Plant Cost Estimating I

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The Problem

For many years, the training of Quantity Surveyors and Estimators, has included tuition in the calculation of a rate per cubic (or superficial) yard and now the metre for the various classes of excavation and disposal and the importation and laying of filling, described in the Standard Methods of Measurement for Building and for Civil Engineering Works. In the days when the work was done by men with spades and barrows and inflation was a word used to describe filling a balloon, the calculation was relatively simple. Times have changed and so has the level of mechanisation and the problem is now very complicated. Even twenty years ago, the problem was not simple because the following matters had to be considered and each of them had a bearing on the final price:—

(i) the capital cost of the machine
(ii) loss of interest on money taken out of the bank to buy the machines, or the interest on a loan
(iii) the number of years of its working life
(iv) the number of hours in a year it could be expected to be available for work
(v) the output per hour
(vi) maintenance and repair costs
(vii) licence and insurance.

Table 1 illustrates a method of calculating the capital cost used during a course for the teaching of estimating:—

Table 1—Calculation of Capital Cost of an Excavator

	£
(i) Capital Cost say	25,000
Interest for 3 years expected working life at 8%	
3 years at 8% = 24%	6,000
	31,000
Less	
Estimated selling price in 3 years time	8,000
Capital Cost for 3 years	23,000
Ditto for 1 year	7,667

(ii) Assume machine operates for about 1800 hours per year, the capital cost per hour is
£7,667 ÷ 1800 hours = £4.26 per hour

To this Capital Cost would be added an hourly charge for repair, maintenance, licence and insurance and hourly running costs, driver's and banksman's pay and "on-costs", company overheads and profit.

The total of all this would be divided by the expected amount of earth (in cubic metres) the machine would dig in one hour and a rate found per cubic metre for the type of excavation described in the item in the Bill of Quantities.

Table 2 illustrates the build up of a rate for the final part of the whole calculation.

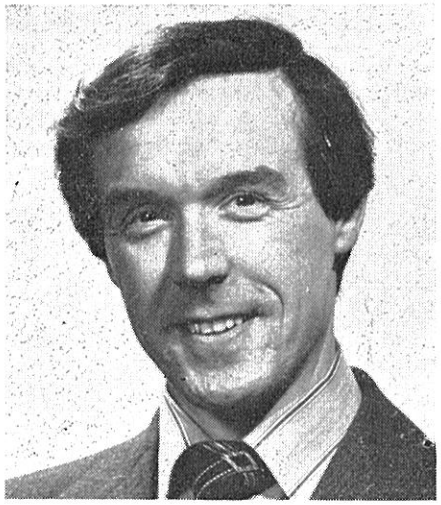

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Table 2—Calculation of a rate per cubic metre for an item in a Bill of Quantities

"Excavate foundation trench commencing at ground level and not exceeding 1.00 metre maximum depth"

Capital and running cost of excavator plus driver and banksman per hour *divided by* Output of machine in cubic metres on this type of excavation in the type of ground quoted in one hour.

Equals—Net cost per cubic metre *plus* Company overheads and profit *equals* Gross rate for insertion in B.Q.

The Present Situation

This style of calculation, with minor variations, appears to have been the pattern for students preparing for the professional examinations for many years and it does have much to commend it from the point of view of the various people involved:

Student—there are many other facts and figures to remember not only in the estimating examination and even this calculation is more than sufficiently complicated.

Lecturer—this calculation can be taught and understood by the students in the time available for this particular topic, bearing in mind the scope of the syllabus.

Examiner—this calculation is sufficiently complex for the student to demonstrate that he/she has (or has not) understood and knows the principal elements of cost on an item for machine excavation and the calculation would not take up too much of the available examination time.

From time to time, well meaning people have exhorted the Construction Industry to drag itself into the 20th Century by making greater use of mechanised equipment and where this has taken place, as in earthmoving, calculations of the type in Tables 1 and 2 will prove to be inadequate. The passage of time which has seen rapid inflation of costs and developments in equipment which, in turn have led to the growth of the specialised earthmoving contractor, whose heavy investment and large weekly costs need financial calculations of a high order and which are not fulfilled by Tables 1 and 2.

The Dilemma

It can be argued that if Tables 1 and 2 are not sufficiently accurate for the needs of a Company with much plant and equipment, then students should be taught methods which are appropriate. The fact is that such methods are much more complicated and lengthy and the dilemma lies in whether or not to devote much longer periods of time both in class and in the examinations to plant costing. The result, of course, would be less time spent on other topics.

The Solution

The solution may be to retain the present style of calculation (as in Tables 1 and 2) in order to provide the young surveyor with at least some simple tools of analysis and to emphasise the weaknesses for the application to major items in the real world of contract estimating. The student whose work or interests take him/her into plant costing would then need to undertake post graduate study in financial and accounting techniques to replace the simple methods with more powerful and sophisticated tools of analysis.

The Weaknesses—Compound Interest

Why is the assertion made that the methods shown in Tables 1 and 2 are unsatisfactory? One answer is to refer to Table 1 and see that the interest is charged at a simple rate. In reality, if the money used to buy the machine was left in the account, the interest it would earn would be calculated on a compound basis.

The formula for compound interest is more complicated than that used in Table 1 and it does make a difference to the figures. The purpose of adding interest to the amount of capital used is that it denotes the money lost to the firms by withdrawing capital to buy the machine. It also may be used to represent the cost of borrowing money. In this case, the cost is significantly greater because:

(a) the rate of interest will be higher
(b) a compound formula will certainly be used by the lender.

Table 3 illustrates the difference which occurs when compound interest is used.

Table 3—Calculation of Capital Cost of an Excavator using Compound Interest.

	£	£
Capital Cost say		25,000
Compound interest for 3 years expected working life at 8%	25,000	
Compound interest on £1 for 3 years at 8%	0.2597	6,493
		31,493

Less	
Estimated selling price in 3 years time	8,000
	£23,493

If the remaining figures are unchanged, the variation in the Capital Cost per hour is an increase of £0.09.

This change in the application of the rate of interest is probably the simplest factor to take into account. Much greater impact is made by the effects of Inflation and Corporation Tax relief.

Inflation

One effect of inflation can be simply shown as follows:—

Capital cost of machine in January 1980—say £25,000

Calculation to recover £23,493 depreciation over three years (Table 3) produces an hourly charge of £4.35.

This will provide the Company with £25,000 to buy a new machine in January 1983. (Note nothing is yet included for interest earned on the £4.35 whilst it is being set aside in a Sinking Fund to save up for the next machine).

If the cost of machines inflates at say 15% per annum for 3 years, the cost of a new machine in January 1983 will have compounded to £38,023. The Company will thus have insufficient funds to buy a replacement machine and the hourly rate should have taken this into account. How this can be done is illustrated in *Table* 4.

Table 4—Calculation of Capital Cost of Excavator using Inflation and Compound Interest

	£
(i) Anticipated cost of new machine in 1983 say	38,023
(ii) *Less* expected selling price of old machine	8,000
(iii) Capital to be accumulated over 3 years	30,023
(iv) *Add* Interest lost on the purchase price of the first machine (Table 3)	6,493
(v) Capital and Interest to be accumulated over 3 year period	36,516

Assume the Company has a deposit account which is paying 8% interest and will place into the account each year that part of the hourly cost which is intended to provide for replacement of Capital and Interest.

(vi) A calculation is possible which will show how much per year should be deposited at any rate of interest and any period of time to amount to a required figure by the end of the period assuming that the interest is left to accumulate with the annual deposits. Valuers refer to this as a Sinking Fund calculation. The total amount required is multiplied by a factor taken from the Annual Sinking Fund Table for 3 years at 8%	0.30803
(vii) Amount to be deposited at the end of each year for three years	11,248
(viii) Divided by 1800 hours per year expected working	=£6.24889
	say=£6.25 per hour

A sum quite different to that in Table 1.

If readers require clarification of the effect of the Annual Sinking Fund, *Table* 5 illustrates how the deposit made at the end of each year will accumulate to the sum required in the stated period.

Table 5 — Illustration of Sinking Fund Calculation

January 1980—buy new machine costing say £25,000	£
(i) Allow 1800 hours working for January 1980 to January 1981 @ £6.25 per hour deposited in a lump sum in January 1981	11,250
(ii) Ditto for January 1981 to January 1982	11,250
(iii) *Add* interest on (i) for one year at 8%	900
(iv) Amount in account in January 1982	23,400
(v) One year's work from January 1982 to January 1983 as above	11,250
(vi) *Add* interest on (iv) for one year at 8%	1,872
(vii) Amount in the account in January 1983	36,522

Notes: (i) the difference between (vii) above and (v) in Table 4 is due to rounding off the hourly charge to £6.25

(ii) no account is taken here of interest accumulation arising if the money is deposited weekly or monthly.

It can be observed that if the rate of £6.25 per hour is used for all three years, it will produce a higher than realistic charge for year one and a lower than realistic charge for year three. The rate for each year should rise to match the inflation in the cost of a new machine and still produce an amount which will show a return on capital invested and at the same time provide funds for the replacement of the machine at the required time.

Tax Relief

No calculations are shown for tax relief in this article but a major effect on the hourly rate is produced when capital allowances are taken into account. It is important to understand that depreciation as shown in Tables 1 to 5 is not the same as tax relief on plant purchases. Further calculations are needed to deal with this and can be shown later.

Buy, Hire, Borrow or Lease

The question is often asked, "Is it better to buy, hire, borrow or lease?" The answer sometimes is easy. "If you have a small amount of work for a specialised machine and you have no capital and low profits, hiring by the hour is the only possibility". When the question is asked about a machine capable of regular use and where capital and taxable profits exist, the answer is far from simple. The calculations shown here indicate a complex analysis, but they only scratch the surface, for none of the other considerations, (running costs, wages, utilization or output) have been included nor has the factor which has the greatest impact of all—namely the timing of receipts and payments. Companies who offer leasing arrangements have made a study of all the factors and the advent of pocket sized programmable calculators and small computers is now enabling Surveyors and Estimators to make their own financial appraisals and answer for themselves the question at the top of this paragraph.

Plant Cost Estimating II

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Tax Savings on Hire Purchase and Bank Loans

In the last article, attention was drawn to the simplicity of the calculations for assessing the Capital Cost of plant used in teaching and examinations and their weaknesses for the real life situation. Some examples were given of the changes which can occur to the hourly rate when other factors are considered.

This article looks at the ways of claiming tax relief on interest charged on Hire Purchase and Bank Loans and was prompted when a former student told me that his firm had bought a lorry on hire purchase at an interest rate of 6½%. It sounded too good to be true, but this is how it appeared.

	£
Amount borrowed	10,000
(Simple) interest at 6½% for 2 years = 13% =	1,300
Total	11,300
Divide by monthly payments	÷24
Monthly payment	£470.83
Rounded off to £470.90 per month	

The interest, it will be noticed, is taken on the intial amount borrowed for the full two years. Repayments are made monthly, which means that the full amount is not borrowed for the whole two years. Part of it is being repaid each month. It is not strictly accurate therefore, to record interest in this fashion. It does, however, provide an easily understood method of calculating the interest payable. The more accurate method when assessing true costs is to calculate the amount of interest on the remaining balance of the capital outstanding after each monthly payment is made. The calculation is more complicated than the one which is shown above and the compound rate of interest is not 6½%.

The firm bought the lorry two months before the end of its financial year and planned to claim tax relief on the interest as follows:—

1st financial year	2 months
2nd financial year	12 months
3rd financial year	10 months
Total	24 months

Total interest £1,300 = £54.166 per month
24

First Financial Year:
Two months interest @ £54.166 = £108.33 paid
Tax at 52% = £56.33 claim for tax relief
Second Financial Year:
Twelve months interest @ £54.166 = £650.00 paid
Tax at 52% = £338.00 claim for tax relief
Third Financial Year:—
Ten months interest @ £54.166 = £541.67 paid
Tax at 52% = £281.67 claim for tax relief

	Total Interest £	*Total Tax Relief Claimed* £
Yr. 1	108.33	56.33
Yr. 2	650.00	338.00
Yr. 3	541.67	281.67
	£1,300.00	£676.00

This method is also incorrect, for it assumes that each monthly payment includes the same amount of interest. If the proposition is accepted that each monthly payment contains a repayment of capital plus interest on the remaining balance of capital, then it follows that more interest and less capital will be paid per month at the beginning and more capital and less interest will be paid per month at the end. This may explain why early repayment of a hire purchase loan always costs more than the buyer expects.

More tax relief is therefore available in the first and second financial years than in the second and third. This is valuable, because in the first year of its life, the lorry is earning the highest income due to lower running costs and hopefully, greater reliability.

Enquiries were made of the Hire Purchase Company to find out:—

(a) the true compound rate of interest; and
(b) the month by month schedule of payments of principal and interest.

The Company was unable to supply the information.

It was necessary to investigate further and the mathematical formula for the calculation of compound interest for monthly payments was adopted. This formula cannot easily be solved when the only information available is:—

(a) the amount borrowed
(b) the monthly payment
(c) the number of months.

The solution can be found by using the formula on a trial and error basis and the Polytechnic's Computer was used to enable the large number of calculations to be performed at high speed.

The Computer carried out a number of calculations and produced the true annual rate of compound interest and the schedule of monthly payments showing the amount of interest and capital paid off each month.

The true annual rate of compound interest proved to be 12.72%—quite a difference to 6½% Simple Interest.

The schedule of payments is reproduced below:—

Financial Year	*Month*	*Payment* £	*CASH OUTFLOWS* *Interest* £	*Capital* £	*Capital Balance* £
1977/78	Amount borrowed				10,000
	11	470.90	100.30	370.60	9,629.40
	12	470.90	96.58	374.32	9,255.08
1978/79	1	470.90	92.83	378.07	8,877.00
	2	470.90	89.03	381.87	8,495.14
	3	470.90	85.20	385.70	8,109.44
	4	470.90	81.34	389.56	7,719.88
	5	470.90	77.43	393.47	7,326.41
	6	470.90	73.48	397.42	6,928.99
	7	470.90	69.50	401.40	6,527.58
	8	470.90	65.47	405.43	6,122.15
	9	470.90	61.40	409.50	5.712.66
	10	470.90	57.30	413.60	5,299.05
	11	470.90	53.15	417.75	4,881.30
	12	470.90	48.96	421.94	4,459.36
1979/80	1	470.90	44.73	426.17	4,033.19
	2	470.90	40.45	430.45	3,602.74
	3	470.90	36.13	434.77	3,167.97
	4	470.90	31.77	439.13	2.728.85
	5	470.90	27.37	443.53	2,285.31
	6	470.90	22.92	447.98	1,837.34
	7	470.90	18.43	452.47	1,384.86
	8	470.90	13.89	457.01	927.85
	9	470.90	9.31	461.59	466.26
	10	470.90	4.68	466.22	0.04

It will be noticed that the total amount of interest charged is slightly higher due to rounding off figures, and the rate per cent of compound interest is more accurately stated.

What is the effect of all this on the claim for tax relief? The Company's new claim is:—

First Financial Year:—
Month 11—interest paid £100.30
Month 12—interest paid 96.58
Total interest paid yr. 1 £196.88

Tax at 52% = £102.38 claim for tax relief.
This claim for tax relief is 81.75% higher than the claim available under the first calculation and makes this exercise well worthwhile.
Second Finanvial Year:—
Months 1-12 inclusive interest paid £855.09
Tax at 52% = £444.65 claim for tax relief.
Third Financial Year:—
Months 1-10 inclusive interest paid £249.68
Tax at 52% = £129.83 claim for tax relief.

	Total Interest £	*Total Tax Relief Claimed* £
Yr. 1	196.88	102.38
Yr. 2	855.09	444.65
Yr 3	249.68	129.83
	£1,301.65	£676.86

This again, is almost the same as the original computation and the differences arise through rounding off the monthly payments,

It is suggested that it would be profitable for any firm buying expensive equipment on hire purchase to carry out this exercise for the following reasons:—

(i) the correct calculation of compound interest is vital, for it enables tax relief to be properly claimed.
(ii) the greater tax relief is available at the time when the profits on a new lorry or machine are probably at their highest.
(iii) the figures given in this example are relatively small, but could have considerable benefit to a firm with large plant holdings on hire purchase agreements.
(iv) knowledge of the true rate of interest at which money is being borrowed is of the greatest importance when the computations are being made of the cost of buying and operating plant and which leads into the calculation of a rate per unit of output for tendering purposes.

It is recognised that a firm interested in checking their own costs may be able to obtain all the figures from the hire purchase company. If this is not possible, and the means of doing the calculations are not readily available, the Author may be able to provide assistance.