Whole Tree Delivery Method for Timber Processing Depots

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Background

- Biosystems Engineering / Forestry partnership
  - U.S. Dept. of Energy grant (DE-EE0006639)
  - Development of a timber processing depot
    - Increase renewable biomass fuel material availability
    - Maximize biomass fuel material yield of individual trees
    - Process timber at centralized location
   - Reduce loss of biomass fuel material from harvesting sites

Background

- Idea
  - Harvest and load entire unprocessed trees
  - Deliver product to a timber depot:
    - Accumulate unprocessed timber in one central location
    - Scan timber for optimized merchantability
    - Process timber for optimal:
      1. Biomass fuel material merchantability
      2. Traditional product merchantability
    - Sort products based on product class
    - Distribute products to appropriate markets

  - Unprocessed tree: has not been delimbed or cut into smaller sections

Challenge

- Hauling an entire unprocessed tree
  - Adhere to transportation regulations
    - Trailer length suitable for loblolly pine (age~18-25)
    - Trailer able to contain tree crowns to prevent:
      - contact with other vehicles
      - contact with highway surface
  - Maintaining high payload capacity utilization
    - Gross vehicle weight
    - Reduce opportunity cost
    - Increase transportation efficiency

55/35

60/35

65

70/40

1"=7.13' | Height/LCR
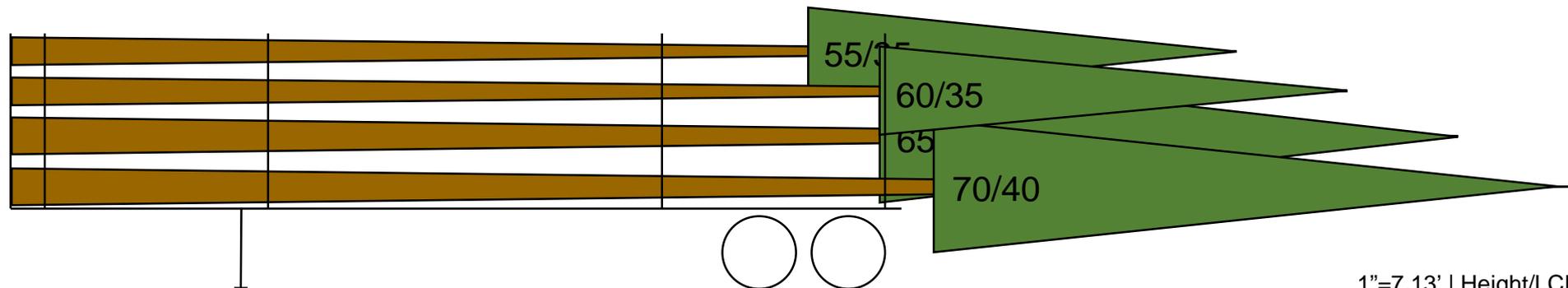
Proposed Solution

- Design log trailer modification
  - Contain tree crowns
  - Easily attachable / detachable
  - Affordable
  - Light weight
  - Trailers remain versatile

55/35

60/35

65

70/40

40'

53'

1"=7.13' | Height/LCR
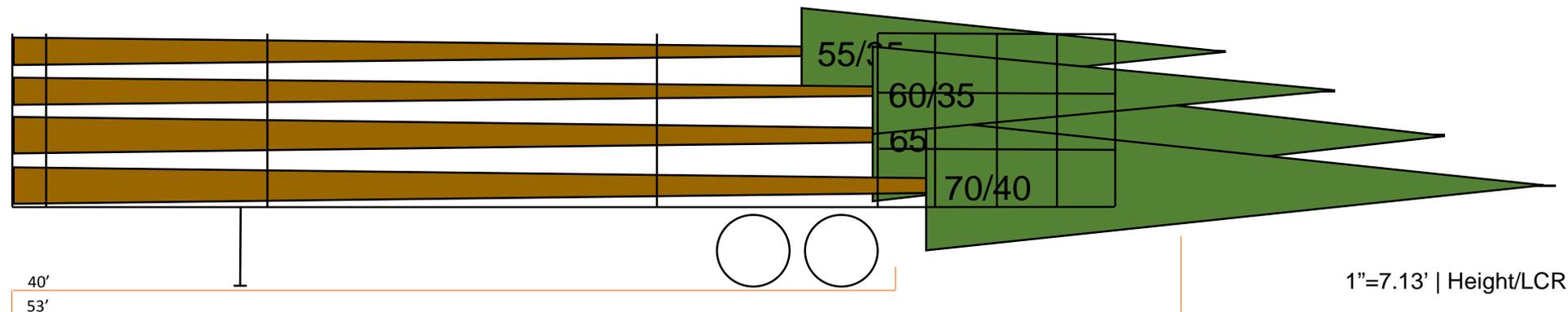
Project Goal

- Develop an alternative method for feasibly delivering unprocessed full length trees to a timber processing depot
  - Trailer modifications
  - Alternative loading configurations
- Avoid all in-woods timber processing
  - Fell it – Load it – Haul it

Objectives

- Develop and build modification for standard log trailer

- Determine which load configuration for the modified trailer achieves greatest payload capacity utilization

- Determine if combination has a higher payload capacity utilization than the unmodified trailer

Modification Design Methods

- Determine constraints for trailer dimensions
- Design modifications for standard log trailers
- Complete load force analysis for part sizes
- Develop materials list for modifications
- Calculate weight of modifications
- Calculate cost of modifications

Design Constraints

- Review of transportation laws and regulations of states within loblolly pine native range

State	Trailer Length	Trailer Length and Overhang Exemptions for Timber	Height	Width	GVW*	Tolerance	Total GVW for Timber
Alabama	53'	Exempt from Length Limitations	13'6"	102"	80,000	10%	88,000
Arkansas [1]	53'	25' Overhang Beyond Center of Rear Tandem Axle, Trailer Length < 53'	13'6"	102"	80,000	-	85,000
Florida [2]	53'	75' Total Length, Trailer Length < 53'	13"6"	102"	80,000	-	80,000
Georgia	53'	100' Total Length, Trailer Length < 53'	13'6"	102"	80,000	5%	84,000
Louisiana [3]	59'6"	66' Total Length, 20' Overhang Beyond Center of Rear Tandem Axle	13'6"	102"	80,000	-	80,000
Mississippi [4]	53'	28' Overhang Beyond Center of Rear Tandem Axle	13'6"	102"	80,000	2%	81,600
North Carolina [5]	53'	14' Overhang Beyond Rear of Trailer	13'6"	102"	80,000	-	90,000
South Carolina	53'	Exempt from Length of Vehicle and Load Limitations	13'6"	102"	73,280	15%	84,272
Tennessee	53'	75' Total Length	13'6"	102"	80,000	10%	88,000
Texas [6]	59'	90' Total Length	14'	102"	80,000	5%	84,000
Virginia [7]	53'	65' Total Length, Trailer Length < 53'	13'6"	102"	80,000	10%	88,000

[1] 85,000 lbs. allowed for forest products
[2] 10% tol. included in GVW of 80,000 lbs. max (72,727 lbs. + 10% = 80,000 lbs.)
[3] 40,000 lbs. tandem axle weight limit for forest products (3,000 lbs. tol. included) (2000 lbs. tol. for single axle weight)
[4] 5% tolerance on tandem axle weight and 2% tolerance on GVW
[5] 90,000 lbs. allowed for forest products
[6] Must purchase Annual Timber Permit
[7] Must purchase 1-year 5% weight extension permit. Additional 5% weight extension permit for Virginia grown forest products issuable by DOT. (10% total)
* Non-Interstate Highway

Modification Design

- Swinging Gate Design
    - Two gates attached to rear standards
    - 180 degree range of motion on vertical axis
    - Slides on & off / easily attachable & detachable
    - Estimated Cost: $3,000
    - Estimated Weight: 1,200 lbs.
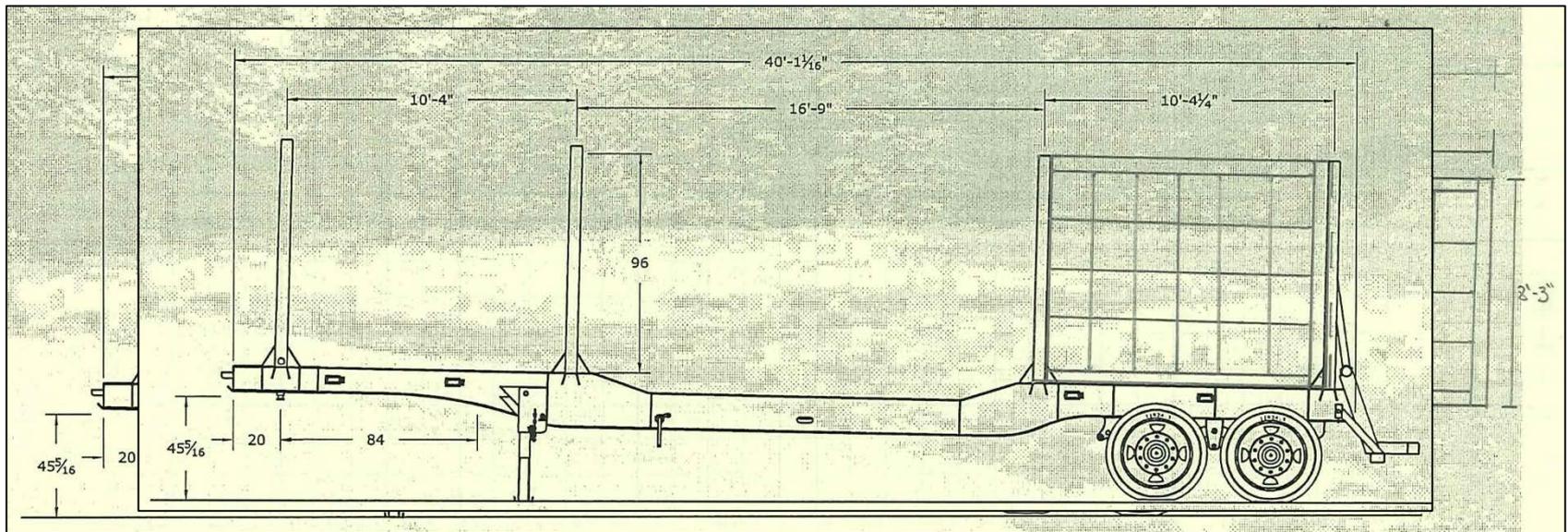
Modification Design

- Extendable Bolster Design
    - Additional bunk on rail type system
    - Collapsible for storability
    - Removable stoppers on rails for easy detachment
    - Estimated Cost: $3,500
    - Estimated Weight: 1,400 lbs.
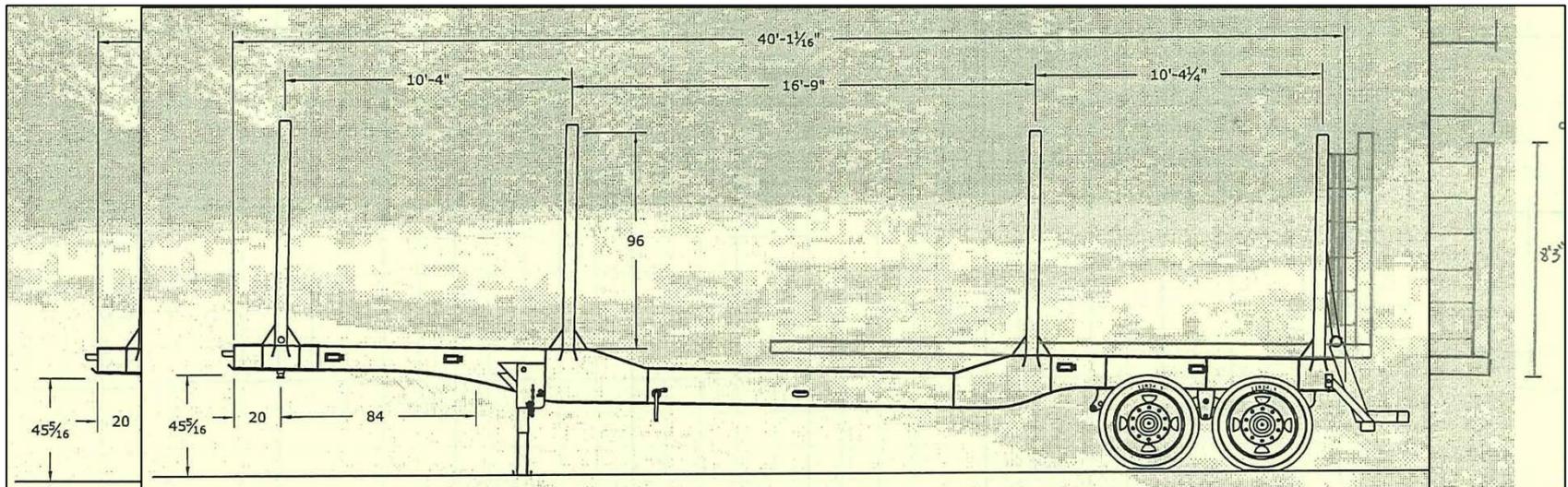
Implementation

- Swinging Gate Design
  - Less additional weight
  - Lower cost

Payload Utilization Methods

- Calculate payload capacity utilization
  - Null Scenario
    - Unmodified trailer loaded with 2nd thin loblolly pine
    - Loaded and trimmed to meet transportation regulations
    - Weigh trailer before & after to determine payload weight
  - Alternative Scenarios
    - Modified trailer loaded with 2nd thin loblolly pine
    - Loaded to meet transportation regulations
    - Standard, indexed, and double bunked arrangements
    - Weigh trailer before & after to determine payload weight
  - Test for significance
    - ANOVA of null plus 3 alternative scenarios
    - Post hoc analysis

Expectations

- Unmodified trailer - loaded with less trees to accommodate transportation regulations
    - Crowns increase void space
    - Branches dragging highway,
    - Branches extending beyond legal width/height
    - Too many branches trimmed and left behind
- Modified trailer – loaded with more trees
    - Better crown containment
    - Reduced trimming
    - Payload capacity utilization highest with indexed arrangement

Questions