# Improved Accounting of Interest Charges in Equipment Costing

Andrew F. Howard,[1]
*University of British Columbia*
*Vancouver, BC, Canada*

## ABSTRACT

Interest charges are an important component of owning and operating costs for logging equipment. Methods commonly employed by researchers and practitioners ignore the difference between interest on borrowed money and proprietary capital invested. Correct formulas for computing interest charges are given and a comparative study between historic methods and the appropriate computations is presented.

**Key Words:** *Equipment costing, interest charges.*

## INTRODUCTION

Interest charges are an important component of equipment costs in forest harvesting operations. These charges must be computed accurately to insure economic analyses such as, equipment replacement studies based on economic equivalence, establishment of contract rates, or equipment rental rates, are done correctly.

There are two kinds of interest costs which accrue to equipment owners: interst on borrowed money and interest on proprietary equity. Methods documented in the literature [1] which are commonly cited and used do not differentiate between the two kinds of interest. The two components of interest are treated differently with respect to taxes in many countries, so separate accounting is required for most economic analyses. Furthermore, the conventional approaches lead to a consistent underestimation of interest costs because of the method used to figure asset value. These are both serious shortcomings which can be avoided using the methods presented here.

[1]The author is Assistant Professor, Harvesting and Wood Science, Faculty of Forestry.

The objective of this paper is to present a comprehensive treatment of interest charges in equipment costing. The appropriate calculations for interest on borrowed money and proprietary equity are given, and examples are provided. The purpose is not to replace standard economic analyses for equipment, rather to augment such studies by improving the accuracy of estimates for one component of machine costs. A comparative study between historical methods and the procedures shown here is also presented.

## INTEREST ON BORROWED MONEY

Many Forestry contractors borrow money to finance equipment. Interest charges on such monies are a function of four things:

1. The principal, or principal outstanding on the loan ($).
2. The term of the loan (years).
3. The interest rate (usually an annual percentage rate).
4. The frequency of compounding (usually annual).

Repayment of loans usually takes the form of an annuity. An annuity is simply a series of equivalent payments with fixed frequency and number. Logically, annuity formulas are used to compute the costs associated with repayment of the loan. The total annual payment is fixed and is calculated using equation 1 shown below:

$$AP = P\,i \,/\, [1 - (1+i)^{-n}] \qquad (1)$$

where

AP = the annual payment ($),

P = the original principal on the loan ($),

i = the nominal annual interest rate on the loan (decimal),

n = the term of the loan (in years assuming annual compounding).

**Table 1** — Computation of Interest Charges from a Bank Loan for a Grapple Yarder.

| | |
|---|---|
| Assumptions: | |
| Purchase price | $ 1,000,000 |
| Down payment | $ 250,000 (25% of purchase price) |
| Annual interest rate | .15 (15%) |
| Term of loan | 5 yrs. |
| Scheduled hours per year | 1200 |
| Annual Payment ($) | = [(1,000,000-250,000) * .15]/[1-(1+.15)$^{-5}$] |
| | = 223,737 |
| Interest year 1 ($) | = 223,737 * [1-(1+.15)$^{-(5-1+1)}$] |
| | = 223,737 * .5028232 |
| | = 112,500 |
| Hourly interest year 1 ($/hr) | = 112,500/1200 |
| | = 93.75 |

| Year | Annual Interest Cost ($) | Hourly Interest Cost ($) |
|---|---|---|
| 1 | 112,500 | 93.75 |
| 2 | 95,820 | 79.85 |
| 3 | 76,632 | 63.86 |
| 4 | 54,564 | 45.47 |
| 5 | 29,184 | 24.32 |

Annual interest charges are simply the product of the principal outstanding and the interest rate on the loan. Keeping track of the principal outstanding each year is somewhat tedious, so it is convenient to have an expression for computing interest charges directly for any year. This expression is given in equation 2.

$$I_t = AP\,[1 - (1+i)^{-(n-t+1)}] \qquad (2)$$

where

$I_t$ = the interest ($) paid in year t, and all other variables are as defined before.

The principal repayment portion of the annual payment is simply the difference between the interest charges for the year and the total payment:

$$P_t = AP - I_t \qquad (3)$$

where

$P_t$ = the principal ($) repayment in year t, and all other variables are as defined before.

Alternatively, the principal repayment in any year can be calculated directly using equation 4.

$$P_t = AP \,/\, (1+i)^{-(n-t+1)} \qquad (4)$$

In equipment costing, only the interest portion of the annual payment is included. The principal repayment serves to increase the share of equity (capital) in the machine of the borrower. Capital recovery in equipment costing is accounted for through depreciation. An example of the calculation of interest charges accruing from borrowed money is given in Table 1.

## INTEREST ON PROPRIETARY EQUITY

Interest charges also accrue as an "opportunity cost" for capital invested in equipment. Owners "incur" costs associated with the investment of capital in logging equipment rather than some alternative investment. In fact, this component of interest charges is actually profit, or return on investment. Interest "costs" of this nature are a function of two things:

1. The amount of capital invested.

2. The rate of return (interest rate) for an alternative investment.

Estimating the amount of capital invested in an individual machine for any year is probably the more difficult of the two. Three possibilities are discussed here. First, the undepreciated value of the machine (book value) could be used. Assets should only be required to provide return on the unrecovered (undepreciated) portion of the original investment which for any year is the beginning book value.

Second, an estimate of the current market value could be used. Opportunity costs arise from the alternative investment which can only be realized if the machine is sold. In this case, current market value is perhaps a better estimate of the amount of capital tied up in the machine. Unfortunately, arriving at an estimate of market value is much more difficult than simply computing current book value. Equipment dealers, equipment auction summaries, and past experience can provide some assistance in fixing market value, however, such estimates are subject to substantial uncertainty.

Finally, the net worth of the machine can be used. The fundamental accounting equation tells us,

$$\text{Net Worth} = \text{Assets} - \text{Liabilities} \qquad (5)$$

Taking the logic applied in the "market value" approach one step further, the owner must settle all outstanding debts when the current machine is sold. Proceeds from the sale must first meet obligations to the lender (liabilities in equation (5)), and it is the remainder which is the true measure of the owner's share of equity.

The outstanding liability on the loan for a given year is simply the present value of the remaining payments of the annuity. Rearranging equation (1) to solve for P (in this case the principal outstanding) gives the appropriate expression.

$$P_t = AP\,[1 - (1+i)^{-(n-t)}]/i \qquad (6)$$

where

$P_t$ = the principal ($) outstanding in year t, and all other variables are as defined before.

In many cases the lender will apply a penalty in the form of additional charges for early termination of the agreement. The sum of these charges and the principal outstanding is the total liability for the machine.

Estimating the asset value for the machine can be done in one of two ways. The current book value (undepreciated value), or an estimate of the current market value can be used. These two approaches are identical to those discussed above, and in fact the use of net worth as an estimate of owner equity share differs only in that it recognized outstanding financial commitments on the machine. The net worth approach for computing interest "costs" from proprietary equity is given in Table 2 using current book value as the estimate of asset value. Declining balance depreciation was used with a rate of 30% to compute the values shown in column two. Column three (Principal Outstanding) was computed using equation (6). Column four was computed using equation (7), (the difference between column two and three). Column five was computed as the product of the alternative rate of return given in the assumptions and column four. Column six was computed by dividing column five by the scheduled hours per year.

## A COMPARATIVE STUDY

Published methods [1] for estimating interest charges are often cited and used in the forest engineering literature. Two procedures are documented, both of which use book value to estimate owner equity share in equipment termed Average Value of yearly Investment (AVI). One method is applicable if straight-line depreciation is used, the other is used if the machine is depreciated using declining balance. Interest charges are computed by simply applying an annual interest rate to the estimated asset value. Neither method distinguishes between interest on borrowed money and owner share of equity. The computation of annual interest costs using AVI (declining balance) is shown in equation (7).

$$I_t = [\,(BV_{t-1}+BV_t) / 2] * i \qquad (7)$$

where

$I_t$ = the interst ($) paid in year t,

$BV_t$ = the book value ($) of the machine at the end of year t,

i = the nominal annual interest rate (decimal).

**Table 2** — Estimating Interest on Proprietary Equity Using the Net Worth Approach.

| Assumptions | |
|---|---|
| Original Book Value[1] | $ 950,000 |
| Depreciation Rate | 30% |
| Loan Parameters | see Table 1 |
| Loan Penalty | none |
| Alternative Rate of Return | .15 (15%) |
| Schedule Hours per Year | 1200 |

| Year | Beginning Year Book Value ($) | Principal Outstanding ($) | Current Net Worth ($) | —Interest— Annual ($) | Hourly ($/hr) |
|---|---|---|---|---|---|
| 1 | 950,000 | 750,000 | 200,000 | 30,000 | 25.00 |
| 2 | 665,000 | 638,763 | 26,237 | 3,936 | 3.28 |
| 3 | 465,500 | 510,846 | -45,846 | — | — |
| 4 | 325,850 | 363,741 | -37,891 | — | — |
| 5 | 228,095 | 194,568 | 33,527 | 5,029 | 4.19 |

[1] Purchase price was reduced by 5% to adjust for nondepreciable items.

A comparative study was made between methods described in this paper, termed the annuity-net worth approach, and AVI for declining balance (equation (7)). The values for the annuity-net worth approach are simply the sum of the values shown in the last column of tables 1 and 2: interest on borrowed money plus interest on proprietary equity. Estimates of interest costs per hour for the two methods are graphed against year since purchase in Figure 1. The date used in the study are the same as shown in tables 1 and 2. The results show that the AVI approach consistently underestimates interest charges when compared to the annuity-net worth approach. The difference ranged from $17.81/hr in year 1 to $4.27/hr in year 5.

## DISCUSSION

The AVI approach applicable when declining balance depreciation is used estimates asset value as the average of the beginning and ending year book values. Asset values used in the annuity-net worth approach are equivalent to beginning year book values provided the liability on the machine does not exceed this value. Consequently, the annuity-net worth approach utilizes a higher total asset value than AVI in figuring the demand for annual return which results in higher annual interest "charges." In years when the principal outstanding (liability) exceeds beginning year book value (years 3 and 4, see Table 2), interest charges accrue from the loan only. Differences between estimates of interest charges for the AVI and annuity-net worth methods are greatest on a percentage basis in these years (year 3, 22.5%; year 4, 23.9%).

The annuity-net worth approach is based on beginning year asset values. The method is appropriate only when a combination of borrowed money and owner capital is used to purchase equipment. If machinery is paid for outright by owners, the beginning year book value (unrecovered portion of capital), or current market value should be used as a measure of current capital invested. In this case, an alternative rate of return should be applied directly to compute annual interest charges.

A comprehensive discussion of the tax treatment of interest charges is not in the scope of this paper. However, the implications of choosing either AVI or the annuity-net worth approach regarding tax treatment are important enough to warrant mention. Interest charges on borrowed money used to finance machinery are tax deductible in many countries. Interest on proprietary capital is actually profit which is usually taxable. The AVI approach

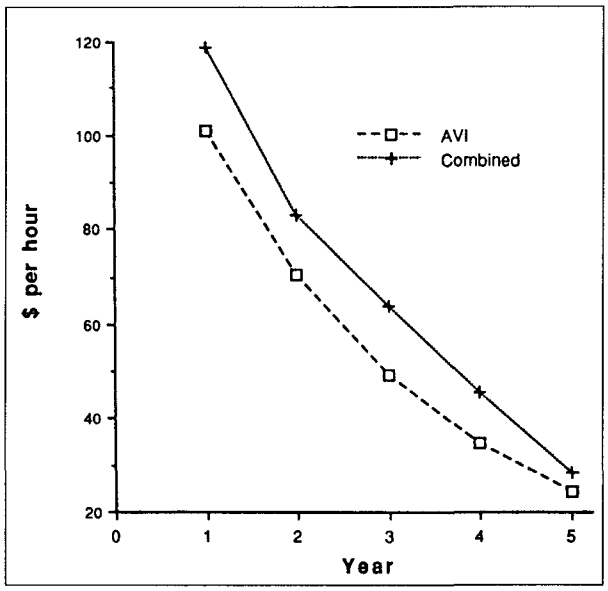


**Figure 1.** Comparison of Annual Interest Costs Between Two Accounting Methods

does not account separately for the two kinds of interest which precludes its use in any economic analyses involving after-tax measures of profitability. The annuity-net worth approach does account for the two kinds of interest separately, which permits assessment of the appropriate tax treatment, and is, therefore, preferred.

The annuity-net worth approach for estimating interest charges presented here requires computations which are not more difficult than those needed for the AVI methods. The annuity-net worth approach is the correct method for computing interest charges, and its use will insure appropriate hourly equipment costs are used in figuring rental rates, contract logging rates, and profitability. Forestry contractors, like all business people, expect acceptable profits from their labors. Accurate equipment costing, including the correct treatment of interest charges, is required to insure equitable returns.

## LITERATURE CITED

[1] Miyata, E.S., 1980. Determining fixed and operating costs of logging equipment. USDA For. Serv. Gen. Tech. Rpt. 55, 16 pp.