SAWSIM® and Linear Programming: A Case Study

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1. Original Problem

1. Sawmill built as a two-line mill, with space for a third small-log line. Small stems and tops are processed to chips in the adjacent pulpmill woodroom. Those chips, plus sawmill chips, are consumed by the pulpmill.

2. It was known that the average stem size would decrease with time.

3. Various proposals were presented to modify the sawmill to accommodate the smaller average log size.

4. Upper-management were concerned, and were uncertain that correct solutions were being offered.

In light of the above, a study was commissioned to predict the production and net income for each of the next ten years, assuming that no major changes to the production facilities were made.

2. Development of the Linear Programming Model

The following information was given for each year:

- Volume of wood available in each forest type.
- Stem sorting capacity and cost.
- Merchandiser deck, sawmill, drying, and planermill capacities.
- Net pulpmill chip requirement.

In addition, the results of a sawmill test run were available.

The original wood flow is shown in Figure 1 below. For a given annual logging plan, the principal decision points were as follows:

- For each forest type, whether or not the stems should be sorted (as shown in Figure 1, some large stands pass unsorted to the Merchandiser Deck, and some small stands pass unsorted to the Pulpmill Woodroom).
- For each forest type, the Stem Sort diameter break-point between sawmill stems and pulpmill woodroom stems.
- The minimum sawlog top diameter to be produced at the merchandiser deck.

Original Wood Flow

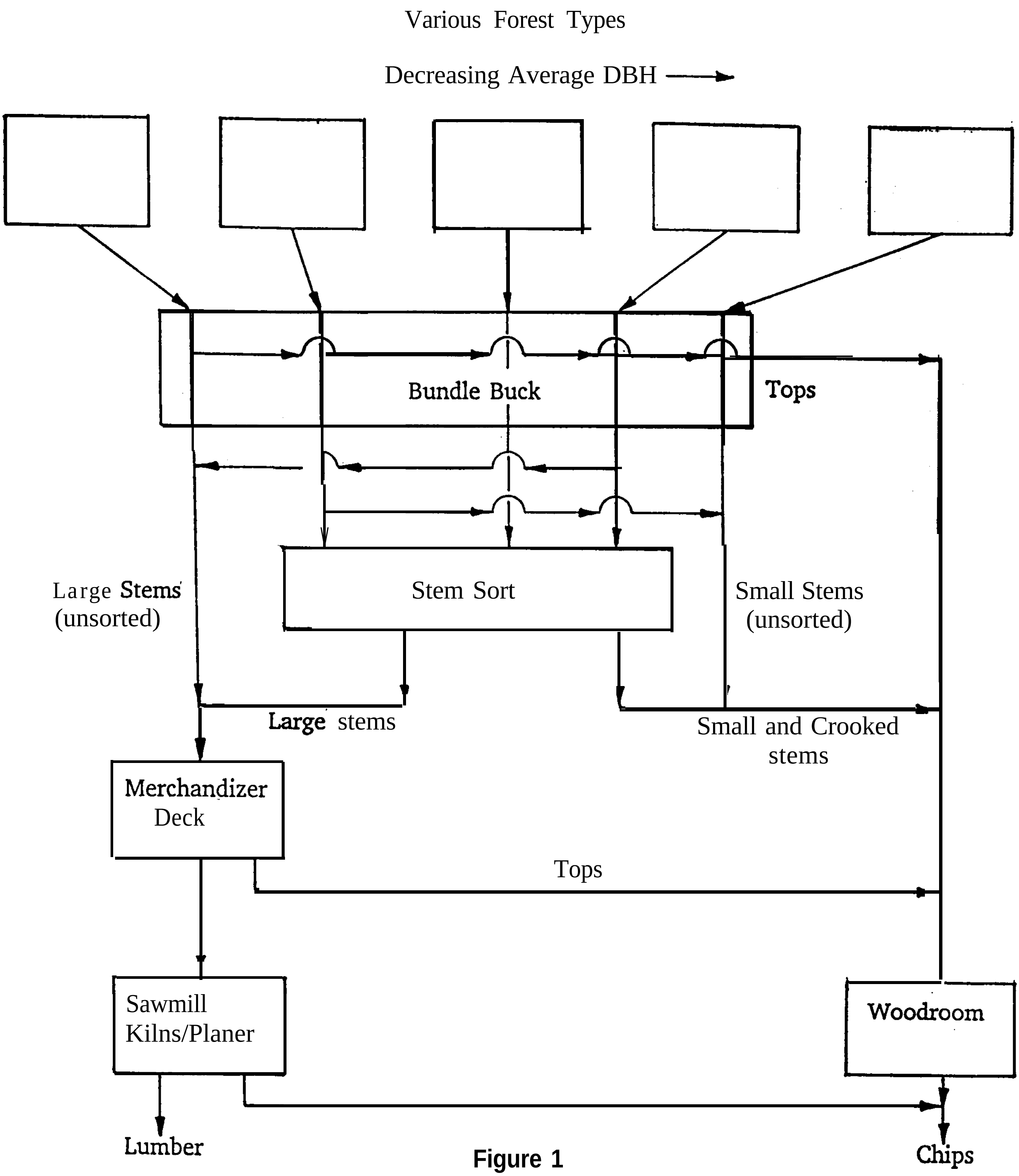

Figure 1

Briefly, the solution procedure was as follows:

1. Use **SAWSIM**® to calculate lumber yields, chip yields, etc. from sawlogs of specific species, diameter, etc. classes.
2. Use a Linear Programming model to calculate material and cash flows.

To develop the Linear Programming model, the following additional data was required:

- Stems per acre in each dbh class and the height-diameter curve for each stand type, by species. A stand type is a grouping of forest types with similar average dbh, elevation, etc.
  Note that in the Linear Programming model development, the log supply definitions may either be based upon taper equation stem form definitions or actual measured stem data for samples taken from each stand type, with the measured data weighted to conform to the estimated stems per acre and the height-diameter curve.

- For each stem dbh class, the yield of sawlogs in each diameter, length, taper and quality class, plus the volume of defect trim and tops. This data was obtained through use of the **BUCKSIM** program (a member of the **SAWSIM**® family of Sawmill Simulation programs).

- The merchandiser deck time per stem.

- For sawlogs of each diameter, length, taper, and quality class, the:
    - Volume per log of each lumber size.
    - Volume per log of chips, sawdust, etc.
    - Time required on each sawmill machine, plus for drying and planing.

  This information was obtained from **SAWSIM**® simulation runs.

- Costs for all production variables which are not fixed.

-Lumber, chip, and other byproduct prices.

3. Linear Programming Model Results

The Linear Programming model results printout included the following information:

- The volume of each forest type used.

- The optimum timber supply allocation, showing the number of stems in each dbh class going: Direct to the s
  Sorted to the sawmill
  Direct to the woodroom
  Sorted to the woodroom

- The number of bucked logs in each class to the sawmill.

- The volume of each lumber size and length produced.

- The volume of sawmill chips and other byproducts.

- The time requirements on the slasher deck and principal machines.

- The volume of chips from small and crooked stems and stem tops processed in the pulpmill woodroom.

- The total on-site chip production.

In general, the Linear Programming model results showed that no additional capital expenditures were necessary to process the smaller wood. That is, the third line in the sawmill was not necessary. The model showed that the increased requirement for on-site chips with time was sufficient to offset the effect of the smaller wood.

The model further showed that the Stem Sort in the original wood flow of Figure 1 was often the bottleneck in the system, and had very high operating costs. In addition, the limited capacity of the sort required that some large forest types be delivered to the Merchandiser Deck unsorted, while some small forest types were delivered to the pulpmill woodroom unsorted. This resulted in sub-optimum allocation of timber from these forest types. Through use of the model, the improved Wood Flow of Figure 2 below was developed. In this flow, all stands are sorted into Sawmill Merchandiser and Pulpmill Woodroom piles in the woods. The increased efficiency of sorting for all forest types, and elimination of the expensive log-yard Stem Sort offsets the cost of sorting in the woods.

4. Additional Benefits of the Linear Programming Model

Additional benefits of the Linear Programming Model included improved communication between forestry, logging, log-yard and sawmill departments. Each department became satisfied that the model contained an accurate representation of the operations for which it was responsible. With time it became possible, for example, to incur additional logging costs for the benefit of the sawmill operations.

Revised Wood Flow

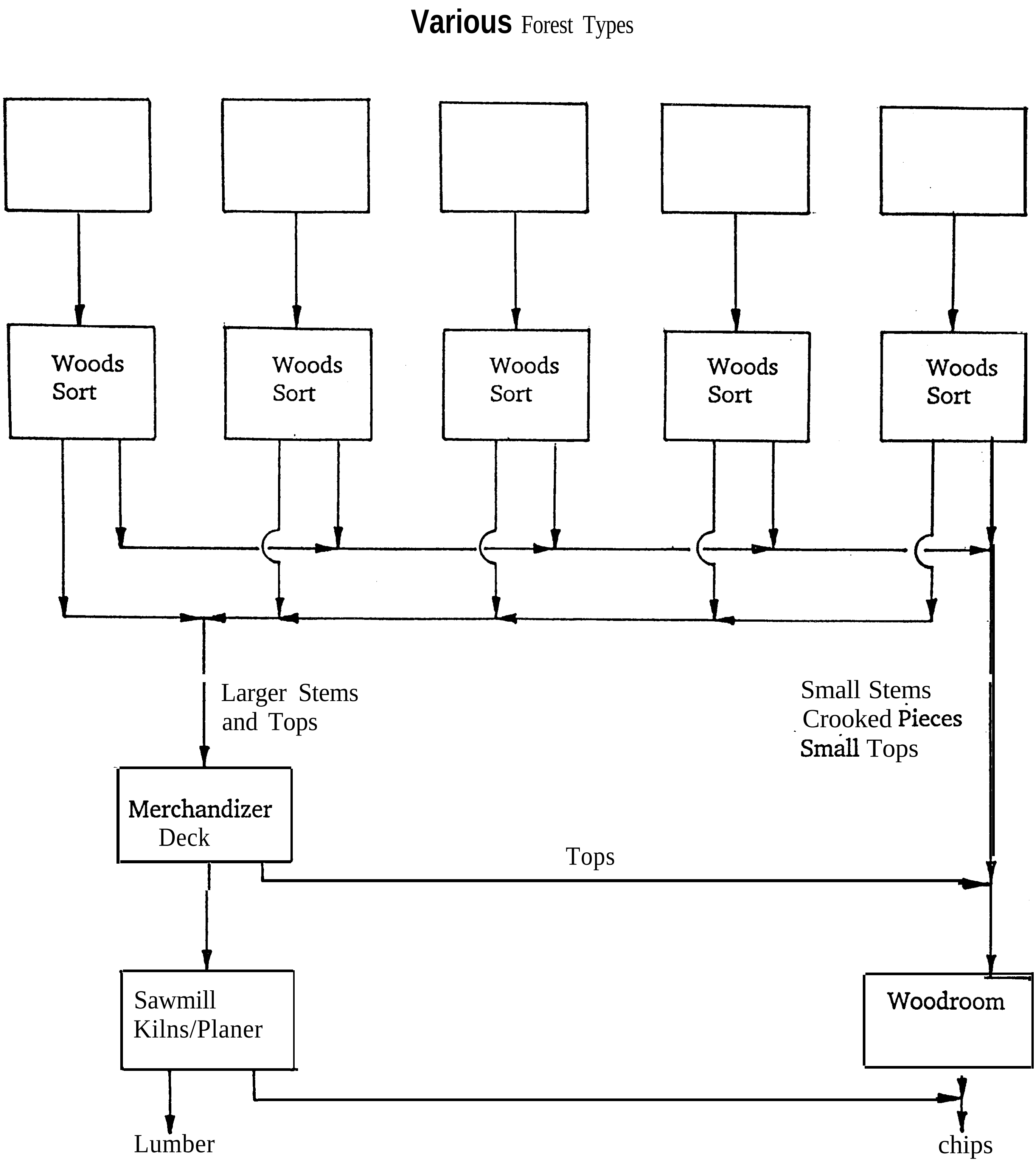

Figure 2

The model was also used to evaluate the overall effect of alternative:

- Logging plans.
- Off-site chip purchases of different volumes and prices.
- Sawmill machine configurations, such as additional primary breakdown and edging capacity.

The model was used to prepare the annual operating plan.

Through use of the model, the predicted average volume per sawlog was determined. This was used to assess and control seasonal variations in the sawmill log supply by evaluating the effects of alternative logging plans. Further, once a logging plan was made, the average sawlog volume was used to control log input to the sawmill on a continuous basis. The log-yard Heede crane operator continually monitors the average sawlog volume into the sawmill (which is measured with log scanners at the primary breakdown). The operator selects appropriate stem bundles from the log-yard for delivery to the Merchandiser Deck to maintain the calculated average sawlog volume for the current logging plan. This ensures a consistent log supply to the sawmill, which can significantly increase its operating efficiency.