Logging System Analysis

- Spreadsheet programs:
  - operate on PC
  - provide a powerful and user-friendly way of estimating costs

- The PC spreadsheets can:
  - reduce the time spent on making calculations
  - permit rapid examination of costs under several sets of assumptions
Spreadsheet Programs

- Three spreadsheet programs:
  - Machine Rate Spreadsheet
  - Auburn Harvesting Analyzer
  - Central Appalachian Harvesting Analyzer
Machine Rate Spreadsheet

- This simple spreadsheet:
  - takes input values for a machine rate calculation
  - computes the hourly costs per SMH and per PMH for a single machine
- The input, assumptions, and calculations follow the method described earlier by Miyata (1980).
Summary of Machine Rate

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

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

\[
IIT (\$/SMH) = \frac{(\% IIT) \times AVI}{2000SMH / Yrs}
\]

Fixed Cost (\$/SMH) = D + IIT

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

F&L (\$/PMH) = Consumption Rate \times Unit Price

Variable Cost (\$/PMH) = M& R + F& L

Labor (\$/SMH) = Hourly Rate \times (1 + Fringe Benefits)

Total Cost (\$/PMH) = Fixed Cost + Variable Cost + Labor Cost
**Machine Rate Spreadsheet**

### Estimation of Hourly Machine Rate Costs

**by Jingxin Wang**

**Machine:** Hydro-Ax 611 feller-buncher with circular sawhead

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable Costs</th>
<th>Labor Costs</th>
<th>Total Hourly Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Costs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>13.125 $/SMH</td>
<td>4.23 $/Wages or Salaries</td>
<td>17.35 $/SMH</td>
</tr>
<tr>
<td>Interest, Insurance, &amp; Taxes</td>
<td>10.0625 $/SMH</td>
<td>1.69 $/Fringe Benefits</td>
<td>11.75 $/SMH</td>
</tr>
<tr>
<td><strong>Total Fixed Costs</strong></td>
<td>23.19 $/SMH</td>
<td>5.92 $/Wages or Salaries</td>
<td>29.11 $/SMH</td>
</tr>
<tr>
<td><strong>Variable Costs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance &amp; Repair</td>
<td>13.125 $/SMH</td>
<td>4.23 $/Wages or Salaries</td>
<td>17.35 $/SMH</td>
</tr>
<tr>
<td>Fuel &amp; Lubrication</td>
<td>6.18 $/SMH</td>
<td>1.69 $/Fringe Benefits</td>
<td>7.87 $/SMH</td>
</tr>
<tr>
<td><strong>Total Variable Costs</strong></td>
<td>19.31 $/SMH</td>
<td>5.92 $/Wages or Salaries</td>
<td>25.23 $/SMH</td>
</tr>
<tr>
<td><strong>Total Labor Costs</strong></td>
<td>5.92 $/SMH</td>
<td>5.92 $/Wages or Salaries</td>
<td>11.84 $/SMH</td>
</tr>
<tr>
<td><strong>Total Hourly Costs</strong></td>
<td>48.41 $/SMH</td>
<td>11.84 $/Wages or Salaries</td>
<td>60.25 $/SMH</td>
</tr>
</tbody>
</table>
Auburn Harvesting Analyzer

- A spreadsheet designed to simplify the estimation of logging costs.
- Originally developed in 1984 at Auburn University, Alabama.
- With few modifications, the spreadsheet can be used to model nearly any logging systems.
- Its simplicity and ease of modification to model new systems have made it popular among logging analysts.
The calculations performed in the Auburn Harvesting Analyzer are identical to those performed manually as we described earlier.

A stand and stock table and other input variables are used to provide input for production equations.
Auburn Harvesting Analyzer

- The production rate and the number of machines in each function are combined to determine:
  - the limiting function of the system, and
  - the actual utilization of each function

- Productivity per SMH is then combined with hourly cost to calculate cost per unit volume for each function in the system.
Production rate for each function is computed within the spreadsheet.

The effects on system production and cost can be quickly examined by changing:

- stand types, or
- other operating variables
### Auburn Harvesting Analyzer

**Logging Cost Analysis Shortcourse**

**Auburn Harvesting Analyzer**

**SYSTEM:**

<table>
<thead>
<tr>
<th>STAND &amp; STOCK TABLE</th>
<th>GENERAL INFORMATION</th>
<th>Tract Size = 250 Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBH</td>
<td>Tons/Tree</td>
<td>Tons/Ac</td>
</tr>
<tr>
<td>8</td>
<td>22</td>
<td>0.094</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
<td>0.417</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>0.524</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>0.910</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>1.204</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>1.605</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>1.408</td>
</tr>
<tr>
<td>22</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL</td>
<td>89</td>
<td>30.51</td>
</tr>
</tbody>
</table>

**TOTAL 89**

**Quad. Mean DBH = 9.35**

**Mill Quota (Tons/Wk) = 9999**

### There are five sections:
- **Stand & Stock Table,**
- **System Information,**
- **Machine Productivity,**
- **Machine Cost,** and
- **System Calculation.**
Stand and Stock Table

- The stand and stock table is found in the upper left corner of the spreadsheet.
- The user enters:
  - the range of DBH values,
  - stand density in each class, and
  - an appropriate local volume table or equation
- The input here is used for calculating the felling production per PMH.
Logging System Information

- General information about the logging system is found to the right of stand and stock table in Section 2.

- The user enters:
  - machine hours scheduled per day,
  - tract size,
  - support costs, and
  - road building costs, etc.
Machine Productivity

- Potential hourly productivity is computed for each function in the system in Section 3.
- These production estimates are calculated using
  - stand and stock table, and
  - general information
- Published production equations or other methods can be used to calculate hourly productivity by each function.
Machine Productivity
(Operator Efficiency)

- The source of production information does not provide a realistic measure of actual production.
- **The operator efficiency value is used to adjust the production.**
- **Value of 1.0** indicates that the operator in the system being modeled produces at the rate indicated by the equation being used.
- **Using a value of 0.85** would indicate that the operator is 15% less productive.
- **While value of 1.20** would reflect an operator who was 20% more productive.
Machine Cost Estimates

- Section 4 contains the machine rate cost estimates provided by the user for each function.
- The number of machines in each function and their availability are entered in this section.
- Fixed and labor costs are entered on a cost per SMH basis while variable costs are on per PMH basis.
System Calculation

- The last section of the spreadsheet:
  - is composed entirely of calculations, and
  - contains no user input
- Information from other sections of the spreadsheet is combined to determine:
  - the limiting factor of production,
  - actual utilization of each function,
  - hourly costs and cost per unit volume
  - weekly production, and
  - the number of days needed to harvest the tract
Central Appalachian Harvesting Analyzer

<table>
<thead>
<tr>
<th>ESTIMATION OF HOURLY MACHINE COSTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price ($)</td>
</tr>
<tr>
<td>Salvage Value (%)</td>
</tr>
<tr>
<td>Economic Life (years)</td>
</tr>
<tr>
<td>Interest</td>
</tr>
<tr>
<td>Insurance</td>
</tr>
<tr>
<td>Taxes</td>
</tr>
<tr>
<td>Weekly/year</td>
</tr>
</tbody>
</table>

**FRAISED COSTS:**
- $/SM/H: 8.44
- $/PMH: 9.96

**VARIABLE COSTS:**
- Maintenance & Repair: 8.44
- Fuel & Lubrication: 6.10

**LABOR COSTS:**
- Wages or Salaries: 12.00
- Fringe Benefits: 4.80

**TOTAL HOURLY COSTS:**
- 46.33

- **VBA**
- **Two sheets**
- **Machine rate and system analysis**
Central Appalachian hardwood stands

Machine and system conditions
(1) Machine Rate

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timberjack 520 grapple skidder</td>
<td></td>
</tr>
<tr>
<td>Purchase price</td>
<td>$165,000</td>
</tr>
<tr>
<td>Salvage value</td>
<td>20%</td>
</tr>
<tr>
<td>Economic life</td>
<td>5 years</td>
</tr>
<tr>
<td>Interest</td>
<td>10%</td>
</tr>
<tr>
<td>Insurance</td>
<td>3%</td>
</tr>
<tr>
<td>Taxes</td>
<td>0%</td>
</tr>
<tr>
<td>Fuel usage</td>
<td>4.4 gal/PMH</td>
</tr>
<tr>
<td>Lube usage</td>
<td>1.0 qt/PMH</td>
</tr>
<tr>
<td>Fuel cost</td>
<td>0.88/gal</td>
</tr>
<tr>
<td>Lube cost</td>
<td>1.30/qt</td>
</tr>
<tr>
<td>M&amp;R</td>
<td>90%</td>
</tr>
<tr>
<td>Wages</td>
<td>10.00/SMH</td>
</tr>
<tr>
<td>Fringes</td>
<td>35% of wages</td>
</tr>
<tr>
<td>Utilization</td>
<td>75%</td>
</tr>
</tbody>
</table>

http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/MachRate.xls
Class Exercises

(2) Auburn Harvesting Analyzer
http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/aha_tons.xls

(3) Central Appalachian Harvesting Analyzer
http://www.wdsc.caf.wvu.edu/JXWang/courses/WDSC422/Labs/CAHA.xls