



# WDSC 422

## Harvesting Forest Products

Dr. Jingxin Wang  
317E Percival Hall  
(304) 293 7601  
[jxwang@wvu.edu](mailto:jxwang@wvu.edu)



# Something about Logging

“As a matter of taste, I admit to liking loggers better than environmentalists.”

John McCarthy, Professor Emeritus of Computer Science at Stanford University

“No Logging – No Mills – No Jobs  
Support Sustainable Forestry  
America Depends On It”

Distributed by the Pulp & Paper Workers’ Resource Council



# Class Notes

<http://www.wdscapps.caf.wvu.edu/JXWang/courses/WDSC422.html>

- Syllabus
- Class Notes
- Lab Assignments
- Homework Assignments



# Introduction and Terminology

- Timber harvesting is an integral step in the management of most forests.
- Harvesting timber products - sawlogs, veneer logs, or pulpwood - can be logically classified into two ways:
  - Desired result of a management plan
  - Part of total manufacturing process



# Some Terms

- **Feller-buncher** – self-propelled machine designed to fell standing trees and arrange them in bunches.
- **Harvester** – self-propelled multifunction machine that may be capable of operating as a swath cutter but also performs processing in addition to felling.
- **Skidder** – self-propelled machine designed to transport trees or parts of trees by tracking or dragging.
- **Forwarder** – self-propelled, self-loading machine designed to transport the stems or logs by carrying them completely off the ground.



# Some Terms

- **Cut-to-length** – bolewood components of a tree, cut to desired lengths.
- **Full-tree** – All components of a tree, except for the stump.
- **Tree-length** – Entire tree, excluding the unmerchantable tops and limbs.
- **Log** – Eight-foot or longer tree segment.



# Phases of Timber Harvesting

1. Purchasing and management
2. Tree marking
3. Felling
4. Delimiting, bucking, bunching
5. Loading, terrain transport, and unloading
6. Truck hauling, railway transport or floating

**Cutting**

**Logging**

**Harvesting**

**Procurement**

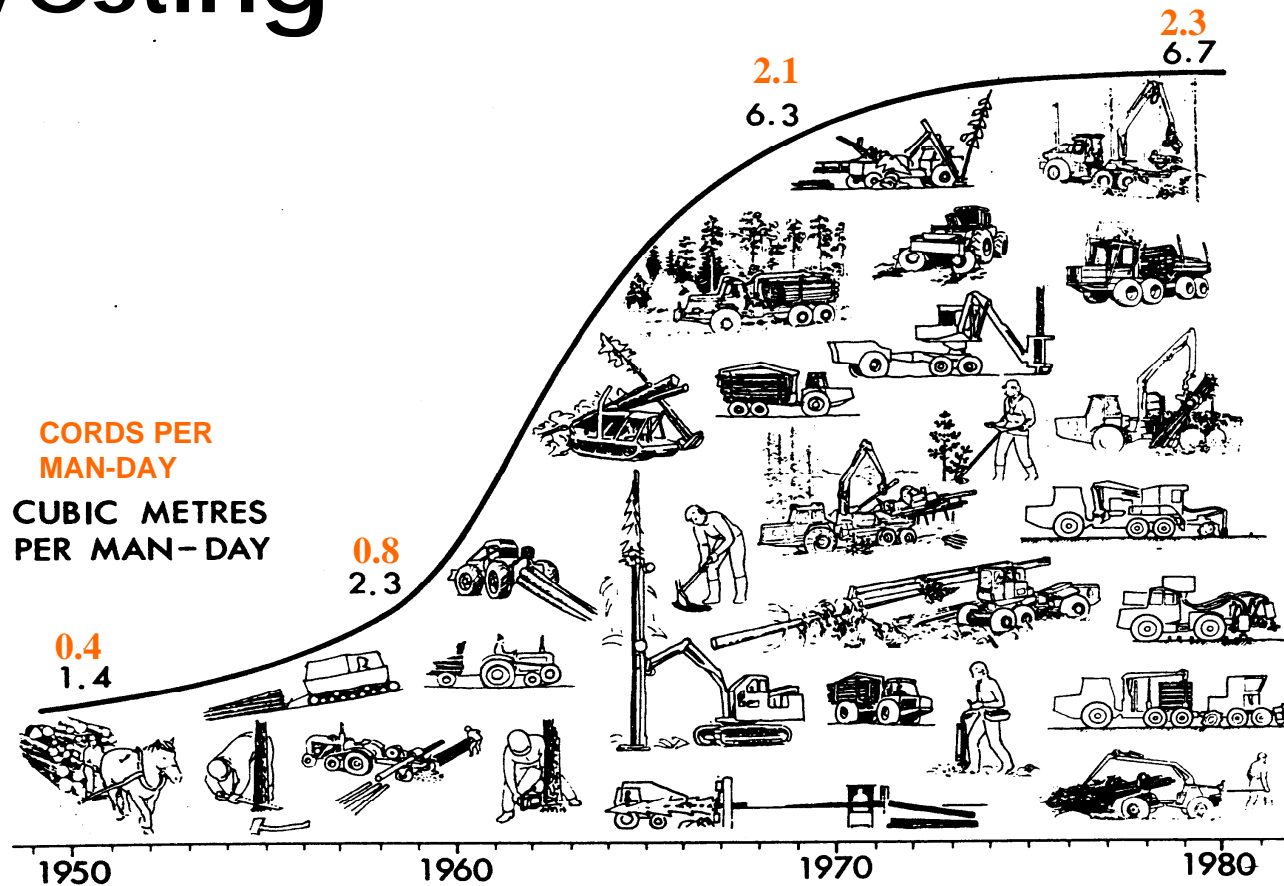


# Brief History

- Radical changes during the 20<sup>th</sup> century
- Harvesting methods used in 1900 were very similar to those used 200-300 years earlier.
- Most of these technological changes have taken place since WWII, specifically in the past 50-60 years.
- As affected by railroad and all-weather high standard roads and highway.



# Development of Timber Harvesting



(Source: Sundberg and Silversides 1988)



# Current Harvesting Techniques

- Felling with powerful, lightweight chainsaws or highly productive machines with shear or sawhead attachments
- Wood is moved from stump to roadside by a variety of well-designed, powerful skidders and forwarders
- Cable yarders and helicopters are often used to move wood in rough area
- Logs are loaded onto trucks with hydraulically powered loader



# Current Productivity

- Produce higher volume of woods with fewer people while keeping lower costs
- Productivity of logging operations has doubled or tripled as measured on a production per worker-hour basis since 1960 in many areas of North America.



# Problems

- Logging equipment and systems are increasingly complex.
- It requires employees with better mechanical and managerial skills.
- Capital expenditures in equipment are higher and force logging contractors to focus on production to keep costs lower.
- It makes difficult to perform harvesting operations in the ways that would be:
  - more environmental-oriented
  - acceptable by today's society



# Input, Output, and Constraints

- Input:
  - Money for capital investment and operational funds
  - Machines to simplify and perform work
  - Timber as a raw material
  - People to plan and manage operations



# Input, Output, and Constraints

- Output:
  - Products delivered to mills
  - Revenue to loggers, and
  - A harvested site that meets the objectives of a landowner's management plans



# Inputs Output, and Constraints

- Criteria:

- Foresters need to know the capabilities and limitations of timber harvesting systems so as to effectively implement forest management activities.
- Each alternative considered must meet:
  - Physically possible
  - Economically feasible, and
  - Socially acceptable



# Product Forms

- Shortwood – implies wood of eight feet or less
- Longwood – means all delimbed roundwood stem that are longer than shortwood
- Full trees – all above ground portion of the tree
- Chips





# Harvesting System: Phases and Functions

- System configuration
- The steps or sequences of activities in a harvesting system are called **phases and functions**.
- Most harvesting systems have five basic phases.



# Five Basic Phases

- Felling
- Processing
- Primary Transport
- Loading
- Secondary Transport

(These basic phases include a variety of functions.)



# Functions

- Felling
- Delimiting, bucking
- Skidding, forwarding, yarding
- Loading
- Chipping
- Hauling



# Sequence of Functions

- Each function performs a specific task in converting a standing tree to a product.
- Felling of a tree is always first function.
- Hauling of wood to mill is the last.
- The sequences of other harvesting functions can vary for a given system.



# Harvesting Systems

- All logging operations today use mechanization to some degree.
- Harvesting systems can be classified by:
  - product forms,
  - degree of mechanization, or
  - machines used



# Harvesting Systems by mechanization level

- Fully mechanized:
  - whole-tree chipping and
  - cut-to-length
- Partially mechanized - typical descriptions found in use today:
  - some skidder operations,
  - cable logging, or
  - helicopter system



# Harvesting Systems by machines used in the system

- Skidder systems
  - Felling with chainsaw or feller-buncher
- Cut-to-length system
  - Harvester and forwarder
- Cable logging
  - Felling with chainsaws or small feller-buncher
- Helicopter logging
  - Felling with chainsaws



# Harvesting Systems

## Chainsaw and Cable Skidder







# Harvesting Systems

## Feller-buncher and Grapple Skidder





# Harvesting Systems

## Cut-to-length System





# Harvesting Systems by product forms

- Shortwood
- Longwood
- Full tree



# Harvesting System by Product Forms



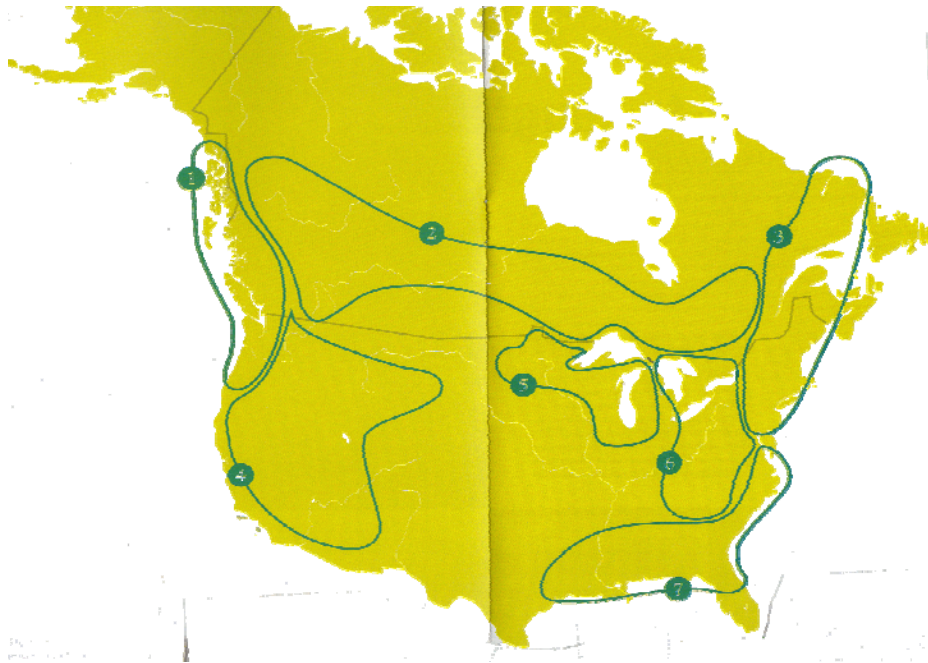
Shortwood



Longwood

(Source: Sundberg and Silversides 1988)

# Harvesting Systems (North America)



- 1 - West coast temperate rain forest
- 2 - Canadian boreal forest
- 3 - Canadian maritime provinces and US Northeast
- 4 - US West
- 5 - US Great Lakes
- 6 - Appalachian region
- 7 - South Central and Southeast US

(Source: Timberjack News, No. 2, 2003)



# Today's Harvesting Systems

- Full-tree and tree-length systems accounted for 94% in the United States (McCary, 1991).
- Ground-based system is the dominant system in the US and around the world.
  - Chainsaws and cable or grapple skidders
  - Feller-bunchers and skidders



# Today's Harvesting Systems

- Other systems also used in the US:
  - Cut-to-length
  - Shovel logging
  - Cable logging
  - Helicopter logging



# Future Concept Harvester

## Timberjack's Walking Technology



1991 First Test Platform



1995 Concept Machine Phase I



2000 Concept Machine Phase II

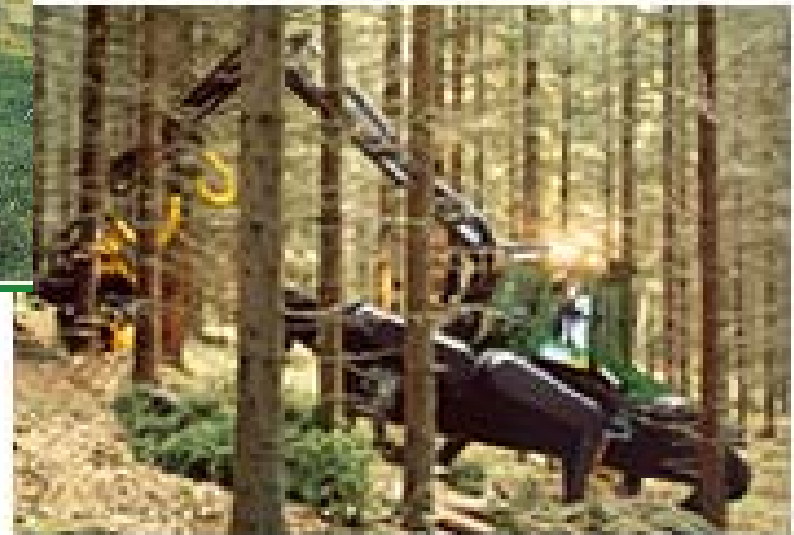
(Source: [www.timberjack.com](http://www.timberjack.com))






# Future Concept Harvester

## Timberjack's Walking Technology



(Source: [www.timberjack.com](http://www.timberjack.com))



# Future Concept Harvester

## Timberjack's Walking Technology



(Source: [www.timberjack.com](http://www.timberjack.com))

# Sawfish



Triton Logging, Inc. – Underwater Harvester  
7000 lbs on land and slightly buoyant in water  
Fully remote with 8 video cameras and sonar  
Powered by a 40-75 HP electric motor, using biodegradable and vegetable oil-based hydraulic fluids  
Feller grapple and 55-inch chainsaw  
Handles larger trees than any land-based mechanical harvester due to water buoyancy  
37-50 inflatable/reusable airbags to float trees to surface (one bag per tree)