INCENTIVES FOR MAINTENANCE LABOR: EXPERIENCE WITH WORK-STUDY-BASED INCENTIVE BONUS SCHEMES INSTALLED BY HIGHWAY DEPARTMENTS IN THE UNITED KINGDOM

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•DURING THE PAST decade highway authorities on both sides of the Atlantic have endeavored to apply industrial engineering techniques to the execution of highway maintenance, and it is now generally accepted that work and method study are applicable to maintenance activities.

The approach generally favored in the United States uses a basis of work measurement and study of broad areas of achievement in bulk quantities such as acres of grass cut and tons of bituminous material laid. In such a system accomplishment is the criterion without detailed analysis of individual achievement or breakdown of multiple activities. The system that is becoming almost universally adopted in the United Kingdom also provides measures of accomplishment in highway maintenance terms, but as a summation of the various activities or elements of work that go to make up that accomplishment. Such an accurate and detailed record of personal or group output is required because a bonus incentive scheme is operated in conjunction with the operation of work and method study and work measurement.

The U. K. highway schemes are based upon the well-proven industrial system of method-time-measurement (MTM). A detailed description is given later, but briefly the various operations are measured and a performance value is fixed representing an "ideal" performance. The execution of an operation above a fixed percentage of this ideal performance earns bonus on a rising scale dependent on performance achieved with a cutoff point for health and safety reasons. The scheme is so geared that the value of the increased productivity exceeds the expenditure in bonus payments and operation of the scheme.

The multiplicity of highway maintenance activities and their execution by a group or by even one man render the application of an MTM scheme far more onerous than in the case of a factory production line. However, this is a matter of magnitude and, as is later described, much has been done to reduce the scale of operations necessary to institute a scheme.

The value of highway maintenance MTM-based, bonus-incentive schemes has been amply proven over 10 years' practical experience, not just in terms of increased productivity, but in the precision-required results in the feedback of extremely accurate performance data which are invaluable to the operation of planned programmed maintenance.

Ethical objections to the use of incentive bonus by a public authority have been made on the grounds that a public service should not be considered in the same way as a competitive private industry. It is a remarkable fact that alone among business enterprises public authorities are expected to function without making a profit or a loss, a feat demanded of their managers which tends to make a tightrope walker look clumsy. To use bonus incentive to raise productivity unashamedly introduces the profit motive for both the worker and the authority.

HISTORICAL REVIEW OF BONUS INCENTIVE IN THE UNITED KINGDOM

Justification

When bonus incentive was originally introduced into U. K. highway authorities 14 years ago, each department designed or had designed for it by consultants an individual scheme agreed to by the trade unions concerned at the local level. The reasons those authorities introduced schemes varied according to the circumstances motivating their inception such as: (a) to catch up on arrears of work by increasing productivity; (b) to improve standards through increased productivity; (c) to reduce costs by increased productivity; or (d) to increase earnings by increased productivity so as to make the job more attractive when recruiting labor.

This variety of motives naturally led to a variety of schemes with different levels; i.e., performance under which bonus became payable and different proportions of the basic wage rate payable for "standard" performance so that the amounts of bonus paid for similar work output varied considerably.

Code of Practice

Obviously a code of practice was required and under the auspices of the joint local authorities/trade unions body, which formulates wage rates and conditions of service, such a code was produced. This code is not a straitjacket but it does provide a common foundation upon which all schemes are now built. However, each scheme is still subject to individual agreement between the authority and the trade unions because there is a wide variety of topography, availability of materials, etc., throughout the country in addition to a variety in methods, organization, and output for various operations.

Growth of Schemes

While the code did provide a common basis of design and implementation it did nothing to promote the further use of work-study-based bonus incentive schemes by authorities. In fact, in early 1968 it was estimated that only about 25 percent of local authorities had introduced bonus incentive schemes, probably due to doubts about the benefits to be obtained. It is also fair comment that very few authorities had made use of work and method study without the use of bonus incentives. A considerable boost has been given to incentive bonus as a result of a study by the government National Board for Prices and Incomes published in 1967.

The board found that, while basic wage rates paid by local authorities were not dissimilar to those paid by other industries, take home pay was generally lower due to lack of bonus, fringe benefits, etc. Thus it was concluded that any further pay increase should be tied to increases in productivity. It was also concluded that there was a considerable range for increased productivity with overall savings to the authorities if work-study-based bonus incentive schemes were introduced, as the following quotation from the report illustrated: "The savings that can be achieved, however, from properly thought out schemes can be very great. The rate of saving in labor costs and on-costs commonly lies in the range £100 to £300 a year for each operative employed after taking account of the costs of devising and administering a scheme. Thus, typically for a labor force of 500 men, the net saving achieved from the introduction of work-study and accompanying incentives would be £50,000 to £150,000."

Since that report the various local authority associations representing small and large authorities, urban and rural, have all corporately agreed that work-study bonus incentive schemes should be introduced by all their members.

The trade unions concerned support this policy so strongly that they have proposed a time limit after which those authorities that have not implemented schemes should be penalized. The joint negotiating body, The National Joint Council for Local Authorities Services (Manual Workers), has also fully supported extending the techniques and has required local authorities to introduce work-study bonus schemes by February 29, 1972.

Interim Schemes

In addition, methods have been examined and in some cases introduced that reduce the necessarily lengthy study period that precedes a scheme becoming operational and employer and employee receiving benefit. One such system is a "bridging operation" known as "The Shorter Term" or "ten for ten" scheme which aims to provide an authority with a scheme quickly, which is controlled by its existing officers, and which will provide an effective temporary solution. Such a scheme is based on rough and ready data unlike the detail, sampling, and research associated with the normal MTM scheme. The principle of the shorter term scheme is that an authority pays a fixed percentage of the basic wage rate when the actual labor costs of a group such as a work crew have shown on average the same percentage reduction from the norm cost.

This situation must apply for a fixed period and there must be no reduction in norm output, quality, or quantity. Thus, if there is a reduction in cost of 10 percent the local authority pays 10 percent bonus without prejudice to the later introduction of a work-study-based scheme. Net potential savings to the authority are cautiously estimated at approximately 1 percent of the wage bill.

Over the country as a whole, shorter term schemes have not proved popular and a more effective shortcut is the transplant scheme. This consists of one authority providing another with data, facilities for work-study officers of the recipient authority to gain experience with the donor's scheme, and services of senior work-study officers on a consultant basis. The scheme can be a full transplant involving all values and methods or merely a partial assistance. Transplants are only practicable between similar authorities and then many performance values are not comparable giving rise to labor difficulties and considerable remeasurement.

National Data Library

Finally, as previously referred to, a recent step forward is the establishment of a national library or data bank of performance values from which an authority can select a compatible value derived from circumstances similar to its own.

THE CODE OF GUIDING PRINCIPLES

Before dealing with the details of design, preliminary survey, implementation, and results, it is necessary to delineate the broad criteria laid down in the Code of Guiding Principles and these can be summarized as follows:

1. Consultation and Participation—between the authority and the trade union and between employers and officers, during method study and work measurement, formally by joint working parties, and by informal contact.
2. Redundancy—deployment onto other work and liaison with recruitment and trade unions.
3. Procedure—notification to trade unions, preliminary survey including cost-benefit analysis and running costs analysis, initial meetings with men before preliminary survey, work-study appreciation courses for all concerned, work specification covering general conditions of scheme of conditions applicable to specific operations including description of methods, rate of bonus, standard times, safeguard for quality and safety, example of bonus calculation, and trial period prior to establishment as normal and agreed condition of work.
4. Relationship of Pay to Performance—rate of bonus to be paid at standard performance to be normally one-third of basic wage rate, implementation of bonus at temporary lower rate permissible during early stages of scheme, and performances to be calculated on individual or group basis.
5. Maximum Bonus—limitation of bonus earnings in interests of quality, safety, and general welfare.
6. Application of Bonus—payable for measured work, not payable for holidays and sickness, unmeasured work and lost time to be recorded so as not to lose bonus on measured work, and unmeasured work and lost time to be minimized.

7. Record of Work Done—details of work must be sufficient for costing and calculation of bonus.
8. Calculation and Payment of Bonus—regularity of calculation and payment with normal payment of wages.
9. Quality and Safety—times to allow for standard of quality and safe working and bonus not paid for substandard work or unsafe methods of working.
10. Arbitration—provision for dealing with difficulties arising from introduction or operation of scheme.
11. General—rights and responsibility of management not diminished.
12. Conclusion—the Code of Guiding Principles cannot be upheld as a perfect system. Although it does provide a common basis, surprising variety exists as is discussed later.

THE DESIGN OF A BONUS INCENTIVE SCHEME

Rather than hypothesize upon the design of a scheme in the interests of clarity it is described in the manner in which it is customarily set forth in the work specification which constitutes the design and operational basis of a scheme. This is typically written in three parts.

Part 1—General Conditions Applying to the Whole Scheme

This part comprises a description of the overall design principle of the scheme, explaining that the average experienced man in his work has the opportunity to earn at standard performance a specific proportion of his basic rate of pay—one-third in the Code of Guiding Principles.

If the type of work is such that work content and conditions vary little from week to week, a straight proportionate scheme will apply by means of which the bonus earned relates directly to the performance achieved during the work period over and above the basic rate as shown in Figure 1. However, being an outdoor occupation, highway maintenance is subject to factors affecting work output which can and frequently do vary from week to week.

In order to even out the subsequent fluctuation in performance and consequently bonus, a geared or stabilized scheme is adopted whereby although the rate of change of

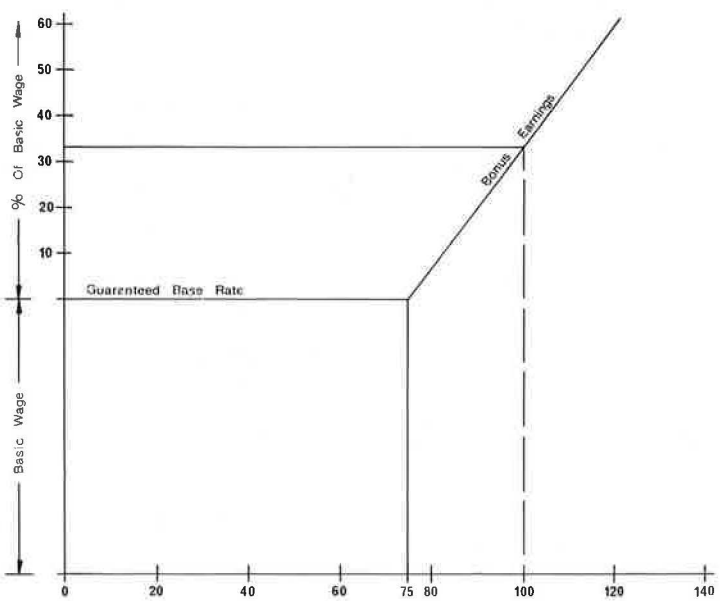

Figure 1. Straight proportional scheme.

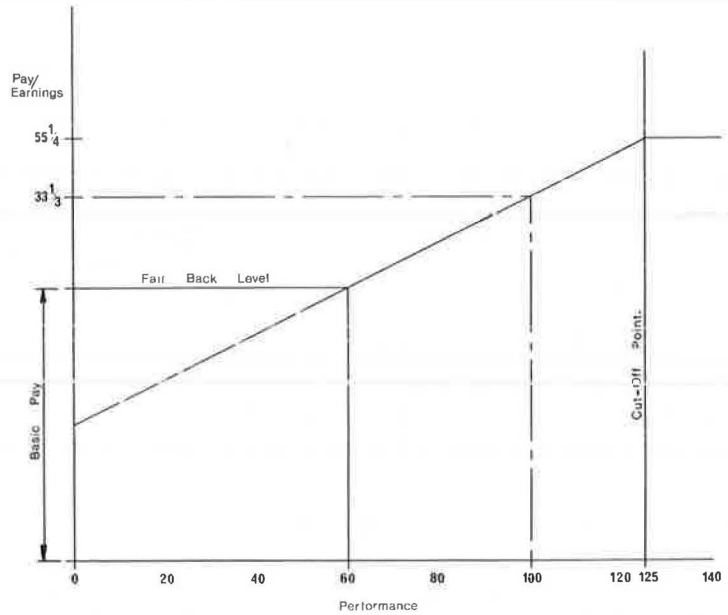

Figure 2. Stabilized scheme.

bonus is constant if the straight line is extended below the bonus starting performance it shows some pay at zero performance as Figure 2 shows. Further modification applied to individual operations as defined in Part 2 of the specification may include variations in the starting level for payment of bonus, alternative levels of performance at which bonus is leveled off to suit the nature of the work, and the use of various devices to stabilize bonus payment, e.g., nonlinear curves. A clause may also be inserted that for new schemes, subject to review after the first year, payment should be at a lower rate of bonus for a standard performance.

This part of the specification will also explain that the standard times include allowances for rest and personal needs, minor interruptions and delays, and may include where applicable moving-up times and site allowances. A maximum bonus rate will be fixed in order to safeguard health and quality of work and to avoid the abuse of machinery and equipment. Since it is impossible to operate bonus-earning work continuously, lost time is recorded when a man or crew is prevented from working for 10 minutes or more. This time is paid for at the basic wage rate but credited at the fall-back level of performance so that, while bonus is not earned, neither is it lost when the individual standard times earned over the week are added in the bonus calculation. Uncontrolled work is recorded when work is done for which a standard minute has not been deduced. It is advisable that this work is minimized by ensuring that as much work as possible is measured. Otherwise difficult labor relations may result.

Generally, during the initial settling-in period, bonus payment is not made for uncontrolled work but thereafter it is customarily assessed at an average performance based on previous earnings subject to a minimum period being discounted.

Safeguards are described covering nonpayment of bonus for substandard work or unsafe methods of working and the alteration of performance values to account for changes in method, organization, materials, equipment, or working conditions, and for rectification of errors or miscalculation.

Part 2—Conditions Applicable to Specific Operations

Part 2 specification comprises a schedule of methods descriptions together with associated materials and equipment for each maintenance or construction operation whether it is carried out by an individual such as mechanical road sweeping or by a group of men whether a specialist team, routine maintenance gang, or construction gang. This specification also deals in detail with the build up of the standard minute values and the methods, materials, tools, and equipment upon which they are based.

Standard Minute Values—Standard minute values are built up from information obtained by work study. The actual time spent on work, including stoppage, is adjusted so as to allow for the effectiveness and speed at which the work is performed. From this is derived a basic minute value for each operation and allowances are added to the basic minute value to cover contingencies, rest and personal needs, and supervision, the final figure being the standard minute value. Thus it is fair to say that an average competent worker with an effective incentive should be able to maintain an output of 60 standard minutes an hour over a whole day, without experiencing more than normal, healthy fatigue.

Such an output corresponds to a standard performance of 100 on the bonus scale (Fig. 2). Work for which a standard minute value has been produced is termed controlled work. Quality, lost time, and uncontrolled work have been previously described but are also covered in Part 2.

Recording of Work—On this matter, any scheme stands or falls. The importance of accurate records must be stressed to the roadmen. It is from the information contained in these records that not only incentive bonuses are paid but also the management decisions are made.

In gang work the gang leader is responsible for completing the work sheets while an individual operative is responsible for his own work sheet. The work sheet for a gang contains details of the men in the gang, including total hours of normal time and overtime for each gang member. The types of machines on the site, the times employed together with controlled work in accordance with the units corresponding to the standard minute values, and a brief description of uncontrolled work and lost time are recorded (Figs. 3 and 4).

Calculation of Bonus—The standard minute values for the various operations undertaken are applied to the controlled work done by gangs or individual operatives, and the pay performance of the gang or individual is then calculated:

$$\text{Pay performance} = \frac{S + U + L}{A} \times 100$$

i.e., pay performance = input/output × 100, which can be described as being the standard hours produced as a percentage of time taken to produce those hours, where

S = standard minutes earned during work period (normally one week);
U = credit minutes allocated to uncontrolled work;
L = credit minutes allocated to lost time; and
A = total number of actual man-minutes worked by gang or operative.

It is necessary to make various allowances to cover necessary work that cannot be rated such as supervision, starting, and finishing work.

Supervision Allowances—A rising scale of credits is allowed per day at standard performance according to the size of the gang is customary.

Start-Up and Shut-Down Allowance—An allowance is given to each man to cover form filling, starting work, and finishing-off work.

Overtime—During overtime, working bonus is paid on the basic hourly rates excluding overtime increments.

Manning—It has already been mentioned that the values assigned to the various operations apply to specific methods, materials, tools, and equipment, but bonus incentive also helps to optimize gang size although this is often specified. If more men are allocated to a job than necessary, performance drops so that bonus earnings are lower.

JOB NO. 6146 PLACE LEXHAM DIVISION 5 WEEK ENDING 28 11 1970

SECT.	ITEM		UNIT	QUANTITY	SMV	SM'S
12	001	Laying bricks for wall	per 100	29·31	137	4015·47
12	002	Mixing mortar by mixer	Cu Yd.	6	75	450
22	032	Unloading bricks	per 100	14·66	7·0	102·62
22	006	Loading soil etc.	Tons	270	1·0	270
03	094	Removing hedge and bank	lin yds	17	4·9	83·3
12	005	Sweeping road	100 lin yds	3		160
05	036	Levelling Ready - Mix concrete	cu yds	28	25	700
		Supervision Allowance		5	350	1750
		Credits from lorry sheet				1742·4
23	001					
23	001	LAMPS FOR WEEK	LAMP			
START UP AND SHUT DOWN ALLOWANCE			M/DAYS	25	20	500
			TOTAL	CONTROLLED	WORK	9793·7

UNCONTROLLED WORK	NO OF MEN	HRS	MINS	MINS	CREDITS	
Erecting fence posts and forming bank	3	112		6720	3360	
Making and fixing shuttering	1	16		960	480	
			TOTAL	U.C. MINS	& CREDITS	3840

LOST TIME	NO OF MEN	HRS	MINS	MINS	CREDITS	
WAITING FOR MATERIAL	7	35		2100	1050	
WEATHER	1	4½		450	450	
		TOTAL	LOST	TIME	& CREDITS	1275

NAME	NUMBER	TOTAL HOURS WORKED SUN	MON	TUE	WED	THU	FRI	SAT
A O Baker	04650		8	8	8	8	8	
R Pease	69153		8	8	8	8	8	
A Woodrow	97625		8	8	8	8	8	
C Lovick	UDC Man		8	8	8	8	8	
K Haws	44717		8	8	8	8	8	
E Fields	33734		8	8	8	8	8	
O Boldero	11173		8	8	8	8	8	
A Robinson	75091		9	9	9½	9	9	
R Flood	34562		8	8	8	8	/	

TOTAL CREDITS 14908·79

TOTAL MAN MINS 21450

PAY PERF 70

OP PERF 87

WORKED OUT BY

SIGNED A O Baker
COMPLETED BY T Brown

WORK STUDY OFFICER JH

Figure 3. Gang work sheet.

DIVISION 2 TYPE OF MACHINE LACRE WEEK ENDING 19TH DECEMBER 1969

ROAD NO	LOCATION OF SWEEPING	UNIT	QTY	SMV	SM'S
C 63	Fair Green & U/C 2138, 2139, 2368, 2391	MILES	2	23·8	47·6
A 47	Middleton C 55 & U/C 2137	MILES	2	23·8	47·6
C 55	Blackborough End & C 57A	MILES	1½	23·8	35·7
A 47	East Winch U/C 2056 C 64 U/C 2028 2140	MILES	2½	23·8	59·5
	RUNNING LIGHT	MILES	39	3·9	152·1
A 10	A 47 Junction To Tottenhill	MILES	4	23·8	95·2
C 62	West Winch Village & U/C 2142 2141 2022 2021 2020	MILES	4	23·8	95·2
A 10	Tottenhill To A 47 Junction	MILES	4	23·8	95·2
	RUNNING LIGHT	MILES	35	3·9	136·5
C 56	Roydon To Pottrow	MILES	1½	23·8	35·7
B 1145	Gayton Village & U/C 2058 2132 2059 B 1153 2060 2130	MILES	5	23·8	119·0
C 56	Pottrow To Roydon	MILES	1½	23·8	35·7
	RUNNING LIGHT	MILES	35	3·9	136·5
	Heacham Village U/C 2257 C 104 103 U/C 2344 2345 2249 2251 2252 2337	MILES	8	23·8	190·4
	RUNNING LIGHT	MILES	32	3·9	124·8
	Heacham Village U/C 2253 2254 2250 2255 2256	MILES	2	23·8	47·6
C 82	Anmer	MILES	1	23·8	23·8
B 1153	Flitcham & U/C 2002	MILES	1	23·8	23·8
	RUNNING LIGHT	MILES	29	3·9	113·1
	TIPS	OCCS	15	4·2	63
	TAKE ON WATER	OCCS	14	10·0	140
	WASHDOWN	OCCS			
	CHANGE BRUSHES	OCCS			
	START UP AND SHUT DOWN ALLOWANCE	M/DAYS	5	20·0	100
		TOTAL	CONTROLLED	WORK	

UNCONTROLLED WORK	HRS	MINS	MINS	CREDITS
SUPERVISION WITH SURVEYOR OR FOREMAN				
SWEEPER MAINTENANCE	6		360	360
	TOTAL	UNCONTROLLED	WORK	

LOST TIME	HRS	MINS	MINS	CREDITS
WEATHER	4	36	276	207
REPAIRS TO SWEEPER	3		180	135
	TOTAL	LOST	TIME	

NAME	NUMBER	N°of days	hrs. of O.T.time	MINS	BONUS
T Brown	98675	5	5		

TOTAL CREDITS 2620
TOTAL MAN MINS 2700
PAY PERF 97
OP PERF
WORKED OUT BY

DRIVERS SIGNATURE S. Hoss

WORK STUDY OFFICER JH

Figure 4. Individual work sheet.

Part 3—Standard Minute Values

Part 3 comprises a schedule of standard minute values. It must be stressed to the roadmen that these standard minute values do not represent the time that must be taken to complete the job to earn any bonus but the time to earn bonus at the standard rate, i.e., 100 pay performance. It must be explained that a bonus payment scale starts at a lower performance figure and, if a longer time is taken than the Part 3 value, subject to the fall-back level, bonus will still be earned but at a reduced rate. To give some idea of the scope of a scheme, it is likely that over 1,600 standard minute values will be required for a workable coverage. A typical extract from a Part 3 specification is shown in Figure 5.

ITEM		UNIT	SMV
11	Clean out existing water grips and move between	Grip	2·46
12	Dig NEW water grips and move between	Grip	5·00
13	Expose water grips by scything	Grip	1·08
14	Rod out piped water grips	Grip	1·20
15	Clean out and empty gully pots	Gully	5·60
16	Mow grass with hand scythe on level ground	100 s.y.	31
17	Mow grass with hand scythe on bank sides	100 s.y.	45
18	Cut grass with Rotary Cutter	100 s.y.	7·5
19	Rake up cut grass to heaps	100 s.y.	15
20	Load grass from heaps to vehicle	100 s.y.	8

WHITE LINING (PAINT)
PAINT SPRAY MACHINE HOFFMAN (with 3 man gang)

ITEM		UNIT	SMV
1	Paint spray white lines on a road which has no markings or roadstuds present, using automatic cams on machine	100 yards of road	41
2	Paint spray white lines on a road where white lines already exist whether roadstuds are present or not	100 yards of road	30
3	Paint spray white lines where roadstuds are present but NO white lines exist	100 yd of road	36
4	Lay 4" wide 2'x1' gap lines at Junction mouths (4" blocks + 8" blocks x 2 = yds. of road)	100 yd of road	64
5	Move up lorry etc. whilst laying lines	Mile	22
6	Fill Ballolini dispenser where applicable	Occ	15
7	Load and off load equipment (3 men)	Occ	30
8	Move between sites by lorry etc	Man Mile	3
9	Start up and shut down allowance	M/Day	40

Figure 5. Extract from Part 3 of work specification.

PRELIMINARY SURVEY

A great deal of preliminary study is necessary before a work-study-based bonus incentive scheme can be implemented.

Method Study and Work Measurement

First of all is the work study itself, constituting method study and work measurement out of which comes the schedule of methods in Part 2 of the work specification and the work values associated with them in Part 3. Even if methods and values are adopted from a neighboring authority as in a transplant scheme, a number of checks are essential to verify that they can be applied to local conditions. As this survey work proceeds it is essential that close contact is maintained with the roadman and his union representative as well as with the field supervisory staff. No one relishes being surveyed by an inquisitive fellow with a stopwatch and note pad.

Cost-Benefit Analysis

Once methods and values have been finalized, the cost-benefit analysis can be computed. This is founded on the measured prebonus average performance and the anticipated performance when the scheme is fully operational.

Prebonus average performance usually ranges between 40 and 50 on the 100 scale and a reasonable operational performance will be in the region of 75. Thus the financial assessment comprises: (a) estimated gross savings based on a combination of performance levels and values in monetary terms after accounting for bonus payments; (b) the cost of such items as additional equipment and materials resulting from the application of work-study recommendations; (c) the cost of any additional supervision; (d) the cost of work-study staff, central and administrative expenses, office accommodation, stationery, traveling expenses, and running costs; and (e) the cost of training courses in work-study appreciation for supervisory staff.

In assessing the financial benefits, the reasons for the introduction of the scheme must be borne in mind and thus the benefits should be considered under the following headings: (a) reduction in total cost; (b) avoidance of increases in costs which would otherwise have taken place; and (c) improvements in the service provided.

THE IMPLEMENTATION OF A BONUS INCENTIVE SCHEME

Labor Relations

As has been previously stated, the trade unions strongly support work-study-based incentive schemes. Nevertheless, the labor force as well as the unions must be informed

as soon as possible after the decision to introduce a scheme has been taken. Regular meetings should be held as implementation progresses and it is more beneficial if these can be held at the divisional or district depots so that the men feel on home ground.

Momentum

The success of a scheme depends very much upon maintaining interest throughout its inception and this is probably dependent on implementation time, information, and involvement.

Time

Some work-study practitioners favor the introduction of a scheme carefully activity by activity over a very long period, while others prefer mass implementation of all activities with the entire divisional labor force participating. While gradual implementation may be technically preferable, with the methods and values for each activity being perfected before another is tackled, its effect on morale and therefore on the ultimate success of the scheme is likely to be detrimental.

Therefore, the division by division method is to be preferred and as an indication of time scale the Norfolk County Council highways department implemented its scheme among approximately 700 men in nine divisions during the five months June to November 1970.

This may well rank as a U. K. record but nevertheless it has proceeded smoothly and a great deal of credit is due to the efforts of the work-study staff, backed up by all the engineering management concerned including the chief officer and the county surveyor, in keeping the men informed and involved.

Information/Involvement

Information with involvement proceeds at meetings and on site, and information through booklets which can be studied at leisure. Meetings should be attended, chaired, but not dominated by top management to establish the mutual trust and involvement of men and management which is the prerequisite of a successful scheme. Experience of meetings shows as much benefit to management as to men.

It is essential that there be constant contact on the job during the implementation or running-in period. This contact is continuously maintained by the work checkers who are needed to run the scheme. It is desirable that the work checkers should have had practical experience in road maintenance and construction so that they are able to discuss and resolve difficulties and invariably misapprehensions, on the ground.

Finally, information must have impact and must readily explain not just the working but the reasoning behind the scheme. An extract which illustrates the precept, taken from a booklet that has been issued to roadmen, is shown in Figure 6.

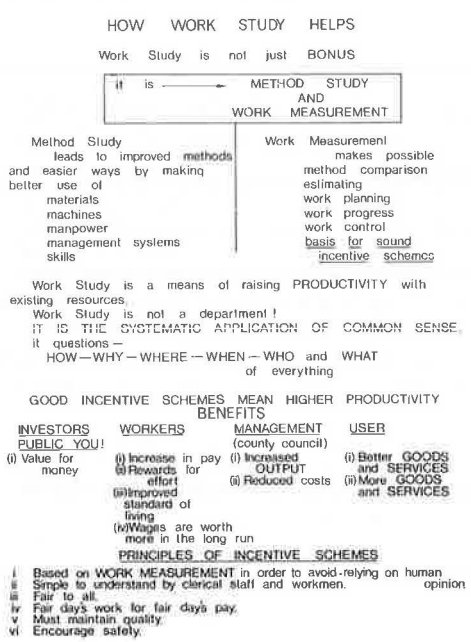

Figure 6. Extract from work study booklet.

MAINTENANCE

Once the process of implementation is complete and the scheme is in full operation it must be maintained. This is a continuous operation aimed at steadily improving performance and overcoming difficulties as they arise.

The key in successful maintenance are the work checkers. They must not only keep in close contact with the work force but also be trusted. It is often said that the highest bonus is earned by the men with the sharpest pencils. It is certainly true that inadequate completion of work sheets is a major difficulty resulting in loss of bonus earned and useless feedback to management.

Work Checkers

The work checkers must not only verify the work-sheet information but provide on-site instruction in its completion. Their overall surveillance, independent of the divisional staff, can prove invaluable in detecting external forces contributing to low performance.

Cooperation

The cooperation and involvement of the work force established at the introduction of the scheme must also be maintained. This is achieved with a consultative committee consisting of representatives of each divisional labor force, the work study staff, and with the maintenance engineer taking the chair. This committee deals with problems affecting values, current methods, and the updating required to take account of changes in methods, plant, equipment, and material.

Flexibility

It is vital that the scheme should be flexible. Otherwise performance will tend to diminish.

RESULTS—MEN AND MANAGEMENT

Pay Performance

While pay performance is obviously of prime interest to the roadman, the divisional and field management are interested in comparing the efficiency of gangs or operatives engaged in the same tasks, and, since lost time and uncontrolled work vary, pay performance does not provide a sufficiently true indication for the purpose of management.

Operator Performance

Consequently, operator performance is calculated for each group or individual as shown in the next to last column of a typical divisional weekly control sheet shown in Figure 7.

Overall Performance

Overall divisional performance is of interest to head office management and for this purpose the overall pay performance is adequate.

Submission of Sheets

Not only is correct recording on work sheets important but the submission of sheets is important. This may seem elementary but work sheets are additional to the normal time sheet and a gang or individual that knows that its performance over the week has been low and more likely to result in supervisory attention than bonus may well not submit a sheet.

Capacity Ratio

From the management viewpoint it is of prime importance that sheets are submitted and to gage the scheme effectiveness a capacity ratio on a divisional basis is calculated, constituting the ratio of actual man-hours on work sheets to possible man-hours. This capacity ratio only indicates the extent of participation and to complete the picture a combination of capacity and performance is required to give the overall efficiency.

[redacted] 2 WEEK ENDING 28 11 70 WEEKLY CONTROL SHEET

NAME	NUMBER	HOURS ON WORK SHEET Col. a	STD. HOURS Col. b	U.W. ACTUAL HRS. Col. c	ASSESSED HOURS LOST TIME IN ACTUAL HRS WEATHER	MATERIAL		TOTAL LOST TIME Col. d	STD. + ASSD HRS. Col. e	PAY PERF $\frac{e}{a}$	OPER PERF $\frac{b}{a-(c+d)}$	DETAILS OF M.W.
A Baker	04650	357·5	163·22	128	42·5			42·5	248·47	70	96	Erecting posts
C Beales	07860	40	39·13	6					42·13	105	115	
J Mason	60556	332·75	262·33	12·5	9			9	273·08	82	84	Measuring roads & sites
F Whitmore	94727	40	29·86	2	1			1	31·36	78	81	Sweeping potholes
K Leveridge	56250	144	70·79	4					72·79	51	51	Hedge trimming
B Jackson	50163	80	57·49		15			15	64·99	81	88	
K Graves	39987	77	44·15	6	1			1	49·18	68	71	Cement mixing & water carting
F Woods	97772	74	64·26	15					71·76	97	109	Moving huts & tools
F Edwards	31082	80	52·28						52·28	65	65	
H Woodgelt	97420	322·5	257 93	9	20			20	252·43	78	81	Digger
K Dent	28020	84·5	62·96	4					64·96	77		Lorry
B Martin	60250	46	33·32	9					40·07	87	90	Sweeper
Held back week 34												
H Woodhouse	97535	32·5	11·04	8	10			10	20·04	62	76	Marking out

T.M.H. TOTAL MAN HOURS	A.M.H. AVAILABLE MAN HOURS TMH – NAH	A TOTAL HRS. ON WORK SHEETS	N.A.H. BREAKDOWN OF NON-AVAILABLE HRS. DEPOT	HOLIDAYS	SICK	ABSENT	OTHERS	E STD. HRS. + ASSD. HRS	CAPACITY RATIO $\frac{A}{AMH} \times 100$	DIV. PAY PERF. $\frac{E}{A} \times 100$	EFFICIENCY INDEX $\frac{E}{AMH} \times 100$
2038·75	1790·75	1705·75		32	16		200	1283·54	95	75	72

Figure 7. Division weekly control sheet.

Efficiency Index

This figure is termed the efficiency index and, with the capacity ratio and overall pay performance for each division, is shown on a weekly return for the benefit of head office management (Fig. 8).

Sensitivity

Since the system is founded on a basis of precise measurement of activities there is a high degree of accuracy in the feedback which thus facilitates sensitive control.

Effectiveness of System

As an indication of the effect of the system the following performance statistics (100 BSI scale) are general but representative of studies carried out by a number of authorities:

1. Overall performance before implementation of results of method study = 23 to 45;
2. Overall performance after implementation of results of method study = 50 approximately; and
3. Overall performances after implementation of results of method study and two years after implementation of incentive bonus schemes = 75 to 90.

Thus, U. K. experience is that the effectiveness of this form of incentive cannot be disputed.

Propriety of System

Nevertheless, many engineers and authorities in the United Kingdom have over the years doubted the propriety of the system seemingly on the grounds that the roadman is already paid an agreed rate for his labor; but it can equally be postulated that the basic rate performance represents a norm for the wage rate and that any increase above the norm ought to be allied to an increase in the rate.

WEEKLY WORK SHEET 5/12/1970 ALL DIVISIONS

DIV	CAPACITY RATIO TARGET = 100 The ratio of actual man hours on work sheets to the total possible man hours $\frac{\text{ACTUAL M/HRS}}{\text{POSS M/HRS}} \times 100$	PAY PERFORMANCE TARGET = 100 Standard hours produced as a percentage of hours taken to produce them Pre-work study perf = approx 50 $\frac{\text{INPUT}}{\text{OUTPUT}} \times 100$	EFFICIENCY INDEX TARGET = 100 A combination of capacity and performance to give the overall efficiency $\frac{\text{CAP RATIO} \times \frac{\text{PAY}}{\text{PERF}}}{100}$	REMARKS
1	81	68	55	
2	81	71	57	
3	95	82	78	
4	88	62	55	
5	81	71	58	
6	92	75	68	
7	93	73	67	
8	91	65	59	
9	80	82	65	
10				
11				
12				
TOTAL				

Figure 8. Head office weekly control sheet.

The design of a work-study-based bonus incentive scheme ensures that bonus is only paid for a genuine increase in performance and that the authority can also profit from the increased output. Experience too has shown that the value of bonus to the roadman is not so much the monetary value but what it represents. It is a tangible expression of a man's worth. He takes a pride in the bonus earned because it is a real measure of appreciation, having far more meaning than a performance figure.

Stimulus to Management

Furthermore, the wish of the gang or individual operatives to earn bonus acts as a very positive stimulus to management. If bonus-earning work is postponed as a result at inadequate planning involving such things as delays in delivery of materials or waiting for an engineer, views are likely to be very strongly expressed.

Justification

The only justifiable engineering criterion whereby any system should be judged is whether it works and, as has been illustrated, work-study-based bonus incentive schemes can and do work. But then, after all they are not exactly new to the construction industry of the United Kingdom. In the reign of King Edward I in the late 13th and early 14th centuries it has been recorded that skilled men received 3d. or 4d. a day and foremen 5d. or 6d. Unskilled laborers were paid 2d. Bonuses for good work, usually at the rate of 1d. per day, were paid.

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Discussion

JAMES O. KYSER, North Dakota State Highway Department—This paper opens a whole area of motivation items that needs evaluation. Private business generally measures its effectiveness by the amount of profit return for each operation. Profit is difficult, or many times impossible, to measure in roadway maintenance operations. In government operations, effectiveness should therefore be measured, as stated by Cox, by management, cost-benefit analysis, performance standards, quality, and safety standards.

I feel that in the private sector of business the stigma many times exists that employees are working for a governmental agency only because they do not have the ability or capability to compete for jobs in the private sector. Government employees have the same physical makeup as any individual, and most usually have the same personal aspirations as employees in private business, with the great desire to accomplish goals to their maximum ability. There is a latent will in all men to succeed, and management must use incentive plans to draw out and develop those hidden capabilities.

A method of measurement of work produced, with published records for all to see, can be a great motivating factor which is of benefit to both the employer and employee. Many times in government maintenance operations a method of measurement has not been available or used. The ability to develop to our own level of competence without undue restrictions is what has made the free enterprise system so great. Fringe benefits, such as paid vacation, sick leave, retirement, holidays, moving costs, and hospitalization, have in many cases become an expected pay item, with the motivating element lost.

Pay scales are an important item in the motivation field. Realizing the benefit from an adequate pay scale, North Dakota recently developed and adopted a reconstructed pay program. The employee should be paid at near the same rate as his contemporaries in the same type of work and in the same general area. To establish this, a survey can be made of the surrounding areas to establish the going rate, and then, considering levels of job difficulty, fringe benefits, working conditions, and working hours, establish rates equivalent to the average scales from the survey. Enough firms should be covered in the salary survey and all factors reviewed so there can be no claim of bias when the new rates are established. Evaluate each job and establish knowledge, skills, abilities, and levels of difficulty for each operation or endeavor that needs to be done. The employee will soon understand that he is rated on his knowledge, skills, and abilities, and by what work he does or what machine he operates most of the time. You will soon find him volunteering for work so he will have an opportunity to operate more difficult machines and improve his knowledge, skills, and abilities, having become aware that there is no great increase except for cost-of-living if he stays at his current level.

Work incentives have been provided for several municipalities in North Dakota. Sanitation workers have been assigned a specific area of coverage; when this coverage is completed in less than the normal eight hours, the employee is paid for his regular hours and the early completion time provides him free time. Routes are evaluated periodically to establish a reasonable length of route for a normal working day. It has been found that most of the time the employee will complete his route ahead of the scheduled time to gain the advantage of free time. It has also been noted that, when this incentive is not present, many times the collectors would not complete their routes in the normal working hours, indicating that time off, even without an incentive pay, is also a good method of employee motivation.

There are other methods of motivation—pride in the organization, pride in quality of work performed, pride in accomplishing an objective. Competition between crews and gangs for quality and quantity of work will create motivation, but we all work for monetary remuneration, and the use of a bonus as an incentive for superior performance and production is probably one of the greater motivating factors. Cox has presented a method of determining bonuses in an area where it is most difficult to measure performance. This dollar bonus incentive and its application deserve further study and greater application for increased efficiency and economy.

LAWRENCE MANN, JR., Lousiana State University—This paper is both timely and thought-provoking in this age of ever-increasing maintenance cost and changing productivity. Industrial engineers in the United States have recently begun to apply incentives to indirect labor. Ongoing systems now exist at such industrial organizations as the Harnischfeger Corporation in Milwaukee and the Oscar Mayer and Company plant in Madison, Wisconsin, but there seem to be no ongoing incentive systems for highway maintenance workers.

In order for an incentive system to have the confidence of both management and workers, a history of satisfactory standards must exist. In the United States, many highway departments have already created standards or are in the process of devising them. Productivity differentials within states as well as between states have long been recognized. This situation led the maintenance and operations cost committee of the Highway Research Board to abandon the course of action that had been followed up to about 10 years ago; namely that of accumulating raw costs for activities from states and comparing them with other states. It was recognized, at that time, that the productivity factor must be included. From Cox's paper we gained the insight that the work done in the United Kingdom included the consideration of productivity coincidentally with the consideration of standards. This appeared to be a necessity for the creation of the incentive systems that he described.

Normally, the fact that a group of workers is organized appears to offer an additional obstacle in creating a standards and incentive program; but, in the case of the United Kingdom, the fact that the union did exist and was receptive to bargaining appeared to make the job of the installation of an incentive program easier. It appears to be only a matter of time before highway maintenance workers in the United States become organized. The fact that this has not yet been done on a broad scale offers maintenance management in the separate highway departments a real advantage in that, in the negotiations of any contracts, the opportunity for standards and incentives has not yet been prohibited.

Cox mentioned that one of the reasons for introducing incentive schemes was to make the job more attractive when recruiting labor. During discussions with Wingate of the Road Research Laboratory in England last summer, the comment was made that the incentive system brought the road workers "up to a level which was competitive with similar type work in other industries in the United Kingdom." One might ask at this point are incentives desirable? If they are so desirable why are they not more widely used in indirect labor operations in the United States?

Incentive systems have been operating in direct labor positions for a great number of years in this country. The purpose of these incentives, of course, is to increase productivity. There seems to be little doubt that the incentive systems have done this. The primary reason that the systems are not in indirect jobs at the present seems to lie in the fact that it is difficult to arrive at standards for these particular types of jobs. In the absence of standards, it is difficult to ascertain what a normal day's work is and, conversely, to reimburse an individual for a fixed percentage more of this normal day's work. Since we are deeply involved in creating standards for highway maintenance work at the present time, it would logically follow that the possibility exists in the near future for the introduction of incentive systems into these operations.

It appears to me that our friends in Great Britain have gained the march from us in this particular area by creating standards and incentive systems at the same time, whereas in this country one usually follows the other. I do not think that Cox has to apologize for the fact that, as of 1968, only 25 percent of the local authorities have introduced bonus incentive systems. This seems to be a substantial percentage in a field which is just getting started. He also mentioned that it would be a fair comment that very few authorities had made use of work and methods study without the use of bonus incentives.

Another area of interest lay in his observation that the trade unions concerned supported the policy so strongly that they have proposed a time limit after which those authorities which have not implemented bonus incentive systems should be penalized. This appears to be a very enlightened attitude and somewhat different from that which the weekly news magazines lead us to believe exist in the trade union group in Great Britain.

Another interesting aspect of Cox's presentation was the manner in which the interim period, that is, the period between the time that incentive systems have been decided on and the time firm standards are arrived at, is handled. The manner is such that a bonus system of some sort is instituted almost immediately.

It is somewhat disheartening that he mentions that the net potential savings to the authority are cautiously estimated at approximately only 1 percent of the wages bill.

He mentions that one approach to the introduction of standards is the "transplant scheme." Under this system the standards created by one authority are borrowed by another authority. Cox rightly emphasizes that this must be done with great care because of the possible great differences in productivity, methods, administration, and so forth, between authorities.

He also mentions a "national library or data bank" of performance values from different authorities. Such an institution does not exist in this country and it would appear that this is one of the important lessons that we might learn from Cox's presentation. The Highway Research Board appears to be the logical coordinating agency for this effort and, as a member of the maintenance and operations cost committee of the Highway Research Board, I and my committee have been investigating ways that we can use the TIES program as a repository for the information that is developed by our committee.

The "code of guiding principles" appears to be well thought out and the steps in introducing such a program appear to be in line with the recommended procedures in this country. Of particular interest is the cost-benefit analysis and the running cost analysis. It would be very helpful if the author could present examples of this calculation and give some insight into the factors used in this analysis.

Cox mentioned that the rate of bonus to be paid at standard performance is normally one-third of the basic rate. Is this amount budgeted by the authorities? If so, what do they do with the average? If not, how do they obtain the additional fund if the budget is based on the basic or normal rate? Another factor of interest is that of performance calculated on individual or group bases. Does the group share equally if bonus pay is made?

In the application of the bonus, mention is made that unmeasured work and lost time are recorded so as not to lose bonus on measured work. What percentage of the work is unmeasured? Mention is made that bonus is not paid for substandard work. Are there specific specifications for work or does the foreman judge whether the work is satisfactory or not? It would be interesting to know the distribution of the bonus. In other words, do most of the people who earn bonus pay earn one-third amount or is there some distribution between 1.0 (normal) and 1.3?

The "basic minute value" evidently corresponds to the MTM system.

It is mentioned that the values assigned to the various operations are applied to specific methods, materials, tools, and equipment but bonus incentive also helps to optimize gang size, although this is often specified. We would assume that whenever a standard is published, the size and makeup of the crew who can make that standard is specified. Much has been said in this country of the creation of methods standards and work measurement for highway maintenance work. In the preliminary survey of the system under discussion, mention is made that these two efforts come first of all. Although not entirely generic to this paper, it would be interesting to hear how these methods and standards are created in the United Kingdom.

The "financial assessment" appears to be very closely parallel to what we call engineering economy study in this country. In essence, that is the information necessary to discover any savings that might be attendant with methods improvements.

Mention is made that some work-study practitioners favor the introduction of the scheme carefully, activity by activity, over a very long period while others prefer implementation of all activities of the entire division of labor force participating. It would be interesting to know the experiences encountered in England when these two methods were applied in highway maintenance work.

In summary, it is interesting to speculate on the applicability of incentive systems on the U. S. scene. If so, how much of what has been done in England can we borrow? Basic to all discussions of highway maintenance operations are the problems of obtaining increased productivity. In the United Kingdom this is being done by incentive systems. What are we doing about it in the United States?

BRIAN E. COX, Closure—The North Dakota scheme described by Kyser is to some degree a pay-incentive scheme since the men know that by improving their knowledge, skills, and abilities they improve their earning capacity. However, there must be a limit to the number of men possessing any particular skill that can be employed and this inevitably places a constraint upon the continuing effect of the incentive. Of course there are the other forms of motivation such as Kyser has mentioned, but I would suggest that these tend to prevent discontent rather than increase productivity.

Mann's remarks concerning standards are particularly apposite, for without uniform standards a bonus-incentive scheme cannot succeed since there will be an uneven bonus earning capacity. As far as budgeting is concerned, this is based on a planned or target overall performance which experience has shown is attainable. This targeting acts as a spur to divisional management since, if the target performance is not achieved, the standards of maintenance cannot be achieved. Group bonus is used where a satisfactory performance can only be achieved by the combined efforts of the crew and in this case each man is credited with the same performance, but the actual amount of bonus paid depends upon basic wage as shown in Figure 2 of the paper.

Concerning the amount of unmeasured work it is generally accepted that this should not exceed 10 percent of the total work load for a successful scheme but the aim must be to reduce it to a minimum.

There must indeed be work specification but such standards of workmanship are not too difficult to devise since they are founded on widely accepted criteria.

Distribution of bonus can vary considerably but 10 percent of basic wage would be an average figure.

Methods and standards are determined using method study and highway engineering techniques although much work remains to be done on the establishment of objective criteria for standards.

Finally from the discussion remarks and the author's own experience, it seems there are few basic differences between the practice of highway maintenance in the United Kingdom and the United States and, therefore, it is reasonable to suppose that the bonus-incentive scheme described could be successfully applied in the United States.