

Reminisce Of An Old Surveyor
Measuring a Distance by Taping
by
Knud E. Hermansen
P.L.S., P.E., Ph.D., Esq.

I don't like to think of myself as old but I am. I have been surveying for close to 50 years. The difference between how I used to survey and how surveying is done now is different. This difference was brought to the forefront of my thinking one day when I was surveying with a young surveyor. As we compared the distance we measured between two corner monuments to the distance set forth in the original survey performed in 1968, the young surveyor was appalled that the original surveyor was off six tenths of a foot between the two monuments. Until this young surveyor spoke I was thinking that the 1968 surveyor had done some exceedingly good measuring given the fact that the distance between the monuments was almost 2,000 feet across uneven landscape filled with puckerbrush. My young associate had never used a tape to measure a long distance. Had he done so, I think that he too would have marveled at the accuracy of the 1968 surveyor.

I would be surprised to hear that any surveying firm operating at this time still tapes long distances. If there is some firm that still practices this ancient art, surely they cannot compete on a fee basis with another firm.

So my young colleagues in the profession will better understand how the boundary they are now retracing was measured, I will reminisce about the lost art of taping a long distance.

Taping required at least two people in the survey crew. Three were ideal, with a person on each end of the tape and one person on the instrument to keep the two people on a straight line between the end points.

My employers at the time were somewhat tight-fisted with expenses so most of my taping was done with one other person.

With the direction to be measured selected, a distant object was chosen to use as a point of reference to guide us while taping. I suppose when taping across open land, a pole was included as part of the survey equipment. The pole was placed in the ground on line with the direction to be taped and used to guide the taping crew. Where I surveyed there was always some natural object that could be used or an appendage of a tree or bush where ribbon could be hung to serve as a guiding point.

Unless we were in farmland or urban land there followed some physical labor as brush and other vegetation was cut and removed from the direction to be taped. Of course if the distance to be taped was part of a traverse, the direction of the traverse was often selected so as to avoid the denser portions of vegetation thereby saving a great deal of physical labor involved with cutting a traverse line. If memory serves me, I seem to remember more time spent cutting a clear a line in preparation to taping the distance than actually measuring the line.

My employer favored a 200 foot steel tape. Most surveyors employed the standard 100 foot steel tape. I heard of a few surveyors that employed a 300 foot steel tape. The longer tape

meant fewer markings on the ground that I shall explain later. However, the longer tape made a wicked sag unless extra tension could be exerted on the ends of the tape to reduce the sag. Of course the extra tension made plumbing the tape more difficult. Still, I came to appreciate the longer tape and used it when I first practiced on my own after becoming licensed.

Now I will say here and now that I was well familiar with tape corrections such as sag, tension, and temperature. We never made those corrections nor do I remember a surveyor that I met at this time that did so though they were common subjects in academic learning. I do not believe these calculations were omitted from ignorance. It must be remembered that calculations during these times were done without benefit of an electronic calculator. As a result, any calculations involving multiplication and division were a tedious undertaking.

Also, the errors associated with the failure to make tape corrections were often as not dwarfed by other factors present in the boundary survey. Would a temperature or sag correction to the steel tape make much of a difference when the corner monument was a 22 inch diameter tree or a three foot diameter stone pile?

My employer did deem it important that the taping be done on a straight line and as near to horizontal as possible unless the end of the tape could be placed at the instrument allowing a vertical angle to be read and used to reduce the slope distance to a horizontal distance. I do not remember ever employing a hand level to check to insure the tape was horizontal, the level of the tape being accomplished by a fair estimate with the eye.

Leveling the tape required a plumb bob be suspended from at least one end of the tape and usually at both ends of the tape. Even on relatively level ground it was necessary to suspend the tape above the ground and employ plumb bobs or else the tape would weave up and down over brush we had cut, fallen trees, stones, and high grass that was normally present on the line of taping.

I don't believe a plumb bob can be found among the equipment of the modern surveyor. Perhaps it may be found buried in the equipment box on the survey truck yet. The plumb bob does not hang from the belt of the surveyor like it did decades ago. To come to the field without a plumb bob was a serious omission – akin to forgetting the tripod. Not only was the plumb bob necessary for taping but it was a necessary piece of equipment to hang under the tripod in order to place the instrument over the point, the optical plummet not being present on transits and compasses that were used to measure directions at that time.

Beginning at the instrument, the tape was laid out in the direction to be measured. Perhaps laid out is the wrong word - for the procedure was to grab the 'zero' end of the tape and drag it in the direction to be measured until the rear tape person would yell "stop" or some other recognizable command. Now in doing this simple task it was important that someone watch the tape or at least be sensitive to the resistance to the drag offered by the tape to prevent the tape from looping upon itself where continued tension would cause the loop to collapse and the steel tape to break. Careful observation was especially important when turning the tape back upon itself. Breaking a tape would cause the ire of even the most placid employer because there was no reason for this event to occur but for negligence. I am sure some survey crew

members did try their best to think of some other plausible excuse that would explain a broken tape and not attach blame to themselves.

Having dragged the tape to its farthest extent without causing the tape to break, the forward tape person would be directed to the right or left by the rear tape person so as to cause the forward tape person to be on a straight line between the two points where the distance was required. This is where the pole or point of reference spoken of earlier assists the taping crew.

More times than not it seemed this simple task would reveal that the forward tape person had passed on the wrong side of a tree or bush requiring the forward tape person to drag the tape back to the offending tree or bush and pass on the correct side of this transgressing vegetation. Surely if the tape did not kink or break in laying the tape out, the risk of a break by kinking the tape increased with this realignment because the forward tape person was looping the tape back upon itself and was now agitated with the extra effort necessary to make the measurement. In their frustration they would tend to pull on the tape harder than good practice should allow.

In some instances, it would be determined that rather than drag the tape back and go on the other side of the offending vegetation, the vegetation could be cut and removed. This idea was good in theory but often fraught in practice. More than once I have seen a good swing of the machete or brush hook designed to cut the offending brush not only cut the brush but go on to cut the tape as well, the tape being next to the offending brush because of the circumstances I have mentioned.

It was always a discussion among survey crew members whether the employer will think the intelligence of an employee to be less if they broke the tape with an overlooked kink or the result of a powerful stroke of a machete. Thankfully that is one conversation and confession that will no longer occur with modern survey practice.

Once satisfied the tape is aligned properly in the direction of the survey, the tape would be raised off the ground in a manner to effectuate a level line. In raising the tape, the taping party often discovers that the recent maneuvering with the tape has allowed the tape to seep under some brush that had been previously cut in clearing the line and allowed to remain in the vicinity. The discovery of the offending vegetation occurred when an effort is made to raise the tape and one or more pieces of brush would also rise with the tape. At this discovery some vigorous attempt is made at shaking the tape to throw off the offending brush. This effort seldom worked other than to jerk the end of the tape out of a person's hand.

With the failure of shaking the brush off, it became necessary for someone to once again walk along the length of the tape and remove offending pieces of brush that had found their way to laying on the tape rather than under the tape.

If a person is following this story and is counting the trips along a particular segment of line, they will realize that the distance of the tape has probably been walked three or four times. First, a person must walk the line to cut a clear sight along the line. Second, a person will walk the line to drag the tape to set up the measurement. The third walk occurs when retracing the steps in order to come back around the correct side of a tree. Finally, the fourth walk of the line

is to throw off brush and vegetation that has climbed on the tape. I know that vegetation can't move or climb on its own but if you had been there you would swear it does just that.

Finally, the tape could now be raised off the ground to effectuate as near as possible a horizontal line that could never be a straight and level line since the weight of the steel tape always caused a sag. To remove some of the offending sag, tension had to be applied to the ends of the tape. I suppose there were surveyors that employed tension handles in the field that allowed the tension, measured in pounds, to be carefully applied to the tape's length but I have never met the field crew that used them in the field doing a boundary retracement survey. Perhaps a diligent survey firm would have had at least one tension handle in their office in order to show a new employee what 15 to 20 pounds of tension felt like.

For those surveyors that have never seen a tension handle, a close similarity can be visualized by thinking of certain weight scales with a handle at one end and a hook at the other end that are sold to fisherman to weigh the trophy fish they plan to catch. I suspect that some of the survey tension handles that were purchased by surveyors were used more often for weighing fish rather than applying tension on a tape.

With the tape raised off the ground, great skill must now be employed to do several tasks at once. The tape person had to keep the tape level, at a consistent tension, and steady enough to fix a point on the ground using a suspended plumb bob.

The rendition of these tasks in print does not begin to describe the difficulty of combining these tasks in practice. First, the plumb bob string must remain fixed and immovable on a mark found on the tape. This requires one hand be employed to clamp the plumb bob string securely to a mark etched on the steel tape. The other hand is employed pulling on the end of the tape to keep a constant and desired tension. It must be remembered that the steel tape is a smooth ribbon but for some minor roughness caused by marks on the tape surface indicating feet, tenths and hundredths of a foot. The last two mentioned etchings only present at the ends of the tape. The combination of the tension, tape smoothness, and liberal sweat on the hands resulting from the physical labor involve in surveying at the time and the reader can deduce the challenge required in making a measurement while exerting tension on the tape. Usually a leather thong at the end of the tape was used rather than holding the tape itself. A consistent tension was employed by tucking the hand next to the body and leaning the body in the direction away from the other person in order to render the desired tension.

Where a leather thong was not present or 'breaking the tape' required, often as not the tape person would grab hold of the tape and bend the tape down at their hand to afford a better grip – much as a person would do when pulling a rope to get a better grip. This grip often left a 'jog' in the tape at the completion of the measurement. After years of usage, a tape would no longer lay flat but would have rises and dips along its length that would be coupled with a few points of extra thickness where the tape had been repaired.

Let me pause in my rendition of taping to state that when I speak of 'breaking the tape' in this instance, I am not speaking of physically breaking the tape. Rather the phrase was used to indicate the entire length of the tape was not to be employed in making the measurement required.

Long ago, some entrepreneur invented a tape clamp. The tape clamp was a handy little gadget that allowed the user to firmly secure the tape with the clamp using the two finger rings that were part of the clamp. Using the finger rings, the tape could be easily pulled without bending of the tape or permitting a slippage along the tape.

I doubt much money was made from the invention. The survey firms that had purchased this gadget were likely as not to leave it unused in the office. When brought to the field, it never seemed to be with the tape person that needed it.

Having mastered the combination of holding the tape level, keeping pressure on the tape, and keeping the plumb bob string firmly attached to a mark along the tape, the tape person could now focus their attention to the suspended plumb bob that was likely as not swinging over the ground much as a lookout does in a crow's nest over a ship in rough seas. Restraining the plumb bob from wild gyrations required the tape person to periodically tap the plumb bob into the ground until the swinging of the plumb bob settled down.

The person at the rear of the tape had a mark that the plumb bob had to be over. When he was satisfied that he had wrestled the plumb bob and by extension the appropriate part of the steel tape over this point he would repeatedly shout some agreed upon term to the forward tape person to let that person know that a measurement could now be reliably made by the forward tape person.

I have seen the patience of the rear tape person sorely tested by the inability of the lead tape person to make a timely mark or reading. The rear tape person will make repeated statements of "good" or "mark" to indicate that he is over the point and the measurement can be made. After some repetition, the rear tape person will become agitated by his own endless repetition and may be heard to stop the repetition in order to yell: "god damn it, I'm good at this end. What is taking so damn long."

If the forward tape person was not measuring to a previously established point, they would tap the plumb bob point onto the ground to make a mark in the dirt, having previously kicked away grass, leaves, and twigs to clear a space on the ground. Once the forward tape person was satisfied the mark made by the plumb bob point represented a fair measurement, they would release the tension in the tape and put a pin into the ground at the mark. This pin would become the basis for the rear tape person to advance upon and measure over.

As I previously mentioned my employer was a kindly man but did not feel justified in purchasing equipment that was not absolutely necessary. Rather than using chaining pins, as they were commonly known, to fix the limit of the tape measurement, we would use nails or sticks with flagging tied to the end of the stick.

Having marked the length of the tape on the ground, the forward person would drag the tape in the direction of the survey to begin again the process of making the next measurement. The rear tape person would follow with the other end of the tape. Now if the rear tape person was not paying attention, they would likely as not kick the pin or nail out of the ground before they spotted it. If the rear tape person did a good job of kicking the pin loose from the ground, the taping would have to begin anew back at the starting point with numerous expletives used against the rear tape person for not paying attention to where they placed their feet. To avoid

repeating the process of taping or bringing upon themselves embarrassment and attracting the ire of the other crew members, more than one rear tape person made a best guess where the pin may have resided before they inadvertently kicked it out. If possible the misfeasance was corrected without the forward tape person realizing what was being done.

I should mention that had the forward tape person measured into a mark or corner already fixed, his job was a little more difficult. Rather than stick a pin, nail, or stick in the ground, he had to find a way to maintain the tension, keep the tape horizontal, maintain a steady plumb bob over the point, and read the marks on the tape at the plumb bob string.

This was done by firmly clasping the plumb bob string over and on the tape using the index finger and thumb and sliding the string along the tape until the plumb bob was over the desired point. The tension was then released while still keeping a firm grasp of the string on the tape. Once all the other distractions were eliminated, the forward tape person could peak under his thumb and see what incremental hundredths of a foot mark the string was held upon.

At this point it is worth mentioning a problem that has plagued surveyors using a tape or chain for a couple of centuries – keeping track of the whole lengths that are used when measuring between two points. When a survey crew measures long distances, it is necessary to tally the number of full tape lengths used. Now it would be wise for a crew member to make a mark in a field book each time a tape length is achieved. What is wise and what was done are two different things. If field books were not available putting notches on a stick or moving stones or acorns from one pocket to another was employed. Despite the best efforts, there are numerous distances where a tally was lost or added that should not have been.

I have alluded to a plumb bob suspended from the tape to the ground. The term ‘suspended’ is only accurate after some effort is obtained to stop the plumb bob from swinging in arcs over the ground. It is not possible to get a plumb bob to hang from the tape to the ground without some swinging. The plumb bob was determined to be contrary when let loose to hang. There were times when the plumb bob was stationary but not vertical as in the case when the plumb bob had to be dropped from chest height and there was a strong wind blowing across the open field. It seems to me that the wind was usually combined with cold temperatures. To all the other problems I have alluded to in trying to keep the plumb bob steady over a mark must be added the lost sensitivity of the fingers when using gloves and the shaking of the body from the cold temperature.

Eventually, the plumb bob was finally settled into compliance by tapping the plumb bob upon the ground until finally the tip of the plumb bob was confined to a small area meeting the tolerance of the tape person. Of course before the tapping could take place, the forward tape person usually had to expose the ground by kicking away sod, sticks, leaves, and other debris using the toe of his boot. This often accounted for the delay that caused the agitation of the rear tape person that I have previously mentioned.

I must not close this reminisce on taping before adding a few more tidbits that provide some added insight into taping practice.

Many tapes were not marked or inscribed like a more recent steel tape or the fiberglass tape still found in the surveyor's tool kit. What I mean is the tape did not contain marks to the

hundredth of a foot along the entire length of the tape. The old tapes were only marked every foot except for the very end of the tape where the tenths and hundredth of a foot marks could be found. This necessitated the rear tape person find a whole foot mark to hold to and the forward tape person use the end of the tape to measure the increments of a foot. To set this up involved the forward tape person yelling back to the rear tape person to 'take a foot' or 'give a foot.'

While on the subject of marks on the tape, I must state that dragging a tape along the ground for days, weeks, and years often succeeded in smoothing the tape and erasing the stampings of the whole feet and making the marking of whole feet difficult to read. More than once I had to look up or down the tape to find a readable mark and work my way back to the mark I was to hold at in order to know what whole foot I was holding at.

I have about exhausted my memory of taping but for three situations often encountered in taping. One situation is the delicate taping required when taping through an electrified cow fence with a steel tape. I need say no more on that topic as the reader can well imagine what often happened. I must add that in addition to the electrified wire, once the survey crew has cleared the electric fence and entered the field, the reason for the electrified wire becomes obvious. Curious cows tend to congregate about the surveyor and become a hindrance in the taping process. However, I suppose a curious cow or heifer is far better than the bulls I encountered from time to time that took offense at the red often worn by the surveyor.

The second situation not fondly remembered is taping upon a concrete or asphalt surface. Since such surfaces were often flat and without obstructions, the tape was laid flat on the surface. Tension was put on the tape ends during the measurement with knuckles touching the asphalt or concrete. In such cases one tape person usually released their tension unexpectedly with the result that the other tape person often left some skin from their fingers on the rough surface of concrete or asphalt.

The third situation that still can incite bad dreams occurred when taping across a busy road or sidewalk. You did not have to experience this situation in order to imagine the peril of a tape suspended above the road surface when a car is observed much too late traveling down the road. Dropping the tape quickly to the road surface would often preserve the tape. Yet, there is many a time the survey crew returning to the office with a broken tape that claimed this very event to be the cause of the broken tape. Of course, there was nothing they could have done to prevent this happening. At least that is what they claimed.

I will close this reminiscence by speaking about securing the equipment used in taping. The tape was coiled with attention paid to making consistent sized loops. The tape was then thrown. I don't mean heaved to the side. I mean that the tape was made into a figure 8 then into a compact circled loop using a twisting of the hands. Throwing a tape was an art that was often done at a surveyor's convention to show prowess. If a person did not know how to throw a tape it turned into a wrestling match where the tape refused to cooperate and often as not ended in a jumble rivaling any fishing line tangle. If the person did know how to throw the tape, a person watching would have the unmistakable impression that a magic trick just occurred. One minute the tape is in a large loop and the next it is neatly coiled in a compact loop.

The other item of equipment deserving some effort at storage was the plumb bob. To see a plumb bob being stored with the string hanging loosely from the end of the plumb bob would reflect poorly on the owner. At some point, another inventor came up with a gammon reel that wound the string up unless the owner resisted the urge of the gammon reel. Before the gammon reel arrived at the scene, a plumb bob string would be carefully wrapped around the head of the plumb bob and a slip put into the string to hold the string in place. A carefully tug on the string would unwrap the string from the plumb bob. A knot in the plumb bob string spoke of an untrained crew person. A knot in a plumb bob string was akin to a hang nail on the finger – it's presence always felt and always hanging up at inopportune times.

Keep this rendition of the taping process in mind young surveyor before disparaging that old surveyor that taped those long distance one small segment at a time.