. A group of twelve workers per shift is required to operate the equipment which is spread over a large area. When the process is running satisfactorily, the work consists of recording instrument readings every two hours. When readings are off and troubles develop, the workers must make the adjustments necessary to resume proper operation.

Production output is established by supervision and varies considerably averaging 60% of equipment capacity. Generally, the output is much less than the process capacity to produce. Obviously production output is under the control of the workers only to the extent that they keep the process out of trouble and operating properly. Major troubles or losses of product due to faulty operation rarely occur.

The only factor controlled by the workers of any significant importance is the rate of steam used per pound of product. Good operation can appreciably reduce the $600,000 annual cost of steam which is the largest single expense of the process. Steam useage is reduced by carefully watching the instruments and making adjustments to keep the ratio of steam to product near an ideal ratio.

Manual effort varies only slightly as production output is varied. Workers average less than 50% busy on this low manual effort job.

Philosophy of the Payment Plan

This plan relates the pay of the group of workers to the amount of production and to their effectiveness in controlling steam useage. Where steam useage is concerned the aim is to give incentive to the workers to reduce the steam rate. On the other hand, the purpose of gearing pay to production output is to recognize some increase in effort and responsibility associated with increases in output. Since productivity varies considerably,it is necessary to have relatively small variations in pay for large variations in output. Also, the plan controls crew size to some extent by penalizing crews when they use in excess of 12 men per shift. Pay is calculated weekly because production cannot be measured on a daily basis. Average production, steam rate, and crew hours result in an incentive bonus of 25% of the daywork rate for the jobs.

Description of the Payment Plan

I. Measures of performance - Performance of the crew is measured on the basis of (A) production output, (B) steam economy, and (C) actual crew labor hours.

A. Production output standards are set on the basis of the maximum capacity of the process which is 807,000 pounds per

week. Standard hours are earned for production output according to the formula: Standard hours = Actual output x 0.0006. Average production output is 60% of capacity. When running at this rate of production 60% x 807,000 x 0.0006 = 291 standard hours would be earned.

B. Steam economy standards are set and are periodically reviewed and revised in the light of technological changes. A typical standard steam rate of 2.50 pounds of steam per pound of solvent will be used in this example. The ratio of standard steam rate to actual steam rate is used to calculate standard hours by the formula:

$$\text{Standard hours} = 2.13 \times \frac{\text{Std. steam rate}}{\text{Actual steam rate}} \times 100\%$$

$$= 2.13 \times \frac{2.50}{\text{Actual steam rate}} \times 100\%$$

In other words, for every percent of ratio of standard steam rate to actual steam rate, 2.13 standard hours are earned. Average performance is 100% steam economy.

C. Actual crew labor hours for the standard 12 man crew for 21 eight hour shifts during a week will total 2016 hours. For every actual crew labor hour up to 2016 hours per week, 0.75 standard hour is earned. Thus excessive crew labor hours earn no standard hours. The crew averages 2016 hours per week and only rarely does actual crew hours exceed 2016 per week.

II. Payment Procedure - Pay is calculated weekly as follows:

A. Calculate the "effectiveness ratio" as follows:

1. Calculate standard hours for production hours for production output, steam economy, and crew labor hours as indicated previously. Find total standard hours.

2. Divide total standard hours by actual crew labor hours to determine the effectiveness ratio.

B. Read the "effectiveness ratio" into the following chart to get the "pay percent":

Effectiveness ratio	Pay percent
1.23 - 1.27	130
1.18 - 1.22	129
1.13 - 1.17	128
1.08 - 1.12	127
1.03 - 1.07	126
.98 - 1.02	125
.93 .97	124
.88 .92	123
.83 .87	122
.78 .82	121
.73 .77	120
etc.	etc.

C. Pay = Pay percent x Actual hours x Daywork rate

III. Example of Pay Calculation

A. Data:

1. Production for week = 564,900 pounds (70% of capacity).

2. Actual steam rate = 1.80 pounds steam per pound of solvent.

3. Actual labor hours = 2016 (12 men x 21 eight hour shifts)

4. Daywork rate = $2.00

B. Calculations:

1.

Production output	Std. Hrs.
564,900 pounds x 0.0006 =	339
Steam economy	
$2.13 \times \frac{2.50 \text{ std.}}{1.80 \text{ actual}} \times 100\% =$	296
Actual crew labor hours	
2016 x 0.75 =	1512
Total standard hours =	2147

$\frac{2147 \text{ std. hours}}{2016 \text{ actual hours}} = 1.06$ effectiveness ratio

2. Reading 1.06 effectiveness ratio into the chart gives 126% pay percent.

3. Pay (based on 40 hour work week for one man)

Pay = 126% x 40 hours x $2.00

Pay = $100.80 for the week

Pay = $100.80 ÷ 5 = $20.16 per day

IV. Notes on the Payment Plan

A. Average conditions of production at 60% of capacity, actual steam rate equal to standard steam rate of 2.50, and 2016 actual crew labor hours used, will result in an effectiveness ratio of 1.00. For this 25% bonus is paid.

B. It is interesting to note how pay varies with respect to changes in the factors of production output and steam economy. Actual crew labor hours remains constant at 2016 for all practical purposes.

1. The 0.75 standard hour per actual crew labor hour will normally result in 1512 standard hours. Since this is relatively fixed and guarantees an effectiveness ratio of 0.75, the variable factors of production output and steam economy will only account for an average of 0.25 of the effectiveness ratio, or about $\frac{291}{2016} = 0.14$ for production output and $\frac{213}{2061} = 0.11$ for steam economy. Due to the 0.75 fixed portion, we may say that the effectiveness ratio is only 25% variable. Therefore, a combined 20% improvement in production output and steam economy would result in only a 5% or 0.05 gain in the effectiveness ratio.

2. Furthermore, analysis of the chart for converting the effectiveness ratio to pay percent shows that for a 10% or 0.10 rise in the effectiveness ratio, pay only rises 2%. This means that pay is only 20% variable with respect to the effectiveness ratio.

3. The overall effect of the above variability discussion is that with respect to production output and steam economy the payment is only 5% (25% x 20%) variable. This means that a combined 20% improvement in production

output and steam economy would result in only 1% gain in pay. Pay is only 2% variable with respect to steam economy, or 3% with respect to production output.

4. Since steam economy is the only important factor controlled by the worker, let us see how pay varies with steam economy performance. When steam economy performance is 200% (actual steam rate = 1.25), and other factors are average, calculation shows that pay rises only 2% (or 40¢ per day). That is, a 100% increase in steam economy performance gives a 2% increase in pay.

APPENDIX B

NOTES ON A DYNAMIC THEORY OF HUMAN MOTIVATION

by

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(These notes are reproduced here through the courtesy of Professor Smith.)

1. Theories of Motivation

Theories range from a single need (e.g., Freud: all human behavior is motivated by the sex drive or some aspect of sex need; Adler: all human behavior is motivated by the individual's need to feel important) to multiple needs (e.g., lists totaling from 25 needs or so to more than 100). The former are too simple to be usable by laymen, the latter too complex.

2. Background of the Maslow-Air Force Theory

One usable theory was developed in 1943 by A. H. Maslow, now of Brandeis University.[1] In 1953-54, Maslow served as consultant for the Air University, Maxwell Air Force Base, Montgomery, Alabama. His theory was adapted for Air Force training needs and is the basic and most important part of the 1954 Air University volume, Principles of Leadership and Management.[2] Maslow further developed the theory in his book, Motivation and Personality, 1954.[3]

3. Self-Motivation

In beginning the study and discussion of the Maslow-Air Force "dynamic theory of human motivation," you should think about yourself

and your own motivation, not about motivating other people. "Know yourself" - first, last, and all the time. After you have tested the theory in terms of your own experiences, after you have studied your own actions in terms of the theory, then you will have the patience and humility to take a look at other people's behavior in the light of their probable needs. Understanding of this theory may help you in your supervisory relationships, in your relationships with others in the organization, and in your personal life as well.

4. "A Dynamic Theory of Human Motivation"

For clarity in explanation, the theory is presented in oversimplified classifications. In actuality, these classifications overlap. Motivation is a complex and dynamic phenomenon which cannot be easily reduced to summary form.

The Maslow-Air Force theory presents as one of its hypotheses the following:

> Almost all human needs can be classified under five headings, a continuum of needs ranging from basic physical needs to more human and social needs.
>
> These five needs are:

PHYSICAL - HUMAN AND SOCIAL

SURVIVAL NEEDS	SECURITY NEEDS	BELONGINGNESS AND LOVE NEEDS	ESTEEM NEEDS	SELF-REALIZATION NEEDS

Survival Needs

Survival needs are the most easily understood motivations. They include the built-in biological needs of the human animal, such as thirst and hunger.

So long as these needs go unsatisfied, the individual is little concerned with other needs. His thoughts and energies are directed toward the satisfaction of survival needs to the exclusion of other needs. In modern American society, however, the individual generally takes for granted the satisfaction of his survival needs and is hardly aware of them.

Security Needs

Once the individual's survival needs are satisfied to at least a minimum degree, his dominant needs become security needs (called safety needs by Maslow). His efforts are directed toward satisfaction in this area. Security needs include not only physical safety but also things such as economic security (job tenure, insurance, savings, and pensions). The common tendency to prefer the familiar and to look upon change with skepticism are manifestations of security needs. Here again, however, most Americans are relatively unaware of their security needs because many of them are adequately met.

Belongingness and Love Needs

When the individual has minimum satisfaction of his survival and security needs, belongingness and love needs become most important to him. These are the needs for love, acceptance, and approval by others. Belongingness and love needs have two aspects: "inside" and "outside". The inside aspect is the individual's desire to be loved and accepted by a small, intimate group—his family and a few very close friends. The outside aspect is the individual's need for acceptance by persons outside this small intimate group—those with whom he works and those in social groups to which he belongs. Belongingness and love needs might be

considered critical in the United States (and elsewhere) because the majority of personality problems appear to rise from lack of satisfaction of these needs.

Esteem Needs

The individual whose survival, security, and belongingness needs are satisfied in at least minimum fashion then becomes concerned with esteem needs—the need for recognition and status. Although esteem needs are related to belongingness needs, the latter are more or less passive. Esteem needs involve the active favorable reactions of others. Like belongingness needs, esteem needs have an outside and an inside aspect. The outside aspect is the individual's need for the respect and recognition of others; the inside aspect is the individual's desire for self-respect or self-esteem.

Self-Realization Needs

If the survival, security, belongingness and love, and esteem needs are all satisfied to at least a minimum degree, the individual's dominant need becomes self-realization (called self-actualization by Maslow). This need is directed toward the individual's self-fulfillment, his desire to become his best self, to realize his capabilities to the fullest. The following sayings appear to reflect these needs:

"The Kingdom of God is within you."
"Become what thou art!" — Nietzsche
"What a man can be, a man must be."
"Realize your fullest growth potential."

Maslow's speculative portrait of The Self-Realizer (The Self-Actualizer), "A Portrait of Psychological Health," as adapted:

Relation to reality: sees things as they are, not as he hopes they are, not as he fears they are

Love for humanity

Acceptance (of self, others, the universe)

Spontaneity

Problem-centered, not person-centered

Detachment (need for privacy)

Autonomy (independent of culture and environment)

Freshness of appreciation of everybody and everything

Philosophical, unhostile sense of humor

Creativeness

Awareness of his own personal weaknesses and limitations

* * * * * * *

In the Maslow-Air Force theory, three additional hypotheses stem from the above five categories of needs and their relative priority. These hypotheses are:

A. The five needs come into an individual's consciousness and demand satisfaction according to the following priority: (1) survival needs, (2) security needs, (3) belongingness and love needs, (4) esteem needs, and finally (5) self-realization needs. For example, an individual is not concerned with nor can he be appealed to in terms of esteem needs until he has minimum and continuing satisfaction of his survival, security, and belongingness and love needs.

B. At any given time in an individual's life, all five needs are present, but one need is dominant or most powerful. The individual's first unsatisfied need in the order of relative priority (see A. above) becomes his dominant need.

C. A critical change in the individual, in the external situation in which he finds himself, or in both may cause a shift of that individual's dominant need along the continuum.

According to the Maslow-Air Force theory, all five of the above needs are always present in the individual. He directs his behavior toward satisfying the need that is dominant at any given time. Though an individual's behavior may not seem logical to an observer, that behavior has a cause (the dominant need of the individual)and a goal or purpose (the satisfaction of that need). The term motivation therefore refers to a dynamic process: the needs of the individual, his behavior, the goals toward which his behavior is directed, and the energy released in the individual for the accomplishment of those goals. The energy of the individual increases with the intensity of his needs.

In considering this theory, it is important to remember that these five needs merge into each other and that there is no clear line of demarcation between them. The individual's dominant need may change within a relatively short period of time, and he may be motivated by different needs in different situations of his daily life (at home, on the job, with social groups). The individual's behavior generally gains at least partial satisfaction of more than one need at a time. It is therefore not easy to determine from the behavior of an individual what his dominant

need is. The fact that many basic needs are present in the individual (even though only one is dominant at any one time) and the fact that all of these needs influence the behavior of the individual constitute an explanation of the complex and dynamic nature of human motivation and of the resultant behavior.

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