ASSESSMENT AND MODIFICATION OF ARBORICULTURAL CLIMBING TECHNIQUES

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Abstract. With the exception of better ropes and saddles, tree climbing methodologies have not changed significantly in 90 years. Climbing still takes an above average amount of strength and skill in order to ascend into the tree to be worked on. Commercial arborists are searching for a climbing system that will make it easier for the climber to reach the work station in the canopy, thus extending the longevity of experienced climbers. This paper reviews the history of commercial climbing and presents a new climbing system. This new method meets the new standards established by the Z-133 committee and demonstrates an easier and less strenuous way to enter the tree. The new system utilizes common tree climbing equipment and a Chance capstan hoist.

This project was conceived in 1988 when John Hendricksen, then chairman of the Z-133 committee, suggested that there was a need to develop a climbing system easier to use than that currently in use. Criteria would have to be met in order for it to be useful to the tree care industry: 1) the climbing system would have to meet all Z-133 safety standards, 2) the climbing system would have to be portable and light weight. After extensive discussion with climbers several problems were identified, such as the comfort and safety of climbing saddles, the strength of climbing lines and how to get into the climbing position with less effort safely.

Climbing saddles and climbing lines have been improved tremendously in the last decade, but climbers still need to physically pull themselves up into the tree. It takes a tree company about three years to develop and train a tree climber to full potential. Good climbers are difficult to find and more difficult to keep. The major difficulty for an ageing climber is the effort required to get to the top of the tree to begin work.

This paper will look at how to get a climber up into the tree. Past, present and future methods are reviewed.

History

Tree climbing is not new to humans. Our prehistoric relatives used it as a means of obtaining food and as a way to be safe from non-climbing animals. Tree climbing in ornamental trees is probably as old as gardens. The use of lines for climbing was first recommended in England in 1759 as an aid in pruning; in 1934 English writers were encouraging the use of ropes as a means of working in trees more safely (11):

> *" There seems to be a definite streak of obstinacy in such people, who often work at a great height from which a fall may mean not only disablement but possibly a slow and ghastly death by impalement. Such belts - should be encouraged. No workman should have an idea that the use of such a belt is a confession of cowardice. The use of a safety-belt is a question of common sense."*

Climbing lines were not commonly used until the early part of the twentieth century and even then only in North America. Lem Stout of the Bartlett Tree Experts wrote (10) in 1957 that he was the first to start using a climbing line in 1917. Prior to that time the climbers used spurs. In many parts of the world climbing lines are still not used. The English use a climbing system similar to that in North America, but most of continental Europe does not, and some of these countries have made it illegal to work in trees from a rope and saddle.

Tree climbing, using a rope and saddle, not only can be a very safe way to work, but also an enjoyable experience. Safe tree climbing depends on the climber receiving good training, being experienced and working with good equipment. The American National Standard Z-133 *Safety Requirements for Pruning, Trimming, Repairing, Maintaining, and Removing Trees* committee (1)

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outlines the proper procedures to be followed by all tree climbers. It requires that a climber:

"shall be tied in with an approved type of climbing rope and safety saddle when working above the ground."

Tree climbing is performed each work day by thousands of tree workers in North America in an efficient and safe manner. An important component of safe tree climbing is the personal attitude of the climber. Tree climbers are required to make many important decisions each day that affect how safe their work will be. While tree climbing can be very rewarding work, a poor decision can result in an accident. Workers who can not make sound decisions based on experience and common sense should never engage in tree climbing. In addition to the climber's mental attitude, prior training and experience are necessary to complete a job safely and correctly. Lastly, tree climbing requires that the climber be in good physical condition and that he be able to handle his own weight in an effortless manner. Men or women with good balance and agility make the best climbers.

Climbing Systems

Tree climbing has evolved over the past 100 years into a system that allows a climber to work in a tree in a safe and efficient manner. The climber places a line at a high point in a tree and using a series of knots is able to move up, down and throughout the tree. Following World War II tree climbing saddles became popular and have been improved tremendously in recent years. This has made climbing safer and more comfortable. However, tree climbing is still very much as it has always been, working off of a rope while crotched into the tree.

Tree climbing ropes have been improved since the 1970's. Todays ropes are stronger, easier to use and longer lasting. Polyester (Dacron) is the principal fiber used today in arborist ropes (9). Polyester lines stretch much less than nylon lines. Polyester lines are used for both climbing and lowering ropes. The Z-133 Standard (1) requires that:

"climbing ropes shall have a minimum diameter of 1/2 inch (12 mm) and be constructed of a synthetic fiber, with a minimum nominal breaking strength of 5400 pounds (24 kN) when new or equivalent or greater strength and durability. Maximum working elongation (elasticity) shall not exceed 7 percent at a load of 540 pounds (10 percent minimum breaking strength)."

As of this printing, polyester and several combination fiber ropes meet this Z-133 requirement.

In North America the most common tree climbing system requires the climber to have a climbing line crotched over a branch while using a taut-line hitch to control movement in the tree. This system is safe, economical, easy to use and, most importantly, works well. The British have developed a modification of this system using a series of prussik loops in place of the taut-line hitch (13). These are basically the only systems used by arborists while working in a tree. Tree climbing gaffs (spurs) are to be used only on trees to be removed. Foresters will occasionally use other tree climbing systems in order to collect samples from trees, e.g., the Swiss Tree Grippers are an example. Most forestry climbing systems will not work in an arboricultural situation because they have been designed to work on tall, straight trees that have few branches. All tree climbing operations can be divided into three steps: ascending into the tree, working in the tree and descending out of the tree.

Ascending into the tree and climbing to the crotch in point is the most difficult part. Ascending is what most often limits a climber's work longevity. As the climber gets older, the physical activity requires more effort. Ascending is also where the most accidents occur. Frequently, the climber does not tie in, but resorts to free climbing. If a climber is not tied into the tree, he/she can fall. It is this author's opinion that a climber should always be tied in. Being tied in can be accomplished by having the climbing line crotched properly and a taut-line hitch tied, being belayed by a ground person or by using a buck strap.

Most large trees have no lower limbs for climbing, so the climber must be able to get a rope into the tree to begin the climb. Several methods are commonly used today in the industry.

Rope Throw. A throw knot is required to get a 0.5 inch (12mm) line up into a tree. Every climber

should become proficient at tossing the throw knot. An experienced climber should be able to toss a 1/2 inch (12mm) throw knot 30 to 40 feet (9 to 12m) up into a tree with accuracy. Experienced climbers always throw the rope over at least the second branch, which allows the climber to stand on the first limb after entry into the tree. In addition to being used on the ground the climber will use the rope throw many times a day while up in the tree.

Once the rope has been tossed over a limb it is necessary to flip the throw knot down to the ground, unless the throw knot was tied so that it would unravel. This flipping is easy if you roll the rope over the limb in a smooth manner. The climbing systems used today requires the climber to have both ends of the rope on the same side of the tree. This can be very difficult to accomplish in tall trees that are heavily branched.

Throw Weight. Several of the throw weights now available are based on the Navy "monkey fist." The most popular with climbers are the rubber ball and the shot pouch. A weighted ball has a 1/8 to 1/4 inch (3 to 6mm) line tied to it. The weight and line are thrown over a branch. Sixty feet (18m) in height is easily obtainable with practice. The weight and line are then flipped back to the ground. Once the light line has been crotched, the climbing line is pulled into position by using a double sheet bend knot or by seizing the lines together. This method can also be used to place a false crotch in the tree.

Body-thrust. Once the climber has both ends of the climbing rope on the ground, he can move into the tree. The body-thrust can be used with a taut-line hitch or the climber can be belayed as a means of being tied in (8). The body-thrust consists of pulling one self up the tree, with a series of hand pulls and body-thrusts.

Foot-locking. Moving into the tree by foot-locking the climbing rope is used by some arborists, but should only be used with the prussik loop system (4).

Belaying. Belaying is a term first used by rock climbers. It identifies a system in which a second person arrests the fall of the climber. Belaying is especially useful when getting into a large tree, Often the belayer will help the climber by pulling down on one end of the climbing line to make it easier for the climber to go up the other (6, 7, 13). When a climber is being belayed, it is very important that the climber and the belayer fully cooperate. The belayer should keep the line taut at all times and not release the line until the climber is tied in.

Hand Climbing. Once the climber has reached the tree branches, it is often easier to climb the tree using the branches as steps than it is to pull up using the rope. When climbing using the branches as steps, the climber should still be tied into the tree. Whether tied in using the buck strap or being belayed, the climber should always try to divide his weight between three points or branches of the tree (12). Climbers should check branches before applying weight to them and take tree species into consideration. Some species have branches that break off easily under weight. Climbers should keep their hands and feet close in to the trunk in order to reduce branch breakage.

Ladders. Tree companies that work on large trees often use ladders as a means of entering a tree. All ladders used in tree work should meet Z-133 standards and be non-conductive of electricity. Metal ladders are conductive and should never be used for tree work.

Climbers should never work off of a ladder unless the climber is tied into the tree. It's not uncommon for a cut limb to kick a ladder out from under a worker, resulting in a fall. Sectional forestry ladders are usually not used by arborists,because they are too time consuming to set up.

Working in the Tree. Many inexperienced climbers crotch their climbing line in at a low point in the tree and then try to work. This does not work. A climber should always climb as high into a tree as is safely possible. The higher you are crotched, the easier it is to work the tree. The tree climbing rope forms an angle with the tree trunk. The narrower your angle, the easier it is to move out from the trunk to the end of branches.

Crotch selection is important. Where you tie in can make your job easy or hard, safe or unsafe. When picking the crotch, take into consideration the strength of the tree. Do not tie in so high that the top of the tree will break. Check the tie in area for decay,and other factors that would weaken the

limb. Do not put your line through a narrow or split crotch as your line will jam.

Besides picking a strong and high crotch, you need to pick one that is on an upright leader in the center of the tree. It is also important to pick a point to tie in that, in case of a slip, will swing you away from any potential hazards such as electric wires. Never set your line so that you could swing into a hazard. When crotching in or recrotching, always be tied in. The easiest way is usually with the buck strap.

When the climber is tied in, he can start working in the tree. In most cases, since the climber is already at the top of the tree, this is where the work should begin, especially when pruning. The climbing line should become a part of the climber, a third arm that can be used for positioning and balance. The line should be kept taut at all times. By keeping the line taut a climber cannot fall far. If a slip occurs, the climber will swing into the center of the tree.

Descending. Upon completion of the work, the climber's last step is the decent. The first step is to make sure that work is finished and up to professional standards. Next, check your climbing line; is it clear to the ground, is it free of branches on the ground and most importantly do you have sufficient line to reach the ground without running out of rope? A climbing line that is 120 feet (37m) long only gives a climber 60 feet (18m) of useable line. If the climber is tied in at 80 feet (24m) the climber will have to recrotch to get back to the ground safely.

Before descending, check to insure that you will not come down into utility wires or onto a sharp fence. Descend from the tree in a controlled fashion and not so fast that you burn your line. Upon reaching the ground, remove your line from the tree, coil it and place it where it will not be damaged.

Future Climbing Systems

In developing this system, a review of fall protection systems used by other industries was undertaken (7). The construction, marine and utility industries offered the widest range of options. Most of these systems were not portable or in most cases would conduct electricity.

With the proposed changes in the Z-133, climbers will have more options available to them. The definition of the taut-line hitch has been expanded to include "the use of a prussik loop or a mechanical ascender in lieu of a taut-line hitch" (2). Some climbers are starting to use the mechanical ascenders when foot locking into the tree (3).

In the past, the false crotch was used primarily on palm trees and as a lowering device for limbs. The new standard will allow a false crotch to "be used at the discretion of the climber in lieu of a natural crotch" (2).

> *False crotching for a climbing line. A 5/8 inch shackle (clevis) with a minimum breaking strength of 5,000 pounds (22.2kN) supported by a line equal to the minimum requirements or a climbing line. The pin in the shackle (clevis) shall be secured in a positive manner (by safety wiring the pin in place or securing the pin in place with a cotter pin). In place of the shackle a 1/2 inch rope pulley with a minimum breaking strength of 5,000 pounds may be used."*

Figure 1 demonstrates the equipment required to install a false crotch.

False crotching has a major advantage to a natural crotch in that the climber does not have to get both ends of the throw weight together on the ground. By using a false crotch the climber can pull his climbing line into place with only one end on the ground.

With a false crotch anchored into place, a CHANCE (5) capstan hoist can be added to the system, thus enabling the climber to be lifted into the top of the tree. Power-Assisted Climbing (PAC) is economical ($1,200) and makes getting into the tree effortless. The hoist weighs only 70 pounds and has a 1,000 pound lift rating. With four wraps on the capstan only twenty pounds of pull is required by the line operator when using a 1/2 inch (12mm) poly-dacron line to lift 250 pounds. The power source of the hoist can be purchased as electric (12V DC, 115 and 230V AC), hydraulic and gasoline. The model tested for this project was 115V AC.

This test unit had an optional rope lock that seemed to get in the way more than it helped. The test model did not have a foot control. This probably

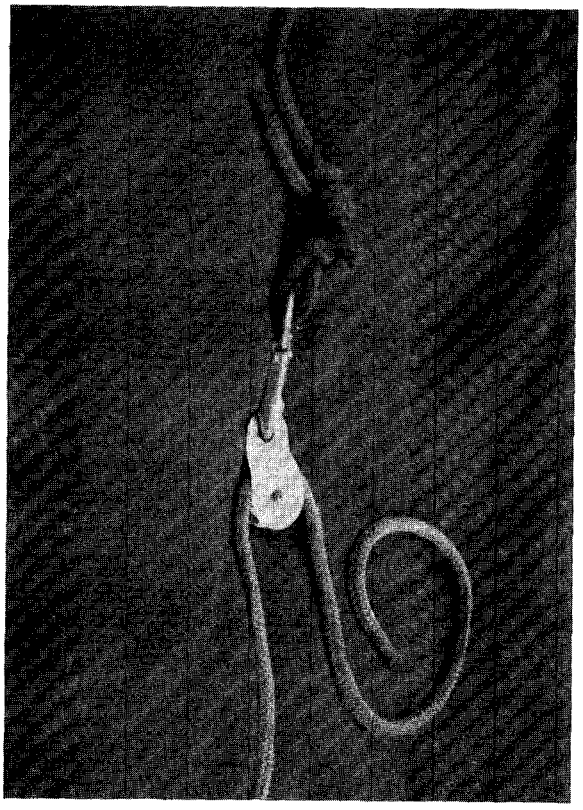

Figure 1. The equipment required to set up a false crotch using a 1/2 inch (12mm) rope pulley that is secured to a false crotch line by a bowlin or a splice. A separate climbing line is then run through the pulley to be used as the climbing line. The climber then places the false crotch line over the limb by using a throw weight and pulls the false crotch up into place. The false crotch line is then secured to the base of the tree. The climber then ties in to the climbing line and commences work.

would have made using the hoist even easier. The hoist attaches to the tree with two chains in about ten minutes (Figure 2). The chain is tightened easily with two turn binders. Padding to protect the trunk cambium will be necessary. The CHANCE company stated that a belt type system could be used in place of the chain system. Bark padding will still be necessary, especially on thin barked trees or during the spring.

The test unit was mounted to a sugar maple (*Acer saccharum*) and a false crotch was set in the tree. Using a 1/2 inch (12mm) climbing line, the climber tied in with a taut line hitch. Four turns

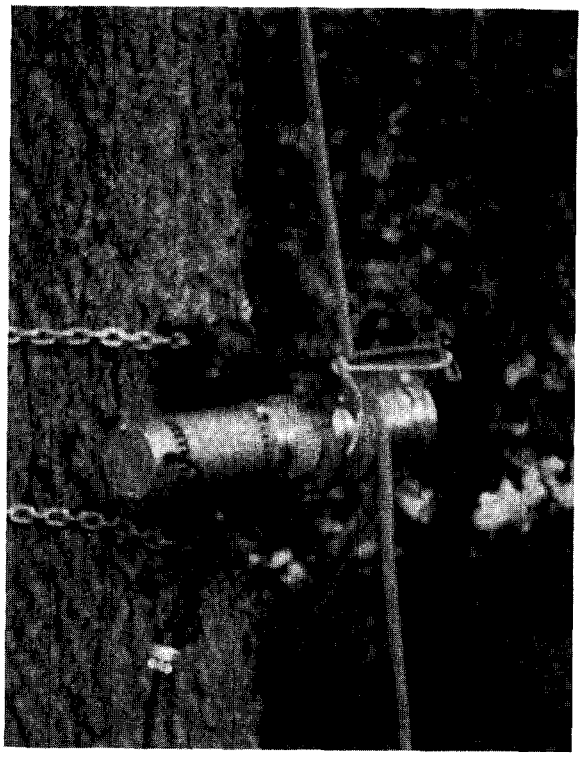

Figure 2. The hoist attaches to the tree with two chains and is ready to be used in ten minutes. Padding of the bark to protect the cambium from the chain is necessary.

were taken on the capstan and the climber was lifted effortlessly into the tree (Figure 3). While being lifted the climber slid the taut-line hitch up.

Is this a viable climbing system? It could be of service in large trees, especially where repeated entry is necessary. Obviously, it is unnecessary in small to medium trees.

Summary

This paper has reviewed current climbing methods and introduced a system that could be of use to climbers, especially in ascending tall trees.

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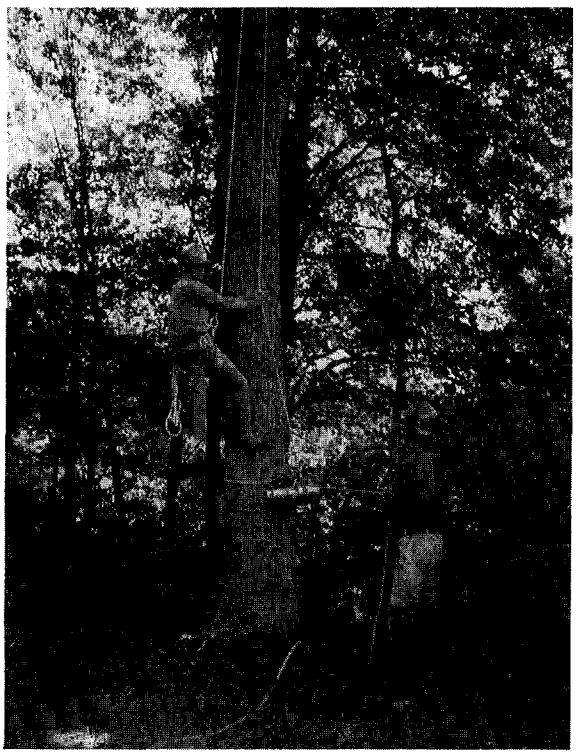

Figure 3. The hoist in use lifting a climber by means of a false crotch. Note, that the climber is tied in with a taut-line hitch for security.

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Résumé. Les arboriculteurs commerciaux sont à la recherche d'un système de grimpée qui faciliterait la tâche de l'élagueur dans sa montée vers sa position de travail au sommet de la cime, augmentant ainsi le nombre d'années employables d'élagueurs expérimentés. Cet article fait une revue historique des pratiques commerciales d'ascension dans les arbres et présente une nouvelle méthode de montée. Le nouveau système utilise un équipement commun de grimpée dans les arbres ainsi qu'un treuil à cabestan. La nouvelle méthode rencontre les normes établies par le Comité sur la sécurité Z-133 et se présente comme étant plus facile et moins ardue pour pénétrer à l'intérieur de l'arbre.

Zusammenfassung. Kommerzielle Baumzüchter suchen nach einer Klettertechnik, die dem Kletterer das Erreichen des Baumwipfels erleichtert und somit die Arbeitsmöglichkeiten erfahrener Kletterer um Jahre verlängert. Diese Arbiet untersucht die Geschichte des kommerziellen Kletterns und stellt eine neue Klettertechnik vor. Das neue System benutzt die übliche Baumkletterausrüstung und einen "Change capstan Aufzug.' Die neue Methode ist in Einklang mit den Normen, die durch den Z-133 Sicherheitsausschuß erlassen wurden und zeigt einen leichteren und weniger anstrengenden Weg in den Baum.