# Cost Estimation

# Cost Estimation

- Hourly equipment costs can be obtained in several ways:
  - Actual cost records
  - Machine rate

# Machine Rate

- The machine rate cost estimation procedure was first developed and published by D.M. Matthew in 1942.
- The method has been widely used in both the USA and Canada for 50+ years.
- Miyata (1980) reviewed the machine rate procedure and assumptions used with this method.

# Machine Rate

The machine rate cost estimation procedure categorizes equipment costs into three classes:

- Fixed or ownership costs,
- Variable or operating costs, and
- Labor costs.

# Fixed Costs

- Fixed costs are incurred regardless of whether or not the machine is operated.
- Fixed costs include:
  - Depreciation (D)
  - Interest, insurance, and taxes (IIT)
- Fixed costs
  - do not vary with the level of production,
  - are always computed on a SMH basis.

# Depreciation

(Fixed Costs)

$$D(\$/SMH) = \frac{(P - S)}{N \times (SMH/Year)}$$

Where

D = depreciation, $/SMH

P = equipment purchase price, $

S = salvage value, $

N = economic life, years

SMH/Year = scheduled machine hours a year

# Depreciation

## (Example)

For example, if a sawhead feller-buncher:

- cost $140,000 to purchase
- had an expected salvage value of $35,000 (25% of P)
- after four years (2000 SMH/year) of use

The depreciation would be calculated as follows:

$$D(\$/SMH) = \frac{(\$140{,}000 - \$35{,}000)}{4\,years \times (2000\,SMH/year)} = \$13.13/SMH$$

# IIT

## (Fixed Costs)

Interest, insurance, and taxes (IIT) are commonly quoted as:

- A percentage of the average value of yearly investment (AVI) of the machine over its entire life.
- AVI is computed as:

$$AVI\ (\$ / year) = \frac{(P - S) \times (N + 1)}{2 \times N} + S$$

# IIT
## (Example)

For the sawhead feller-buncher in the example, AVI is:

$$AVI\,(\$/year) = \frac{(\$140{,}000 - \$35{,}000) \times 5}{8} + \$35{,}000 = \$100{,}625/year$$

# Fixed Costs IIT
## (Example)

If interest was assumed to be 15%,
insurance to be 3%, and
taxes to be 2% of AVI respectively,
then IIT would be computed as:

$$IIT(\$/SMH) = \frac{(0.15+0.03+0.02) \times \$100{,}625/year}{2000 SMH/year} = \$10.06/SMH$$

# Fixed Costs
## (Example)

The total costs for the feller-buncher will be:

$$\text{Total Fixed Costs} = D + IIT$$
$$= \$13.13/SMH + \$10.06/SMH$$
$$= \$23.19/SMH$$

# Variable Costs

- Variable costs
  - are incurred only when the machine is operated
  - usually reported on a $/PMH basis
- Cost items which vary with machine operation include:
  - Fuel and lubricants (F&L)
  - Maintenance and repair (M&R)

# Maintenance and Repair (M&R)

- Includes items ranging from scheduled preventive maintenance to major repairs:
  - These costs are best estimated from previous experience with similar equipment in similar conditions.
  - However, such experience is often not available, especially with new equipment models.
  - Commonly used way for estimating M&R costs is based on a percentage of depreciation cost.

# M&R

## (Variable Costs)

$$M\&R(\$/PMH) = \frac{(\%M\&R) \times (P - S)}{N \times (SMH/year) \times UT}$$

Where

P=equipment purchase price price, $
S=salvage value, $
N=economic life, years
SMH/Year=scheduled machine hours a year
UT=utilization rate, % of SMH
%M&R=assumed value or from records

# M&R
## (Variable Costs)

Alternatively, the above equation could be represented as:

$$M\&R(\$/PMH) = \frac{(\%M\&R) \times D}{UT}$$

Where D=depreciation, $/SMH
UT=utilization rate, % of SMH
%M&R=assumed value or from records

# M&R
## (Example)

Again using our example of the sawhead feller-buncher, Let's assume that:

- M&R costs are equivalent to 100% of D, and
- Utilization averages 65%.

M&R can be calculated as:

$$M\&R(\$/PMH) = \frac{(1.00) \times \$13.13/SMH}{0.65} = \$20.20/PMH$$

# Variable Costs

## tire and track

- There are two ways of handling tire and track costs in the machine rate calculation:
  - <u>As a part of maintenance and repair</u>
    - this is the most common method
    - the cost of the original set of tires or tracks on the machine is included with the initial purchase price of the machine
  - <u>Separate tire and track costs from M&R</u>

# Fuel and Lubricants

## Variable Costs

- Fuel and lubricants (F&L) costs depend on:
  - Consumption rate
  - Unit price
- Fuel is either gasoline or diesel.
- Lubricants include:
  - engine oil, transmission oil, hydraulic oil,
  - grease, and
  - other lubrication fluids

# F&L Costs

- Consumption rates for fuel and lubricants are known for a vehicle from available records,
- Prices for fuel and lubricants are easily obtained from local petroleum product dealers or service stations.

The F&L costs are simply computed as:

F&L ($/PMH) = consumption rate × price

Consumption rate = gal/PMH

Price=$/gal

# F&L Consumption Rates

Consumption rates may also be estimated using the following equations reported by Miyata (1980):

$$\text{Diesel engine (gal/PMH)} = 0.037 \times \text{HP}$$
$$\text{Gasoline engine (gal/PMH)} = 0.050 \times \text{HP}$$
$$\text{Engine oil (gal/PMH)} = (0.005 \times \text{HP}) + \text{C/T}$$

Where HP=net horsepower at maximum rated engine speed
C=crankcase capacity
T=time between oil changes (PMH)

# F&L Costs

## (Example)

For the sawhead feller-buncher, used in our example, assume:

- Diesel fuel is consumed 6.5 gal/PMH costing $0.75/gal
- Lubricants are consumed at a rate of 1 gal/PMH at a cost of $4.65/gal.

$$\text{F\&L (\$/PMH)} = (6.5\ \text{gal/PMH}) \times (\$0.75/\text{gal}) + (1.0\ \text{gal/PMH}) \times (\$4.65/\text{gal})$$
$$= \$9.53/\text{PMH}$$

# Variable Costs

Total variable costs are obtained by summing M&R and F&L costs. For the machine in our example:

Total Variable Costs = M&R + F&L

= $20.20/PMH + $ 9.53/PMH

= $29.37/PMH

# Labor Costs

- Labor costs include:
  - wages paid to employees and
  - all fringe benefits associated with the cost of labor.
- Labor costs in the machine rate are usually calculated by:
  - taking the wage rate and
  - adding a percentage for fringe benefits.

# Labor Costs

- The fringe benefit percentage can be obtained using:
  - figures from payroll records or
  - roughly estimates.
- Labor costs may be computed on either a productive or scheduled machine hour basis. We usually use a SMH basis.

# Labor Costs

- Many logging contractors pay their employees by:
  - day,
  - production, or
  - some combination of hourly rates with a production bonus
- These methods must be converted to either a $/SMH or a $/PMH.

# Labor Costs

## (Example)

In the example, let's give a fringe benefit rate of 40% of wage. If the operator is paid $6.50 per hour, labor costs are then calculated as follows:

$$\text{Labor Cost (\$/SMH)} = \$6.50/\text{SMH} \times (1+0.40)$$
$$= \$9.10/\text{SMH}$$

# Total Cost

To obtain the total hourly cost of operating sawhead feller-buncher in the above example, we combine our estimates:

Total Costs ($/SMH) = Fixed Cost + Variable Cost + Labor Cost
= $23.19/SMH + $29.73/PMH ×(0.65) + $9.10/SMH
= $51.61/SMH

# Total Cost

It can be also reported on the PMH basis.

Total Costs ($/PMH) = Fixed Cost + Variable Cost +
Labor Cost
= ($23.19/SMH)/0.65 + $29.73/PMH +
($9.10/SMH)/0.65
= $79.41/PMH

# Pros and Cons of Machine Rate

## (Advantages)

- Widely used and understood by nearly everyone associated with the timber harvesting industry
- Simple to perform and requires relatively little information
- Useful for discussing logging equipment and systems at meeting attended by group of competitors where violations of antitrust laws could potentially occur.

# Pros and Cons of Machine Rate

(Disadvantages)

- Neither income taxes nor the time value of money are included in the calculations.
- Costs for a machine are assumed to be a constant over the life of the machine.
- Costs computed with the machine rate are highly dependent on the assumed purchase price, salvage value, and economic life.

# Combining Costs and Productivity

- An estimate of cost per unit volume of production.
- For the sawhead feller-buncher used in the earlier example, total hourly cost was $51.61/SMH or $79.41/PMH.
- Assuming that this machine could produce 37.4 cords per PMH, an estimate of cost per cord could be obtained as follows:

# Combining Costs and Productivity

$$\text{Cost Per Cord} = \frac{\text{Cost per Hour}}{\text{Volume per Hour}} = \frac{\$79.41 / \text{PMH}}{37.4 \text{ cords} / \text{PMH}} = \$2.12 / \text{cord}$$

# Direct Logging Costs

- So far we have only addressed the direct costs associated with logging.
  - such as the costs of felling, skidding, loading, and hauling.
- These costs are important and usually command most of a contractor's attention.
- These costs (or direct logging costs) often account for 65-85 percent of total costs.

# Indirect Logging Costs

- The remaining cost factors associated with logging are often labeled “indirect”.
- These costs can account for the remaining 15-35% of the total.
- Lack of attention to these cost factors can also result in an operational loss.

# Indirect Logging Costs

Indirect logging costs are usually caused by:

- Moving expenses from one tract to another.
- Logging permits from local counties.
- Road and landing construction.
- Overhead expenses usually including:
  - office expenses,
  - legal and accounting services,
  - bookkeeping, and communications.

# Indirect Logging Costs

## (Moving Expense)

- Is one of the most frequently incurred indirect costs for a logging contractor.
- Moving disrupts production in addition to incurring the actual costs of labor and fuel to move.
- Several approaches may be used to minimize such disruption, production losses, and costs:
  - Adequate pre-harvest planning
  - Placing road in proper location

# Indirect Logging Costs

## (Moving Expenses)

- Let assume a logger spends ½ day moving to a 65-acre tract with 23 cords per acre.
- He normally moves 10 loads per day, but loses 5 loads (9.5 cords/load) while moving.
- His current cut and haul rate is $35/cord. Labor, equipment, and fuel costs come to $1200 during the move.

Considering these costs, moving to this tract would cost this logger:

$$Cost/cord = \frac{5 \times 9.5 \times 35 + 1200}{65 \times 23} = \$1.91/cord$$

# Indirect Logging Costs

## (Moving Expenses)

If the logger could move after-hours and not lose the 5 loads of production, his moving cost per cord for the tract could be:

$$Cost / cord = \frac{1200}{65 \times 23} = \$0.80 / cord$$

However, if the logger has to move off the tract and later return, his moving cost would at least double:

$$Cost / cord = 2 \times 1.91 = \$3.83 / cord$$

# Indirect Logging Costs

## (Permits, roads and landings)

- If the logger is moving to a tract, he will have to obtain permits and build road entrances.
- Assuming that the permits and road construction cost $3000.

We compute the cost of permits and road as follows:

$$Cost / cord = \frac{3000}{65 \times 23} = \$2.01 / cord$$

# Indirect Logging Costs

## (Overhead)

If a logger spends $650 per month on supplies,
$350 per month on radios and phones, and
$2000 per month on a bookkeeper and office,
then total monthly overhead expenses would be $3000.
Assuming that the logger moves 50 loads per week (475 cords),
we could compute overhead costs per cord:

$$Cost\,/\,cord = \frac{650 + 350 + 2000}{475 \times 4} = \$1.58\,/\,cord$$