Tethered Logging



Harvest Systems process

Cut the tree down
Manual falling
Mechanical falling
Move the tree to the landing
Ground based
Skyline
Helicopter

Tethered

Remove the limbs (can also be done in the woods)

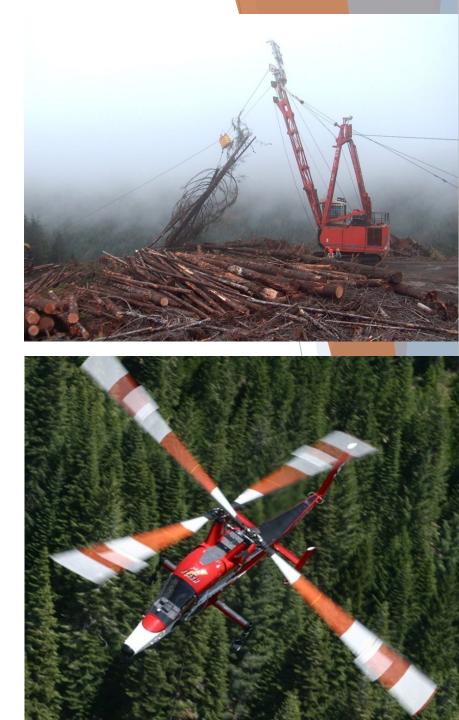
Load onto a log truck/chip van

What is Tethered Logging?

- Tethered logging allows for equipment operations on slopes that in the past would be considered inoperable
- Tethered logging is a fairly new concept in the United States, first appearing around 2014
- It has been done primarily on private lands thus far
- It's application on Forest
 Service lands is still limited,
 but has great potential



- On Forest Service lands harvesting on sites exceeding 40% slope has required skyline or helicopter yarding
- CTL and mechanical whole tree harvesting have traditionally been limited to slopes of approximately 40%
- Both skyline and helicopter are higher cost yarding systems, compared to ground based systems



What is Tethered Logging?

- Tethered Logging (also known as winch assist) refers to using a winch to assist a machine up and down the slope on steep ground
- This system may utilize 2 separate machines or only 1
- The 2 machine approach:
 - An assisting machine (sometimes called a winching machine) remains stationary, usually on a road and assists a working machine up and down the slope.
 - A working machine is the machine that is cutting or moving timber
 - The winchline on the 2 machine approach is a <u>dynamic line</u>, it moves





What is Tethered Logging?

- The 1 machine approach:
 - Winches may also be mounted directly on the working machine. The line is then anchored to a stump, standing tree or machine anchor
 - The winchline on the 1 machine approach is a <u>static line</u>, it doesn't move





The Concept of Winch Assist?

- A good analogy to illustrate winch assist is trying to pull a stuck vehicle out of a snowy ditch
 - If you leave the stuck vehicle in neutral and try to "pull" it as dead weight, it can be difficult
 - However, if you "drive" the stuck vehicle out of the ditch and the towing vehicle is there to "assist", it is a much easier task
 - A winch assist is designed to assist, not pull the machine up a hill



Two machines: Assisting Machines



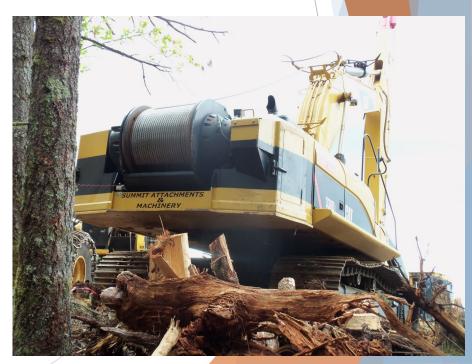




Assisting Machines: Converted Excavators

- The most common assisting machine is an excavator that has been modified to accommodate a winch line
- These machines are stationary on a road and assist the working machine
- The assisting machine is radio controlled by the operator in the working machine, there is no operator in the assisting machine
- Some models use 2 winch lines while others have 1 line
- Line capacity is approximately 1,100'-1,800' depending on manufacturer





One Line System



Two line System







Assisting Machines- Purpose Built

- There are also purpose built assisting machines
- Meaning they are built for the sole purposes of performing winch assist
- These machines are often anchored to a tree and the blade on the front of the machine is dropped to hold it in place
- The assisting machine is controlled remotely by the working machine operator
- Line capacity is often around 1,800' but varies by model





Video of a T-winch A Purpose Built Assisting Machine



Winches Mounted on the Working Machine

- As of 2019, harvesters and forwarders by one manufacturer are the primary machines in the United States that have integrated winches for winch assist (i.e. winches attached to the machine)
- These machines spool approximately 1,200 feet of line, but operators limit distances to 1,000' for safety
- Since the line on these machines is not a dynamic line there is less wear on the line
- These machines will anchor to a stump, tree or another stationary machine



Working Machines That Can Be Assisted

- Several types of machines can be winch assisted
- The current machine applications include
 - Directional fellers and feller-bunchers
 - Shovels
 - Skidders
 - Harvesters
 - Forwarders

Directional Fellers and Feller-Bunchers

- Probably the most common application of tether logging is on a feller-buncher or directional feller
- Tethering of falling machines allows skyline units to be mechanically cut and bunched, increasing production
- It eliminates hand falling which improves safety
- Directional fellers may also be used to shovel log timber after falling if they have a grapple felling head





Video of Tethered Directional Feller

Additional Grouser Height on a feller-buncher for Greater Ground Penetration and Traction



Shovels

- Shovels may be tethered
- They may move trees to a skyline corridor and bunch them for a grapple carriage
- They may also shovel log stems all the way to a roadside landing
- If they are equipped with a directional felling head, they can cut their way down the hill and shovel log back up





Video-Shovel Logger Tethered



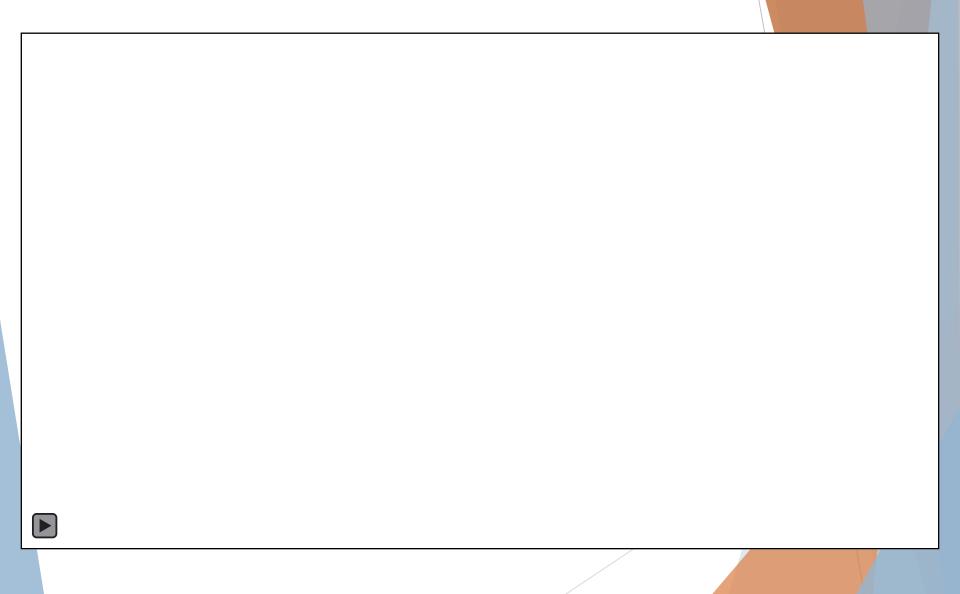
Skidders

- Skidders may be tethered, but this is not currently a common practice
- Skidders are fitted with tire chains on 4 wheeled machines or trac bands for 6 wheeled skidders to improve traction
- The winch line is attached to the front of the machine, skidding is always adverse





Video- Tethered Skidded



Harvesters and Forwarders

- Harvesters and Forwarders may be tethered and function as a cut to length operation
- Harvesters must work from the top down as the winch is mounted in the rear of the machine
- Forwarding may go up or down the slope when tethered
- Currently harvesters and forwarders are the primary working machines that have winches mounted directly to the machine in the United States
 - It is very rare for other working machines to have winches on the machine
 - Some harvesters and forwarders are designed to work on steep slopes even when not tethered



Close up of Synchrowinch on a Harvester



Recent innovations by some manufacturers now allow for operations on steep slopes, of up to 75%



This can be done safely and without significant negative soil impacts

Innovations That Allow Operations on Steep Slopes

- Development of 8-wheeled harvesters
- Balance bogie axles
- Trac-bands designed for steep slopes
- Flexible frames with multiple articulation points
- Long machine frames
- Tethered synchronized winch assist

8-Wheeled Harvesters

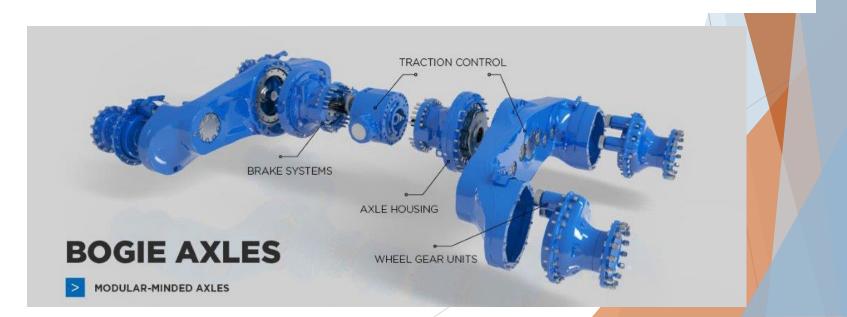
- Wheeled harvesters in the past were primarily 6 wheeled machines
- Development of the 8wheeled harvesters offers superior traction on steep slopes
- This is largely due to all wheels being on dual bogie axles rather than only one axle being a dual bogie
 - Bogie axles have two sets of wheels on each end of the axle



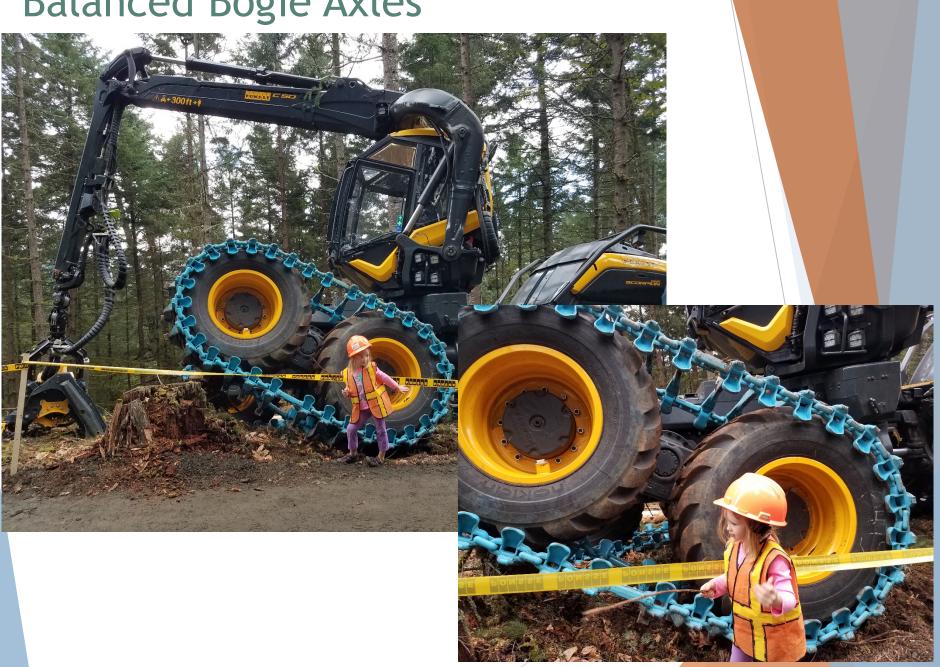


Balanced Bogie Axles

- On steep slopes balanced bogie axles apply equal downward pressure to both wheels on the axle
- With non-balanced bogie axles on steep sites, the lead wheel tends to rise up and reduce traction, similar to the front tire of a motorcycle rearing up while trying to climb a steep hill
- Balanced bogies maintain downward pressure to the front wheel on steep slopes, allowing the machine to maintain full traction with the ground
 - Balanced bogies also maintain traction climbing over a stump or rock



Balanced Bogie Axles



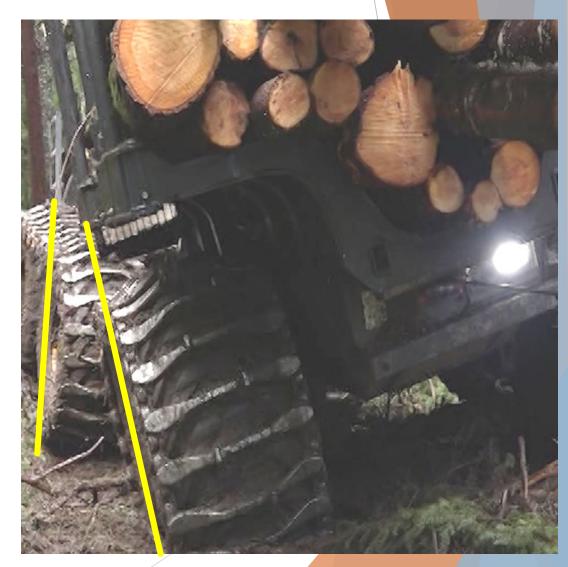
Trac-Bands Designed for Steep Slopes

- Trac-bands are flexible steel tracks that are fitted around rubber tires on a bogie axle
- Trac-bands have long been used on harvester and forwarder bogie wheels to improve traction and reduce ground pressure
 - Trac-bands designed for steep slopes provide superior traction and reduced soil impacts when operating on steep ground



Flexible Frames With Multiple Articulation Points

- Multiple articulation points allow for the machine to conform to the land instead of the land conforming to the machine
- Bogie wheels operating independently, with tracbands, roll and flex over ground obstacles
- High levels of adhesion and stability are achieved due to multiple points of contact



Video- Bogie Tracs Maintaining Traction With the Ground. No spinning and Digging (click slide to view)



Video of Harvester and Forwarder with Winch Assist (click on slide to view)



Integrating Tether Into Logging Systems









Why Tether Log? Improved Safety

- Tethering improves safety by taking people off the ground and putting them into OSHA approved equipment cabs
- They are no longer exposed to hazards such as falling trees, widow makers and rolling logs
- Tethering also allows machines to operate safely on steep ground as it redistributes the weight of the working machine improving stability



Why Tether Log ? Increased Efficiency

- Efficiency is increased as timber can now be mechanically cut and bunched for skyline yarding
- Timber may also be moved to the landing with a shovel, a forwarder or even a rubber-tired skidder
- In the past, steep ground had to be cut by hand and cable yarded
- Tethering allows for an increase in mechanization of operations which increases efficiency
- This lowers total stump to truck logging cost





Why Tether Log? Reduced Soil Impacts

- Tethering also reduces soil impacts compared to a non-tethered machine on the same site
- When a machine is tethered the machine's weight is more equally distributed on the tracks or wheels
- Machine sliding and spinning of tracks or wheels is also reduced
- This results in reduced rutting and displacement of soils



Tethered Falling and Skyline Yarding

- Falling can be done with a directional feller or fellerbuncher and bunch timber for skyline yarding
- Chokers can be set on these bunches and conventionally yarded
- If a motorized grapple carriage is used, bunches can be placed directly under the skyline eliminating the need for chokers
 - This creates a completely mechanical skyline operation



Tethered Falling With Tethered Shovel Logging

- Timber can be mechanically felled with a tethered fellerbuncher or directional feller
- It can then be shovel logged with a separate tethered shovel
- Falling with a directional falling head with a bar saw and grapple allows shovel logging with the same machine





Tethered Falling With Ground Based Skidding

- This application of tether is still very uncommon
- Timber can be cut with a tethered mechanical feller of some type
- Then skidded with a tethered rubber-tired skidder
- Skidding is adverse as the tether is attached to the front of the skidder



Tethered Cut to Length

- Harvesters and forwarders can be tethered and work as a cut to length logging system
- Only one manufacturer in the United States currently equips its machines with machine mounted winches
- This allows the harvester and forwarder to operate tethered without a separate assisting machine



Soil Effects

- Equipment operations on slopes exceeding 40% slope may rightfully cause concern with regard to soil displacement and rutting
- Rutting on steep slopes is often caused by tracked or wheeled machines breaking traction with the ground going uphill at the limit of their operability
- The machine's wheels or tracks spin and dig into the ground, leading to the creation of dug in ruts
- On steep ground machines can also break traction with the ground and slide downhill, creating ruts and displacing soil

Soil Effects

- On steep ground, a much greater percentage of a machine's ground pressure goes to the downhill wheels or downhill portion of the tracks
- This can cause the soil profile to shear allowing the machine and the upper portion of the soil profile to side down the hill, resulting in soil displacement
- Tethering reduces these impacts by enabling the entire length of track to remain in contact with the ground
- This equalizes the ground pressure the machine exerts on the soil reducing both sliding and spinning
- In tethered cut to length operations, presence of a slash mat provides an additional level of soil protection

Untethered Tracked machine on 48% slope, machine slid down hill resulting in ruts and soil



Then the machine tried to get back uphill, resulting in deep ruts from spinning tracks



If this machine had been tethered, sliding and spinning of the tracks would not have occurred. The tether would have stabilized the machine on the hill

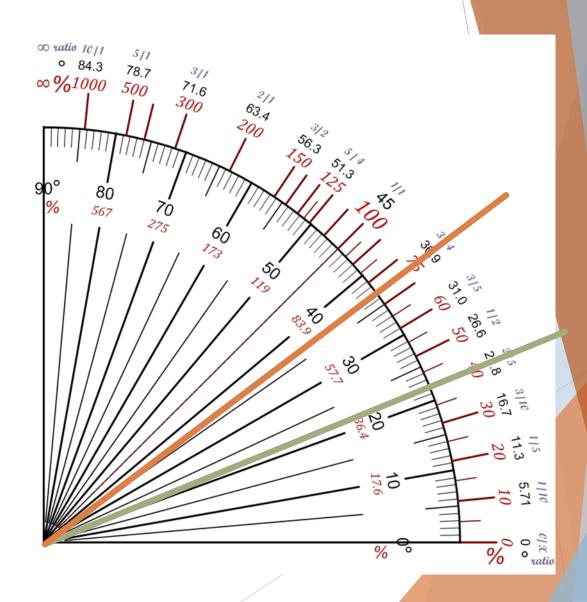
So How Steep *Can* we go?? How Steep *Should* we go?

Without Winch Assist

40% adverse and 65% favorable

With Winch Assist

75% adverse and favorable



How steep <u>CAN</u> They go? Or How steep <u>SHOULD</u> they go



It is not all about "Steepness"

> Slope Soil Type and Soil Conditions Vegetation, Tree Size, and Piece Size **Operator Skill** Site Conditions (Weather AND Ground) Machine Access and Anchors

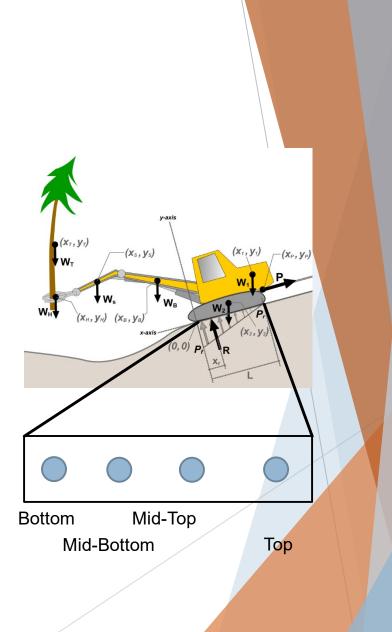
Physics of Cable Assist- When not tethered, more weight goes on the downhill end of the tracks, resulting in sliding and soil damage Physics of Cable Assist- When tethered, ground pressure is more evenly distributed reducing sliding, soil shearing and compaction

Field Testing



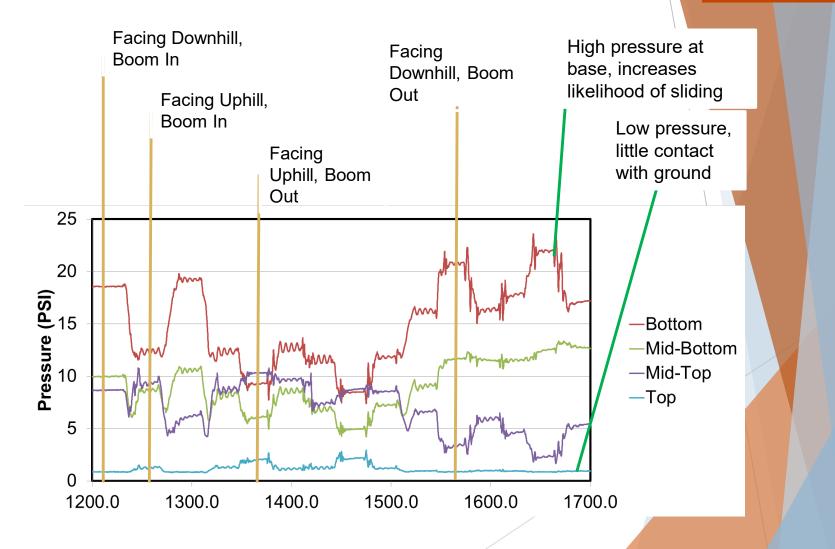
Series of field tests performed, monitored ground pressures at different points on the machine's tracks.

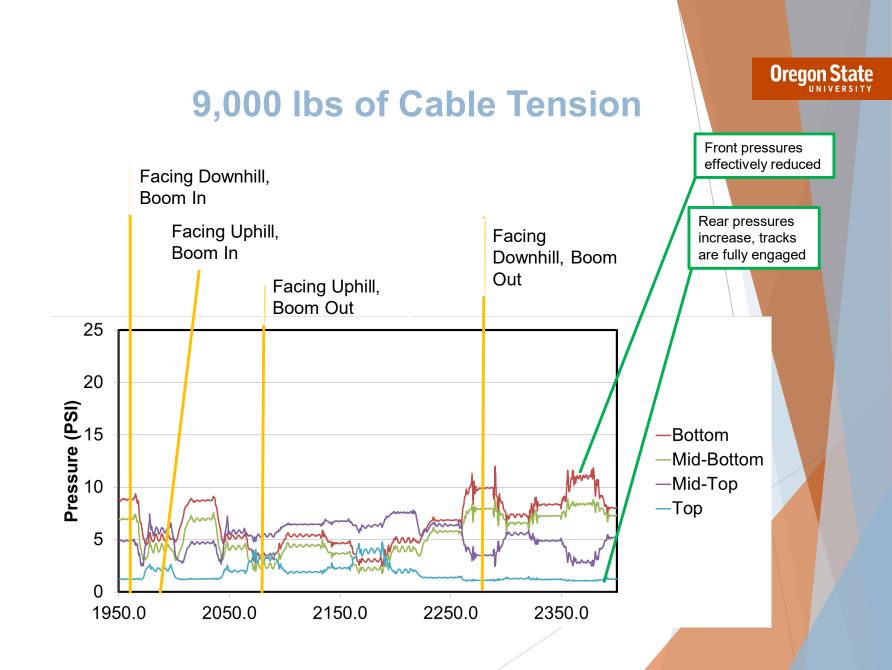


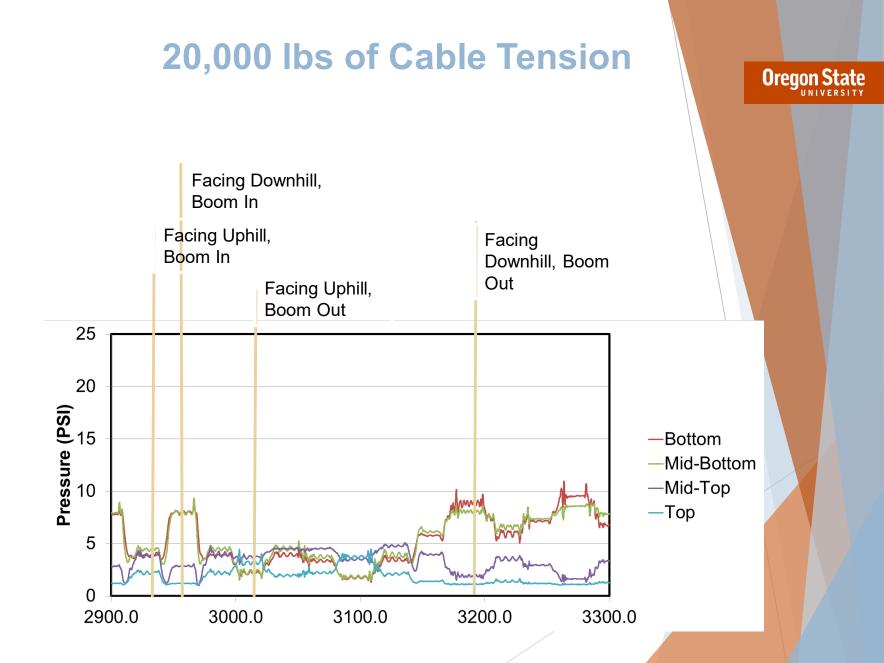


No Cable Tension

Oregon State







Questions

