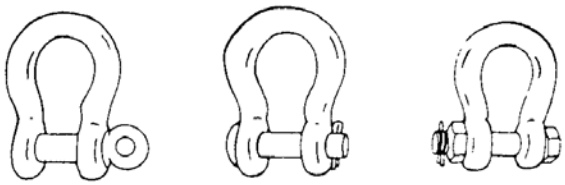
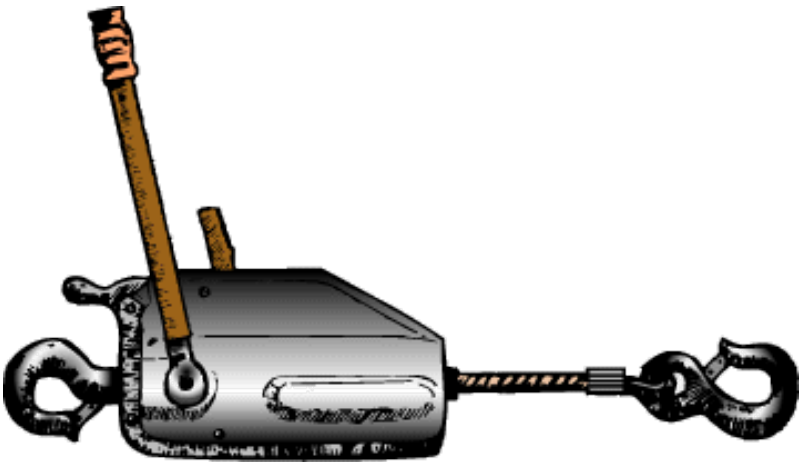
*An introduction to*

# Rigging for Trail Work





***"Give me a lever long enough and a prop strong enough,***
***I can single handed move the world." Archimedes***

The purpose of this seminar is to provide a hands-on introduction to the terms and tools used in pulling and lifting using a Griphoist winch.

The IATA has relied on Griphoist and rigging setups to move rock up and down 70 percent cross slopes and across 100-foot wide ravines, to move 45-foot timbers across rivers and streams, to move soil up steep slopes during tread construction, and to pull stumps from the treadway.

Hoisting rock or timber using a Griphoist and rigging setup is a specialized skill that requires training and experience. Your instructors are trained and experienced in the use of this equipment however *we are not experts in this field*. We will not operate beyond our limits of experience and knowledge and ask that you do the same.

Our time together will include a review of terms and tools used in rigging, safety and setting up and using a Griphoist and rigging system.

This handout is intended to be a resource for continued education and reference. Source material is liberally drawn from:
Trail Services of Maine and rigging master Lester Kenway,
http://www.trailservices.com/PDF/TrailServices_Catalog2018.pdf;

Federal Emergency Management Agency,
http://www.fema.gov/pdf/emergency/usr/module4.pdf;

Mazzella Lifting Technologies,
http://catalog.mazzellalifting.com/Indexes/Hoist/page107.aspx

And a range of assorted training and field notes accumulated over the last several years by IATA staff/tm.

Thanks for all you do for the Ice Age Trail Alliance and the Ice Age NST!!

## Mechanical Advantage (MA)

*Mechanics* is the branch of physics dealing with energy and forces in relation to bodies; distance traveled and force used are two elements of work and energy. Mechanical Advantage is (simply) defined as the ratio between the output force that a machine exerts to the input force that is furnished to that machine to do work. MA is the relationship between the weight of a load being lifted and the power of the force required to lift/push/hold that load.

## Knowledge is Safety

Winch work involves hazards in addition to those found in routine trail construction. Continually assess the Hazards present in your work area, follow safe procedures and wear the proper clothing and PPE.

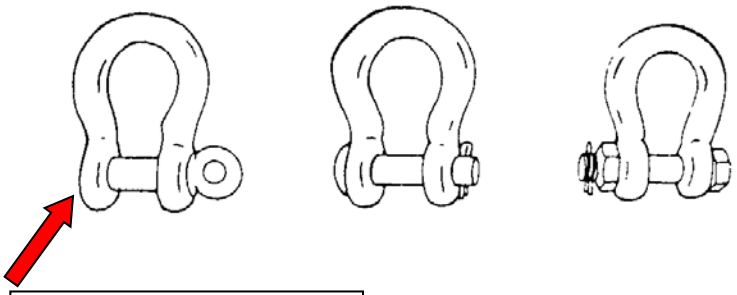
## Terms, Tools and Accessories for Wire Rope Systems

- Snatch blocks- a pulley, usually with a hook, whose side opens so that wire rope can be inserted.
- Shackle - a U-shaped steel piece closed with a heavy pin used for connecting slings, chain, and wire rope. Check rating stamp and the working load (WL) rating of each shackle in the set-up to confirm safe WLL.
- Nylon lifting slings (Endless Loops and Eye and Eye) – used to anchor Griphoist® machines to trees and cinching rocks and logs for transport.
- Fiber ropes (Manila, Nylon, Dacron) – used as brake and pull lines; ropes are attached to the load and used to control or create momentum.
- Load – the object being moved.
- Anchor – typically the base of a large, healthy tree(s) or a large boulder.
- Spar Tree – a tree used as a vertical support for the rigging system.
- Griphoist - is a portable lever operated manual hoist with traversing wire rope used to lift, pull and place loads utilizing principals of mechanical advantage.

Rock climbing gear is not rated for or appropriate equipment to use in rigging and highline systems.

Trail work usually occurs on slopes. Highline systems involve people working as a team who may be hundreds of feet apart; clear and ongoing communication amongst the team is the most important tool!

## SHACKLE TYPES



**Screw Pin – Use These** "Round "Safety Pin"

**IATA uses these**

| | model | nominal capacity lbs (kg) | weight lbs (kg) machine | weight lbs (kg) wire rope | dimensions in. (mm) machine | dimensions in. (mm) handle ext./closed | special wire rope diameter in. (mm) | special wire rope break. strain lbs (kg) |
|---|---|---|---|---|---|---|---|---|
| ***TU range*** *materials handling and manriding* | **TU-17** | 2,000*/1,500** (800/600) | 18.5 (8.4) | 30ft./9m 8 (3.6) | 20-3/4x9-3/4x4-1/2 (528x284x113) | 28/18 (730/450) | 5/16 (8.3 | 10,000 (4,800) |
| | **TU-28** | 4,000*/3,000** (1,600/1,200) | 41 (20) | 60ft./18m 28.9 (13) | 26x13x5-3/4 (660x360x145) | 45/26 (1147/648) | 7/16 (11.5) | 20,000 (9,600) |
| | **TU-32** | 8,000*/6,000** (3,200/2,400) | 59.5 (27) | 30ft./9m 8 (3.5) | 27x13x6-1/8 (685x365x156 | 45/26 (1147/648) | 5/8 (16.3) | 40,000 (19,200) |
| ***light-duty range*** *only for materials handling* | **T-508** | 2,000* (800) | 14.25 (6.6) | 30ft./9m 8 (3.5) | 16-1/2x9-7/8x3-7/8 (420x250x99) | 27/16 (690/405) | 5/16 (8.3) | 10,000 (4,800) |
| | **T-516** | 4,000* (1,600) | 30 (13.5) | 60ft./18m 28.9 (13) | 20-7/8x12-7/16x5 (530x315x127) | 45/26 (1147/648) | 7/16 (11.5) | 20,000 (9,600) |
| | **T-532** | 8,000* (3,200) | 51 (24) | 30ft./9m 8 (3.5) | 24-7/16x14x5-1/8 (631x357x148) | 45/26 (1147/648) | 5/8 (16.3 | 40,000 (19,200) |

*Capacity for materials handling. **Capacity for manriding; conform to all safety regulations.

**Increase the capacity of the GRIPHOIST-TIRFOR**

The lifting and pulling power of GRIPHOIST-TIRFOR winches can be greatly increased by the use of multiple sheave blocks. These can increase the nominal capacity of the GRIPHOIST-TIRFOR machine by 2, 3 or 4 times or more (see diagram opposite). For most applications, an allowance must be made for friction in the sheaves. Ensure that the capacity of the blocks, fittings and anchor points are suitable for the load. When using the GRIPHOIST-TIRFOR for pulling purposes it should be remembered that the necessary pulling effort is not equal to the weight of the load to be moved. It should be calculated.

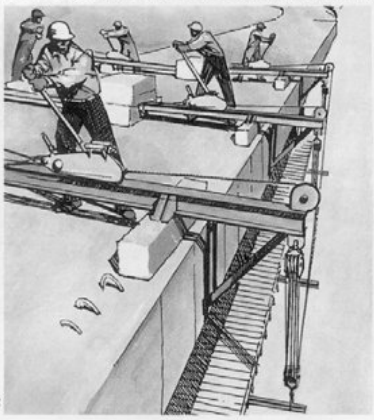
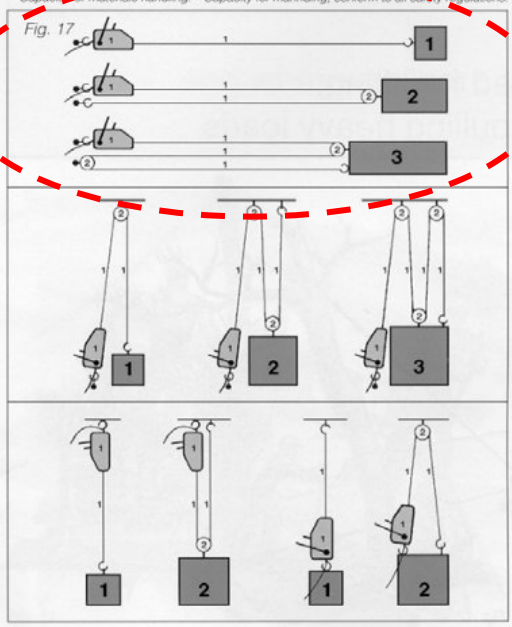


Fig. 16

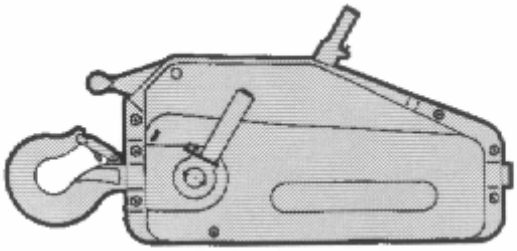



**How to set up a 2-1 or 3-1 pull**

**GRIPHOIST® SUPER PULL-ALL**

light duty wire rope hoist for material hoisting • 1,500 lb. capacity • weighs 8.25 lb. • Works well for tensioning "zip" lines for moving gravel and crushed stone and for pulling stumps.

**GRIPHOIST® WIRE ROPE** - Standard assemblies include hook and swaged thimble as well as tapered welded point.



**GRIPHOIST TU-17 & TU-28**

A winch that enables users to raise and lower loads; Internal 'jaws' clamp on and pull wire rope forward or backward.

The TU-17 has a 2000 lb. capacity, uses 5/16" wire rope and weighs 18.5 lb.
The TU-28 has a 4000 lb. capacity, uses 7/16" wire rope and weighs 41 pounds.

**Snatch blocks** are helpful for building systems to move materials. "Snatch" means that the side of the block will open to accept a line. Snatch blocks are used to build mechanical advantage, change pulling directions, hang highlines from trees and roll loads along a high line.

**BLACK RAT ® SNATCH BLOCK** is a simple twin plate style block that attaches to a load with a shackle. The 5" sheave fits up to 7/16" wire rope • WLL = 3,520 lbs • weighs 8 lb.
**Not Rated for Lifting.**

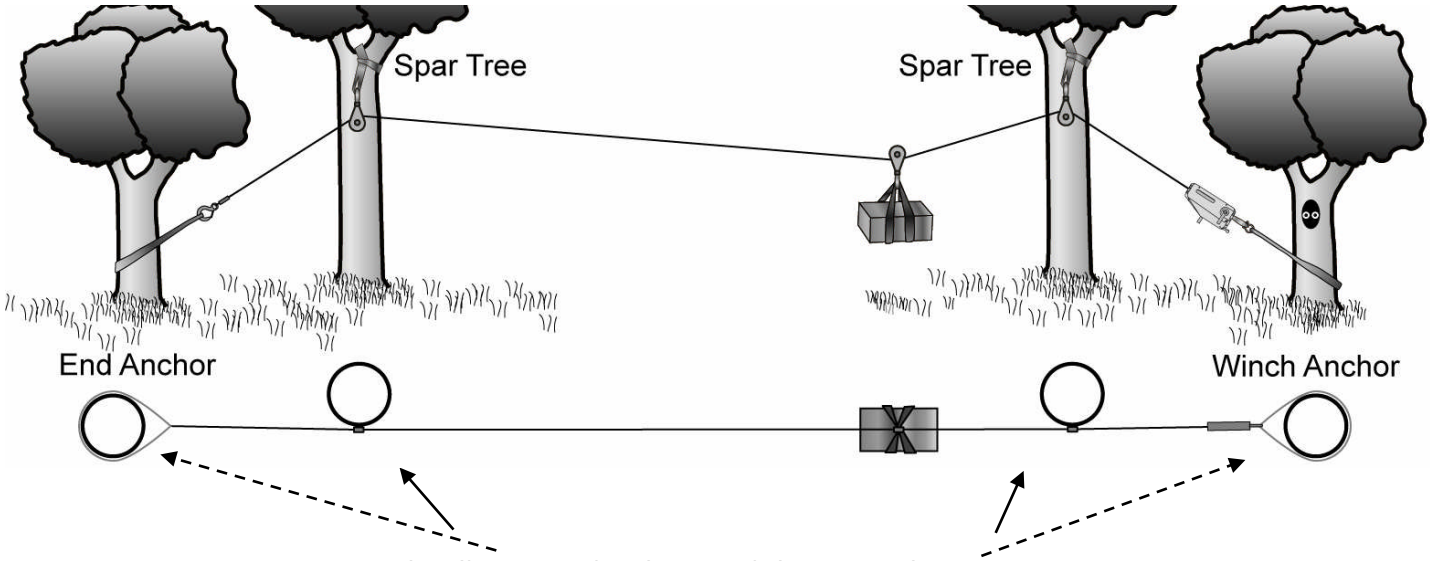
# The Four Basic Components

# Of a Griphoist-Powered Rigging System

1. One or more Griphoist winches with wire rope
2. Anchors
3. Accessories (slings, blocks, shackles +)
4. Trees or towers.

## Setting up a Highline

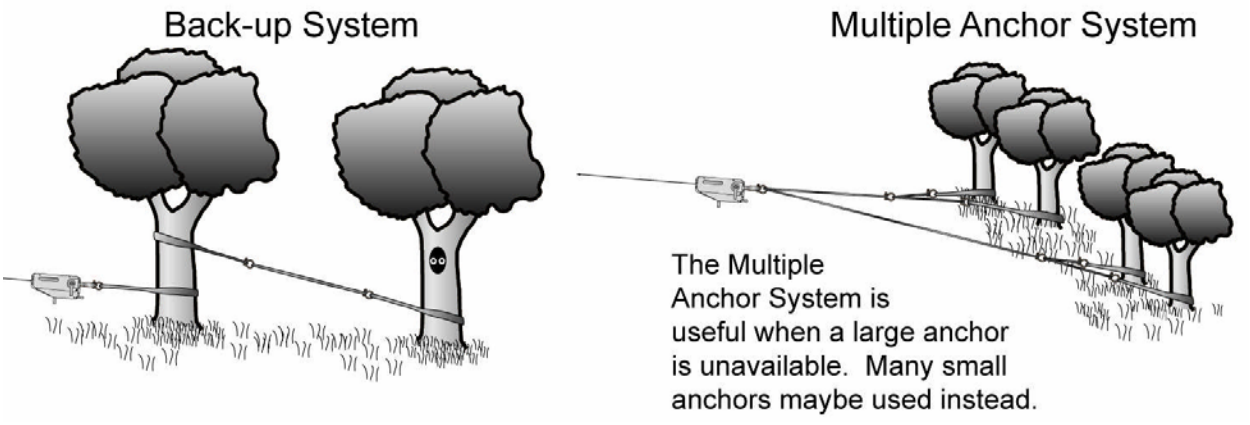
Griphoist powered rigging systems help trail crews move rock, wood, and other materials to work sites, up steep slopes, and across many barriers.




*The distance a load moves is between the spar trees.*

**Pick solid anchors, and monitor them for changes. <u>Use multiple anchors when in doubt.</u>** The most common anchors are stout trees or large boulders; smaller trees can serve as anchors if the lines are attached at ground level and to multiple trees.

Things to monitor include: excessive *tilting* of trees or movement of boulders, evidence of impending tree fracture (*cracking noises*), slings *creeping* up the anchor - provoked by too steep an angle towards a spar tree, and progressive *abrasion damage* or cutting of slings by rough edges on the anchor.



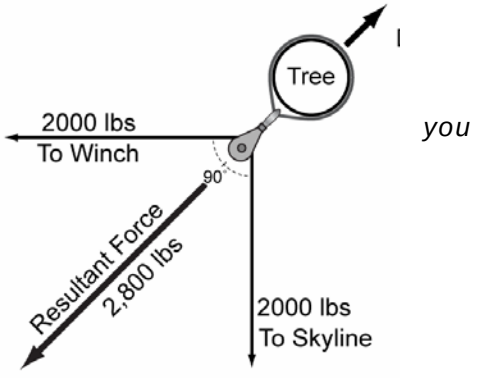

When the available anchor points appear to be small or questionable, use multiple anchor points. It pays to do the best job possible with the anchors. ***Winch anchor failure is likely to hurt someone.***

## Vertical Supports

When using trees as vertical supports, always analyze the forces being put on the tree and use appropriate guy lines to prevent toppling or breaking the tree.

- It can take 2000 pounds of tension to lift a 300 pound load in a typical 100 foot long high line system. If this horizontal force is applied to a tree 12 to 16 feet off the ground, it can pull the tree over.
- The simplest way to prevent excessive sideways force on the "Spar" tree is to layout the system in a near linear fashion. With a linear arrangement, the force on the spar trees by the line is matched by the tension from the Griphoist and end anchor. With this setup, the spar trees experience only a downward force.
    - When spar trees are the focus of a horizontal change in direction of the cable, the angles must be studied and a guy line(s) or backstay(s) applied that will oppose the resultant force that will be applied to the tree by the angled cable.

*Since an angled cable multiplies the resultant force experienced by the spar tree, at least one guy line made from lifting slings, chain or wire rope may be needed. If you are in doubt about estimating the direction of the resultant force, use two guy lines, each one directly opposite of the two cable directions.*



**Maintain a safety factor of 5 when applying all accessories and hardware to a system.**
Always *look at and check your hardware slings and equipment* before and during the set up to ensure safe working load limit - "Use the right tool for the job".

The WLL "Working Load Limit" marked on many products is 1/5 of the breaking strength of the part. Griphoist® machine that produces 2000 pounds of tension needs an anchor sling rated at 2000 pounds WLL (breaking strength of 10,000 pounds). A 4000 pound WLL snatch block (breaking strength of 20,000 pounds) is certainly OK for lifting a 500 pound boulder.

# Applicable Concepts and Definitions

**CENTER OF GRAVITY (CG) AND POSITION CHANGES** – the CG is the Point at which the whole weight of object is acting vertically downward = balance. If a load is suspended at its CG, it can be turned in any direction with little effort.

If load is lifted to the right/left of CG, it will tilt at an angle. If a load is lifted below its center of gravity, the weight of the load will be above the lifting point, and the load will tip over. It is important that loads be hoisted above the load's CG.

**RESISTANCE FORCE** - Force found in the location of the contact between two surfaces acts parallel to those surfaces in a direction opposing the relative motion between them. The greater the weight (force of gravity) of an object the greater the friction force.

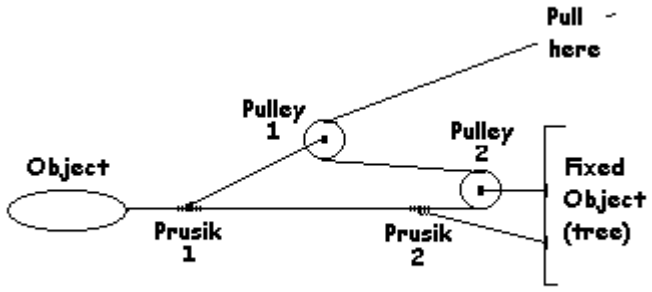
**FRICTION** - The smoother the two contact surfaces, the less the friction between those surfaces. Liquids can reduce the friction between two surfaces. Materials with rounded surfaces that break the contact between objects will generally reduce friction. Lifting operations often involve lifting only one side of the object which reduces the weight on the contact surface and consequently decreases the friction force.

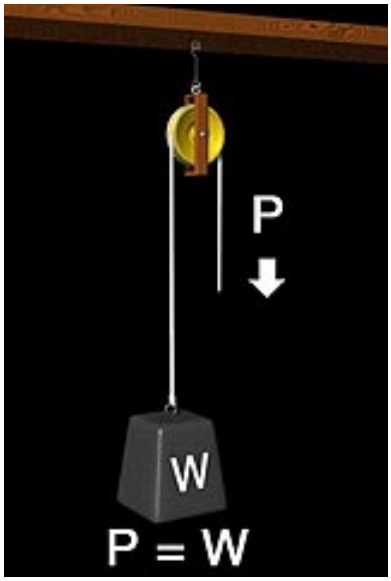
**INCLINED PLANES** are a gradual slope used to move an object a certain distance using less force. Examples include ramps, wedges and screw threads. Efficiency is gained by reducing the required force to raise an object. Efficiency depends on the slope of the incline and the friction on its surface.

- Slope/Grade % of Load's Weight
  - 45 degrees = 100%
  - 35 degrees = 60 %
  - 25 degrees = 40%
  - 15 degrees = 25%

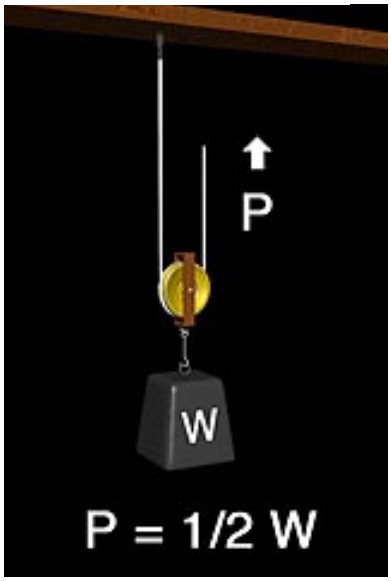
**LEVERS** are used to move a load that is heavier than can be moved by manpower alone. Leverage is the means of accomplishing work by transferring force from one place to another or to change a force's direction.

**PULLEYS** are used to lift, pull, move, change direction and reduce friction as it relates to loads and Mechanical Advantage.




The pulley on the left is a fixed pulley; it doesn't move when the rope is pulled. The pulley on the right is moveable; as the rope is pulled up, it can also move up. The picture on the right shows the rope is supporting the weight from two sides, so each side carries only half the weight (2 upward tensions are equal and opposite to the downward weight, so each tension is equal to 1/2 the weight). Therefore, the force needed to hold up the pulley in this example is 1/2 the weight and the mechanical advantage of this system is 2; Mechanical Advantage in this example is the weight (output force) divided by 1/2 the weight (input force).



**Zip Line:** used to move duff, dirt, etc. Zip lines are especially helpful when working on steep cross slope for worker safety and minimizing ecological impacts on the slope.

**Proper use and care of wire rope**

Wire rope used in rigging applications is under high tension – a failure in equipment or improperly setting up equipment can result in severe injury. Wire rope is a precision machine that is designed to do a specific job.

- Do not allow the rope to become kinked or bent and use the right diameter rope for the winch and hardware in the system being used
- Avoid getting wire rope in the dirt as much as is practicable. Wipe dirt and grime off wire rope often throughout the day. At the end of the season (or mid-season if heavily used) oil and wipe off wire rope.
- Winches are capable of moving objects weighing several tons; hardware must be rated and strong enough to do the job. Maintain a safety factor of 5.