Greater Falling Accuracy

Using the Tapered Hinge

By Daniel Murphy

The ability to fall a tree accurately is crucial in preventing property damage and often allows the arborist to quickly fall a tree rather than climbing and rigging a technical removal. Understanding the mechanics of a good hinge is essential in developing falling accuracy and confidence. This article will focus on the mechanical principles of a tapered hinge, which when combined with proper falling techniques, give excellent control in falling side leaning trees.

These principles have long been understood and taught by professional loggers and can be found in books by Douglas Dent and Jerry Beranek. Though well understood and used by the logging industry, the use of tapered hinges seems to be far less established in the tree care industry. This article is primarily written for the benefit of the urban arborist.

This large cherry has a significant side lean and is threatening a house that is not in the picture. The decision to fell rather than climb this removal was made because there was 1) a wide open landing zone, 2) a well-placed tree from which to anchor a retainer line, and 3) enough sound wood on the tension side to trust the hinge. Notice the pull line (outlined in green), and the retainer line (outlined in red). Both lines were set from the ground and tied off at arrow A, using the fishing pole technique, which does not require isolating lines. All photos courtesy of Daniel Murphy.

It is generally preferable to fall a tree or spar either in the direction of lean or directly opposite the direction of lean. However, often the only unobstructed landing zone lies to the side of a tree's lean. Here the faller faces a risk that the lean of the tree will cause the hinge to fail, prior to the tree committing to the desired direction of fall. The results can be catastrophic. The faller has several options to create a mechanical system that has enough strength to resist gravity and usher the tree into the desired direction of fall.

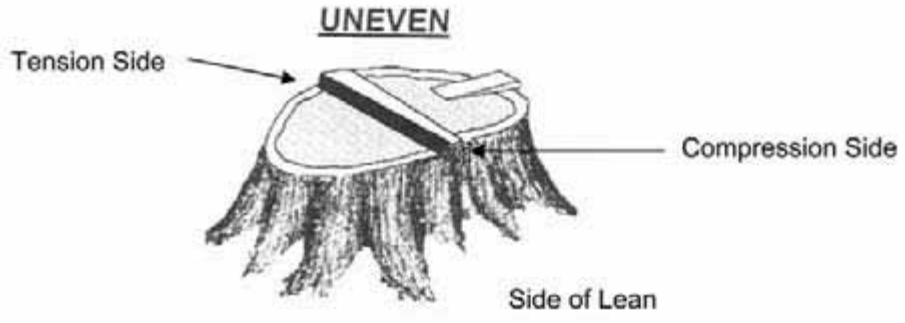
Many arborists compensate for a side leaning tree by adjusting the gun (that is aiming the notch to sight the tree) past the desired direction of fall. This method uses a standard hinge with holding wood of equal width across the length of the hinge. Logging instructor Tim Ard suggests "aiming the tree an additional 50 percent of the side lean in the opposite direction. For example, a tree with 5 feet of right side lean must be aimed 7½ feet to the left of the intended target."[1] This adjusted gun technique is somewhat imprecise, but will work in trees with moderate side lean, especially on trees like elm and hickory, which have excellent strength of wood fibers to resist hinge failure. However in falling trees with a heavier lean, especially when leaning toward valuable property, this method cannot be trusted.

In *Professional Timber Falling*, Douglas Dent clearly states that the preferred method for falling a side leaner is to compensate for lean by using a tapered hinge. Dent calls the tapered hinge "an extremely

important part of the faller's technique." Jerry Beranek also recommends this technique in the *Fundamentals of General Tree Work*, referring to it as the "uneven" hinge. On a standard hinge, the width of the hinge (or holding wood) does not vary, so that the face and the back cut are parallel. The tapered hinge differs in that the holding wood is very narrow on the compression side (toward the direction of lean), and then gets consistently wider, reaching its widest point on the tension side. This is easily achieved by making the back cut at a slight angle to the face.

Here are Dent's instructions for cutting a tapered hinge. First, the notch is cut facing the desired direction of fall. The back cut is then made to create a hinge, which is tapered across its length, with the widest part of the hinge being placed on the tension side, opposite the lean.

As in all chain saw operation(s), this technique must be learned by doing. It is best to practice using the tapered hinge in non-critical situations to get a feel for its use in different species and circumstances. One way to approach the technique is to keep about the same total amount of fiber in the hinge as in a standard hinge, approximately 10 percent of the trees DBH. By angling the back cut it is possible to remove about half of the fibers from the compression side while leaving that approximate amount of additional fiber on tension side. (see diagram)



Beranek's illustration of the tapered hinge. Calling it the uneven hinge, he states "This is an applicable hinge for controlling trees with side lean or offset limb weight providing that the beefy side is on the tensioned part of the stump." This tree would have leaned toward the viewer, making the near side of the hinge compression and the far side tension. Reprinted, with permission, from Fundamentals of General Tree Work *by G.F. Beranek.*

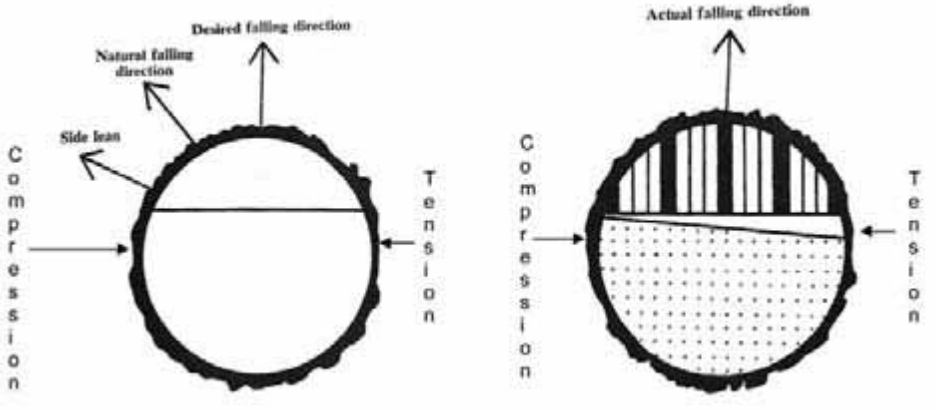
Another way to learn this technique is to practice on trees that are either slight front leaners or set with a high pull line. Make the back cut by running the tip of the bar forward until it is about ½ inch from the notch on the compression side of the hinge. Then while using constant pull, leave the tip in place and push the body of the saw forward until the tree begins to move. This should leave a hinge that is ½ inch thick on the compression side and much beefier on the tension side.

The tapered hinge takes advantage of the different properties of tensioned fibers and compressed fibers. The wood on the bottom side of a horizontal limb (or on the lean side of a tree) is under compression, because the weight of the limb is pushing the wood fibers together. Wood under compression, when cut, will pinch the kerf, as when undercutting a limb. As the limb is undercut, its weight will begin to pinch the kerf, sometimes trapping the saw.

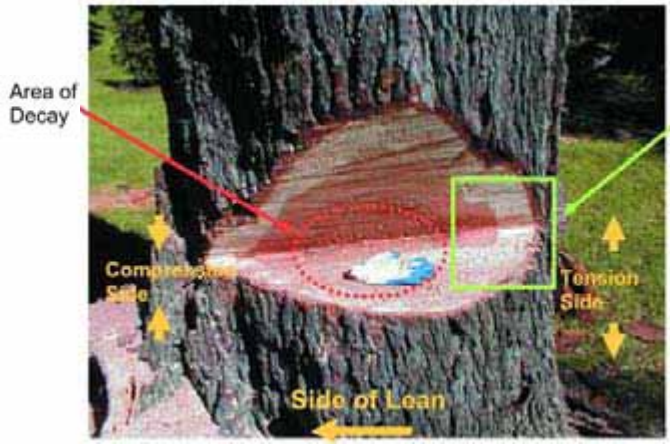
Conversely wood on the top side of a limb is under tension. Tensioned fibers are being stretched or pulled apart. As wood under tension on the top side of a limb is cut, the kerf will begin to open, until the limb fails.

Tensioned fibers provide the majority of strength in any system such as a limb or a hinge. Compressed fibers do little to keep the limb or hinge from failing. Because arborists have been taught to undercut any heavy limb, they rarely get a chance to see a large limb fail at the slightest violation of tensioned fibers. Some time ago, I removed a large tulip limb without an undercut. The chain had barely touched the top of the limb, when it exploded. The same limb could have been undercut at least halfway through before failure. Most arborists are familiar with the fact that wood under compression can be cut without causing a limb to fail. A large limb will invariably pinch the saw in an undercut before the limb fails. This clearly demonstrates the superior holding ability of tensioned fibers.

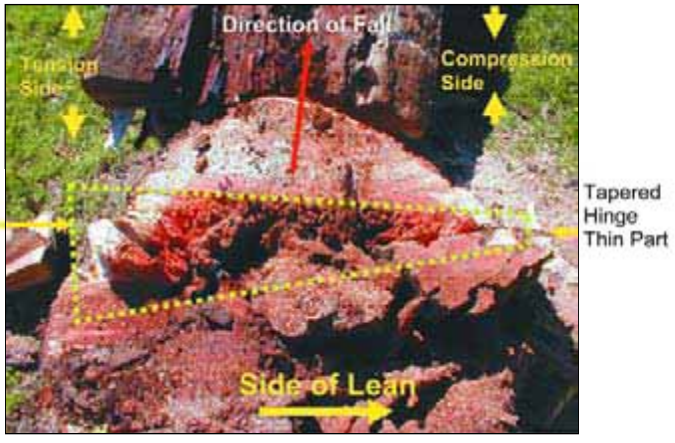
The great difference in strength and holding ability between wood under tension and wood under compression is the mechanical principle that makes the tapered hinge technique far superior to the



Here Dent's illustrations show the tapered hinge used to compensate for a side lean to the left. The tension wood, on the right side of the hinge, has the greatest ability to hold against the lean. Reprinted, with permission, from Professional Timber Falling *by Douglas Dent.*



This notch in this cherry tree is clearly cut well, as it wide and clean with no bypass. The rot in the center of the tree will weaken the hinge, but there is enough good wood on the tension (right) side to hold against the lean, especially with a retainer line well set. There is also good wood on the left (compression) side, but that is less important as it will do little to hold against the side lean. The glove is for perspective.



This bird's-eye view shot shows a reverse view of the tapered hinge with the widest part of the hinge to the left (tension) able to hold against the tree's lean to the right. The combination of a good tapered hinge and a good retainer line allowed the faller the confidence necessary to fall this tree without climbing, saving many man hours on the job.

adjusted gun technique. While the notch determines the direction of fall, the beefy side of the tapered hinge works to prevent the weight of a side leaning tree from changing that direction. In trees with a heavy side lean, it may be necessary to combine the tapered hinge with a slightly adjusted gun. This is far more accurate and reliable than the adjusted gun technique.

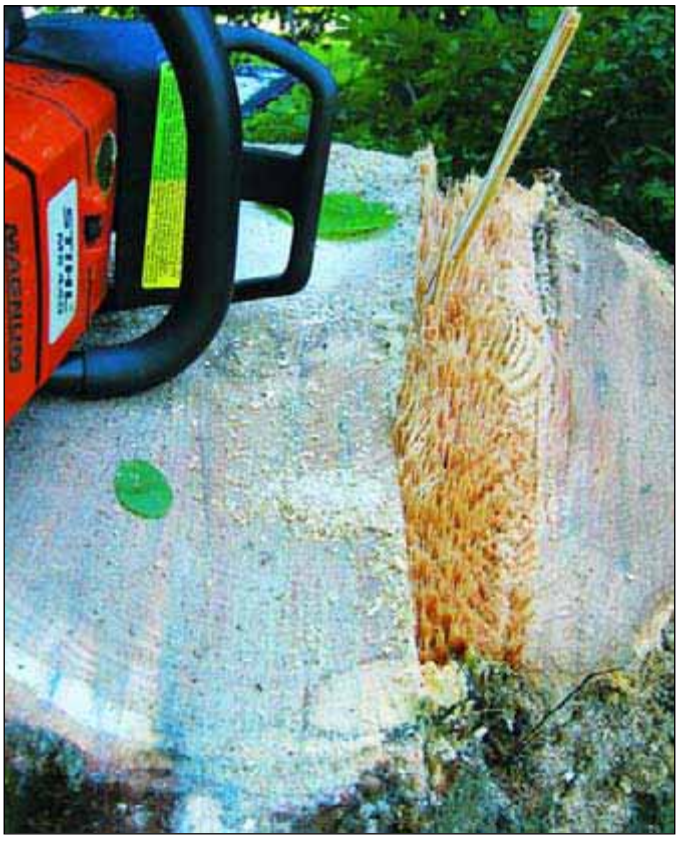
This principle, when properly understood, can guide the arborist in a variety of situations.

When inspecting a side leaning tree or its notch prior to falling, any defect or decay on the compression side is far less reason for concern than decay in the tension side, where even a small imperfection can seriously undermine the strength of the holding wood. The arborist may have to take additional precautionary actions when the tension side of a hinge is compromised, which could include setting a retainer line or removing weight from the side of lean.

These photos show the hinge wood on a fairly large Mulberry. The compression side is to the left. This tree was a heavy front leaner with a good bit of side lean. The thin strip of holding wood on the compression side was left to keep the tree from twisting. The triangular shaped fibers on the right side of the hinge had the best holding ability against the trees lean to the left. This was a non-critical situation where very little property was at risk, allowing the faller to experiment with a fairly exotic form of the tapered hinge, which happened to work well.

Even in trees that have little or no lean, the faller may choose to protect a house, fence or other property by using a slightly tapered hinge, which leaves more holding wood on the side of the hinge away from the property. This technique affords extra confidence in falling, especially when working with a tight landing zone or brittle wood that has relatively little holding strength.

When falling a tree that is slightly wider in diameter than the length of the saw's bar, the faller will often side cut, or "nip a corner" of the hinge to ensure that the hinge is shorter than the bar. In critical situations it is of course better to carefully cut the hinge from both sides of the tree, but when the choice is made to nip a corner of the hinge, an understanding of the differences between the effects of tension and compression is helpful. Always nip the corner

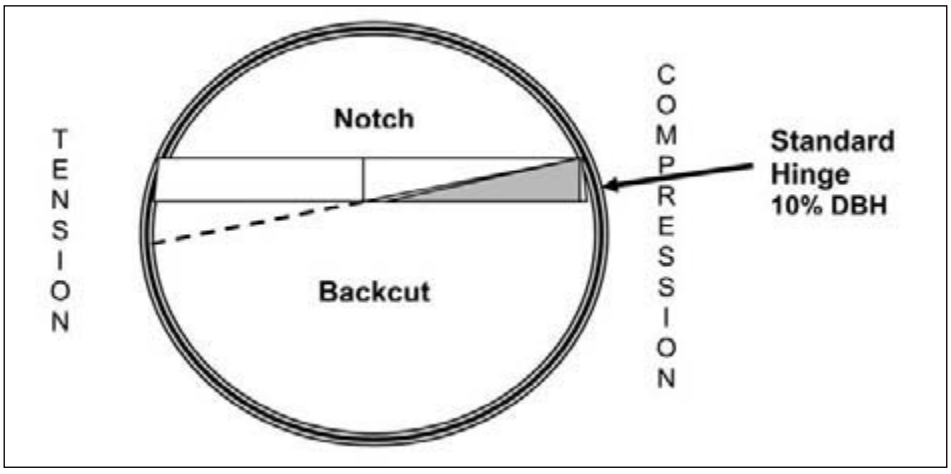


The hinge on this 24-inch diameter, front-leaning red oak has a slight taper on the near side. The tree had no side lean. The slight taper was used as an added measure of protection to ensure clearing a house on the near side.

on the compression wood side, or when a straight tree is felled near to a house or other obstacle, nip the corner closest to threatened property. This added measure of protection gives the faller greater confidence.

The tapered hinge can also be very helpful when "turned on its side"[2] and used in rigging and removing limbs. When free-falling limbs, an arborist often needs to swing a limb horizontally to one side or the other to avoid an obstacle. He will find an open faced notch with a tapered hinge to be much stronger than a standard hinge, allowing the limb to swing farther to the side before failure.

This is especially apparent on light and medium sized limbs. On light limbs, the bottom half of the hinge can be removed entirely, leaving a small pie-shaped hinge on the tension side (which is the top) of the limb. The limb can then be pushed around



The width of a standard hinge is approximately 10 percent of the tree's diameter at breast height (DBH). The tapered hinge removes about half of the hinge fibers on the compression side, shown in the shaded area, and leaves approximately that many additional fibers on the tension side, as outlined by the dotted line.

by hand. It is important, however, on heavy limbs, to leave some holding wood across the full length of the hinge. Otherwise, the weight can cause the limb to twist as it falls. The tapered hinge's holding ability in swinging light and medium limbs is sure to convince even the most skeptical arborist of its superiority.

This technique can also be used when rigging limbs into a lowering line. Swinging limbs to the side, rather than straight dropping, reduces shock loading by allowing the lowering line to slowly take the weight of the limb as it begins to fall. With good technique, the lowering line takes almost all the weight of the limb before tear-off, making for a very smooth action. The tapered hinge is also a crucial component in some advanced rigging techniques that are beyond the scope of this article.

It is also important to understand the difference between tension and compression while pruning trees. The wounds left by pruning cuts can cause significant decay, especially in larger cuts. Many arborists, when reducing limbs and leads, will hide their cuts by making them on the top side of the limbs. There is a trade-off here between aesthetics and structure. Though wounds left on the top of limbs are not visible from the ground, the resulting decay will be in the tension side of the limb, which will weaken the limb far more than if the decay were in the compression side. This is an important factor to keep in mind when working to prevent future storm damage.

Any hinge is only as good as the notch and back cut that define it. For example, a low back cut[3] or bypass cut on the notch can cause any hinge, tapered or not, to seize or fail. It is therefore extremely important that the faller understand and master basic falling techniques. The majority of falling problems are caused by an improper notch. It is therefore recommended that every tree faller learn the proper technique for cutting an open faced notch. The open faced notch is the preferred notch in the vast majority of falling situations, because amongst other benefits, it greatly reduces cutting errors, such as bypass cuts.

The tapered hinge is an extremely valuable technique that is simple to learn and adds to the arborist's bag of tricks. It can be used very effectively in both rigging and falling. However, a word of caution is in order. When learning the tapered hinge, the arborist is encouraged to experiment in non-critical situations. Start practicing by freefalling low limbs when no ground obstacles are at risk, and falling small trees to the side of their leans when hinge failure does not endanger property. Learn the capabilities and limits of the tapered hinge in different types of wood before use in critical situations.

The tapered hinge can be used in many, if not most, falling situations, making it very practical for arborists of all skill levels. The great value of this technique can only be understood after its application on the job. Those who learn and adopt this technique can look forward to a breakthrough in productivity, performance and confidence, and the joy that developing improved skills provides. Work safely.

1 From Web site www.forestapps.com/tips/sidelean/sidelean.htm

2 The author wishes to thank arborist Ken Casey for bringing the many merits of the tapered hinge to his attention.

3 The low back cut is not recommended for precision felling, however it is necessary when pushing or pulling trees from below their center of gravity.

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An abbreviated tapered hinge on this 8-inch dry maple lead was used to compensate for side lean. Holding wood on part of the compression side of the hinge has been completely removed. CAUTION: The abbreviated tapered hinge should be used only on small wood and light limbs as heavy side leans will cause the hinge to twist and fail.