

Logging System Analysis

Harvesting Function and System

- ◆ Function is the subdivision in a harvesting system, for example:
 - Felling
 - Skidding or forwarding
 - Loading
 - ...
- ◆ Functions are combined together to form a harvesting system.

Elemental Functions of Chainsaw



- Walk to tree
- Acquiring
- Felling
- Delimiting and topping

Elemental Functions of Feller-buncher



- Move to tree
- Cut
- Move to dump
- Dumping

Elemental Functions of Cable Skidder



- Travel empty
- Choke load
- Travel loaded
- Unchoke load

Elemental Functions of Grapple Skidder



- Move to load
- Grapple load
- Move during loading
- Travel loaded
- Delimiting using a gate
- Ungrapple

Elemental Functions of Harvester



- Move to tree
- Boom
extend/retreat
- Cut
- Swing boom
- Processing

Elemental Functions of Forwarder



- Move to load
- Load
- Move during loading
- Travel loaded
- Unload

Logging Systems

Three common systems could be combined as:

- ◆ Chainsaw felling + cable skidder
- ◆ Feller-buncher + grapple skidder
- ◆ Harvester + forwarder

Harvesting Functions (Skidder Systems)

- ◆ Chainsaw and Cable skidder
 - Fell
 - Delimb and top
 - Skid
 - Load and haul
- ◆ Feller-buncher and grapple skidder
 - Fell and bunch,
 - Skid and delimb,
 - Load and Haul

Logging System

- ◆ There may be multiple machines performing a single function such as:
 - two skidders pulling behind one feller-buncher
or
 - a single loader serving four tractor trailers

Logging System

- ◆ Each function has inherent productivity under the given conditions.
- ◆ This is to say,
 - a machine taken by itself will have no restraints from its sister functions
 - it will produce wood at some rate plus or minus its inherent variability

Limiting Functions

- ◆ Machines don't produce at the same rate:
 - Some are more productive than others
 - Some have higher utilization than others
- ◆ For example,
 - Feller-bunchers fell more trees per day than manual chainsaw operators.
 - A skidder may not be able to skid all the wood produced by a feller-buncher within the same period of time.

What is a Limiting Function?

- ◆ In the FB + SD system,
 - If the feller-buncher produces wood twice as fast as the grapple skidder can skid, at some point the feller-buncher must quit work.
- ◆ For a trucking operation,
 - If four trucks are needed to haul the wood produced and you only have one truck, the in-woods part of the crew will have to slow down.
- ◆ Under these situations,
 - **skidding and hauling are apparently the least productive functions of the logging systems that are called the limiting functions.**

Why Balancing Harvesting System?

- ◆ Minimizing costs per unit
- ◆ Maximizing profits
- ◆ Maximizing production

What is System Balancing?

- ◆ To mesh functions together effectively to form systems, each function must produce wood at about the same rate.
- ◆ The process of making each function in a system produce equally is called system balancing.

Balancing the System

- ◆ Four ways to balance an operation:
 - Add or subtract machines
 - Work some functions more or less scheduled hours
 - Change work conditions
 - Change machines

System Balancing (Example)

For example, say we have a feller-buncher feeding a grapple skidder.

FB	15.07 cords/PMH	MA=70%	10.55 cords/SMH
SD	7.36 cords/PMH	MA=75%	5.52 cords/SMH

- The system productivity is that of the least productive function,
 - the skidding is controlling the system
 - the feller-buncher is restricted to $5.52/15.07=0.37$ or 37% UT
- If addition of another skidder,
 - the skidding productivity is ($2*5.52=11.04$ cords/SMH)
 - it brings the system up to near optimum production (**10.55Cords/SMH**).

Utilization of a Function

$$UT = \frac{\text{System Rate}(\text{cords} / \text{SMH})}{\text{Machine Production Rate}(\text{cords} / \text{PMH}) \times (\# \text{ of Machines})}$$

System Balancing (Example)

Balancing a feller-buncher and skidder system:

Feller-buncher:

productivity	15.07 cords/PMH
MA	70%
total fixed cost	\$15.91/SMH
total variable cost	\$19.14/PMH
labor cost	\$7.00/SMH plus 30% fringe

Skidder:

productivity	7.36 cords/PMH
MA	75%
total fixed cost	\$15.57/SMH
total variable cost	\$17.79/PMH
labor cost	\$7.00/SMH plus 30% fringe