Topics in Forest Transportation
Network Design

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Balancing Transportation Costs

“The skidding distance that gives a skidding cost which, when added to the cost of railroad construction results in the lowest total cost per thousand for both skidding and railroad construction, shows the distance apart that the railroad spurs should be.”

Analysis - Uniform Terrain Conditions

“Based on actual practice in Florida”

**Important factors:**
1. Skidding method,
2. Ground slope,
3. Season of the year,
4. Size of the logs,
5. Volume per acre

**Table 9.** Most economical distances between railroad spurs and the most economical direct-skidding distances; and the combined cost per thousand of railroad construction and skidding

<table>
<thead>
<tr>
<th>Operating conditions</th>
<th>5 Stand per acre</th>
<th>Tractor skidding</th>
<th>Horse skidding</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Distance between railroad spurs</td>
<td>Combined cost</td>
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<td></td>
<td></td>
<td>Feet</td>
<td>Dollars</td>
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<td>0 to 15 per cent slope:</td>
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<td>Summer work—</td>
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<td>3 to 5 log timber</td>
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<td>20</td>
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<td>9 to 12 log timber</td>
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<td>20</td>
<td>1,800</td>
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<td>Winter work—</td>
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<td>9 to 12 log timber</td>
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<td>15 to 30 per cent slope:</td>
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<td>2,600</td>
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</table>

1 Twice the maximum direct distance.

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A Simple Cost Trade-off Model

Skidding directly to the road from both sides.

Skidding cost is $0.40 per Mbf per station.

Road construction cost is $38.00 per station.

Volume per acre cut \((v)\) is 12 Mbf

Optimum spacing, \(w^*\), is 11.7 stations (1170 feet).

\[ w^* = \left(\frac{1652}{v}\right)^{1/2} = \left(\frac{1652}{12}\right)^{1/2} = 11.7 \]

Silvicultural Prescription Impact

Lower volumes removed per hectare will increase the spacing between roads.

Note: \( v \downarrow \Rightarrow w^* \uparrow \)

Distance between roads increases

The number of years required to harvest an area accessed by a road system will also influence road spacing.
Yarding Technology Impact

Changes in yarding methods can change the optimal road spacing.
Road Cost Impact

- Low Standard: Low Construction Cost, High Log Hauling Cost
- Medium Standard: Moderate Construction Cost, Moderate Log Hauling Cost
- High Standard: High Construction Cost, Low Timber Hauling Cost

Distance between roads increases
Landing Type Impact

Possible increase in road related costs,  
\[ w^* \uparrow \]

Certain increase in the yarding cost.  
\[ w^* \downarrow \]

- Higher road related cost?  
- Increased road spacing
- Greater yarding distance.
- Closer road spacing
Cable Yarder Configuration Impact

YARDING SYSTEM COMPARISON

Note increase in road spacing
Environmental Impact

The cost of soil erosion and water pollution associated with roads should be included in their total cost - including these costs would decrease the amount of road built (spacing between roads would increase).
Other Management Activities Impact

The cost of forest access for other management purposes should be considered in the road spacing decision.
Yarding Pattern Impact

Yarding to a continuous landing along the road illustrated on sloping terrain.

The road spacing for two-way yarding is much farther apart compared to one-way yarding.
Analysis - Terrain Constrained Patterns

Location Principle: “Reduce the number of roads that climb between levels and increase the proportion of the drainage served by road levels spaced at the economic interval”.


Four road patterns: A—Random development; B—Switchbacks at regular intervals from lowest road; C—Regularly spaced roads climbing in direction of lowest road; D—Single climbing road with others on levels roughly parallel to valley bottom road.

The preferred pattern
Practical Layout - Satisficing

Planning Steps:

1. Identify possible landings with their economic yarding distance on the map.
2. Determine which landings can be reached by truck road of the specified standard.
3. Identify a systematic pattern of roads that connects the landings.

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1 To obtain an outcome that is good enough. Simon, Herbert A. 1957. *Models of Man.*


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Possible Research Topics

Optimal shape of the boundary between two settings given different yarding (total transportation) costs at each.

Possible Research Topics

Optimal location of road junctions using multiple junctions and varying road standards.

Possible Research Topics

Global optimization using multiple settings on a non-convex harvest area.

Network Design in Forestry

• has a long history of theoretical development;

• has provided practical design rules;

• and continues to provide good research opportunities.