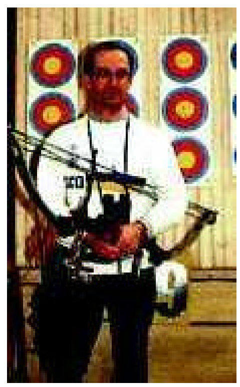
SoCalArchery

Bow Strings
What to Make and How to Make It.
By Pedro Serralheiro

This Article has been reproduced with the permission of
Archery Focus Magazine
http://www.archeryfocus.com


Pedro Serralheiro

Part 1of 3

Pedro Serralheiro is a medical doctor who lives with his wife and daughter in Portugal. Pedro has won numerous recurve and compound championships. His most impressive statistic is that of the 153 individual events he has entered, Pedro has won 124 of them! He is currently ranked No. 1 in Portugal.

To shoot a bow you need a string, preferably one made of the new synthetic fibers. But which type of material will make the best string for my application? How many strands should I use? What length should I make my string? All of these questions and more will be answered in this three-part series. We will deal with the following aspects of bowstring making:

Bow String Fibers, Understanding Them.

Almost all bowstrings in modern bows begin life as an industrial fiber. While the brand names of many of these fibers are well known to archers, their properties are less well understood. And the point is the properties of these

fibers are of crucial importance when choosing strings for your bow, be it recurve or compound. Today we have a huge variety of options, allowing the customers to select the blend of performance, durability and cost that best suits their needs.

Polyester (Low Cost)

Polyester is today's the "classic" string fiber. It is called by the Dupont trade name Dacron, although there are other suppliers of polyester fibers. Polyester is widely used for its combination of reasonably low stretch, good strength, low cost and durability. It's the only fiber allowed on all wooden bows (except some models) because it doesn't put great stress on limb hooks and wooden handles. It is difficult to control because it changes constantly in length, especially on hot and humid days. Today some allied polyester fibers are on the market offering the performance of regular polyester with greater strength and less stretch. (see Table 1)

Aramid (Medium Cost)

A popular class of high performance fiber are the aramids, the most well known being Kevlar (a Dupont trademark) and Twaron (made by German manufacturer Akzo). More susceptible to UV damage and breakdown due to folding and flogging, but much stronger than polyester, aramids present no creep or stretch. Due to unexpected failures and a short life cycle, aramid fibers have been replaced by newer and more reliable fibers. Flex loss 28 %.

Table 1

Product	Maker	Strength	Fiber Type	Flex Loss	Stretch	Creep	Ft/lb*
B50	Brownell	50 lbs	polyester	0 %	++++	++++	4300
B500	BCY	50 lbs	polyester	0 %	++++	++++	4200
B75	Brownell	55 lbs	allied polyester	0 %	+++	+++	4200
PENN 66	BCY	57 lbs	allied polyester	0 %	+++	+++	4300

* Waxed

Table 1

LCP (Medium Cost)

Vectran is a high performance, thermoplastic, multifilament yarn spun from Liquid Crystal Polymer (LCP). Vectran is the only commercially available melt spun LCP fiber. It exhibits exceptional strength and rigidity, five times stronger than steel and ten times stronger than aluminum. A natural aramid replacement, also comes with unexpected failures which limit its use to compound cables. LCP has no stretch, no creep, outstanding cut resistance, minimal moisture absorption and high abrasion resistance. Flex loss 20 %.

HPPE (Medium-To-High Cost)

High Performance Polyethylene (HPPE) has a unique combination of properties. Its density is slightly less than one, so the fiber floats on water. But its tenacity can be up to 20 times that of a good quality steel. Spectra and its European counterpart Dyneema, the most well known products, offer very low stretch, high strength, good UV resistance, and much less strength loss in

flex than Kevlar or Vectran. Although used on almost top brand bows, as cables and strings, creep is always a concern with this class of fiber, even in the new ones like HPPE 2000, which offers 20% less creep than normal HPPE. (see Table 2)

Table 2

Product	Maker	Strength	Fiber Type	Flex Loss	Stretch	Creep	Ft/lb*
Fast Flight	Brownell	92 lbs	Spectra	5 %	+	++	8700
Dyna Flight	BCY	120 lbs	Dyneema	5 %	+	++	8900
Fast Flight 2000	Brownell	115 lbs	Spectra 2000	5 %	+	+	6750
Dyna Flight 97	BCY	120 lbs	Dyneema SK 75	5 %	+	+	8900
ASB	Angel	110 lbs	Dyneema	4 %	+	+	–
D &%	Brownell	130 lbs	Dyneema SK 75	5 %	–	+	7511

* Waxed

Table 2

Composite Blends (High Cost)

To address the unexpected failures found on no creeping fibers (aramids and LCP), some manufactures have blended with great success Vectran and HPPE. The best known are S4 by Brownell and 450 Plus by BCY. These composite blends offer the archer the durability of HPPE with a much needed characteristic for modern bows, no creep. Their strands are a little larger in diameter than HPPE, so you will need fewer strands. With these fibers bowstring strength is never a problem. (see Table 3)

Table 3

Product	Maker	Strength	Fiber Type	Flex Loss	Stretch	Creep	Ft/lb*
450 Plus	BCY	155 lbs	Vectran + Dyneema	8 %	–	–	4700
S4	Brownell	160 lbs	Vectran + Spectra	7%	–	–	4020

* Waxed

Table 3

Creep

Creep is the nightmare of any competitive archer, because it causes different string lengths over time. But don't be too concerned of that because with modern fibers, even if they exhibit some creep, bowstrings will stretch to their final length after you shoot 200 or 300 arrows. Then, when making a new one, just compensate for the measured elongation. To have an idea what to expect see Table 4.

Table 4

Product	Creep
450 Premium	1/8 in.
450 Plus	1/8
S4	1/4
Dynaflight 97	1/4
Fast Flight	5/8

Table 4

Fiber Cycle Life

Only with aramids and Vectran are unexpected failures a problem. So if you decide to use them, replace your bowstring very frequently and, even so, expect some failures. With polyester, HPPE, and composite blend bowstrings, replace them every year, or if you shoot a lot replace them 3 to 4 times a year. Take special care with the cables of compound bows. Any time you doubt your compound cables or string, or your recurve string for that matter, replace them. If you shoot outdoors most of the time, your string and cables lives will be shorter due to sunlight (UV deterioration). (see Table 5)

Table 5

Product	Cycles to Failure
450 Premium	325 000
450 Plus	648 000
S4	220 000
Dynaflight 97	850 000
Fast Flight	755 000

Table 5

Fiber/String Maintenance

With any type of fiber you will need to wax them to get the most from the string in cycle life and performance.
Caring for those fibers is easy, no magic wax is needed. Just use standard bowstring wax as you have done in the past with polyester or HPPE. The only exception is the LCP`s where you will need a specially formulated synthetic wax.

Strand Comparison

For a comparison of numbers of strands per string, see Fig. 6. To conclude Part I, I invite you to examine Table 7 below, concerning strings of 60" length, where some curious data are shown. For instance, and assuming the AMO standards of arrow weight, you will see that different fibers give different weight strings. As the Easton arrow selection tables are made with Fast Flight strings, the lightest fiber, if you use composite blends you might want to go with a lighter arrow.

Table 6

Product	Number of Strands
450 Premium	12
450 Plus	16
S4	10
Dynaflight 97	16
Fast Flight	20
B50, B500, B75, & PENN 66	12

Table 6

Table 7

Product	Strands	Strength	Total Length	Weight	Spool Length	Strings from One Spool
450 Plus	12	1860 lbs	720 in	89.34 gr	1175 ft	19.58
S4	10	1600 lbs	600 in	87.03 gr	1005 ft	20.10
DF 97	16	2400 lbs	960 in	79.93 gr	1750 ft	21.88
FF 2000	16	1840 lbs	960 in	82.86 gr	1688 ft	21.10
FF	20	1840 lbs	1200 in	80.39 gr	2175 ft	21.75
B 50	12	600 lbs	720 in	97.67 gr	1075 ft	17.92
B 75	12	660 lbs	720 in	99.99 gr	1050 ft	17.50
PENN 66	12	684 lbs	720 in	97.67 gr	1075 ft	17.92
D 75	16	2080 lbs	960 in	74.50 gr	1877 ft	23.46

Table 7

Table 1 Serving Materials

Bowstring	Recommended center serving	Recommended end serving	Comments
Composite blends	Composite braided*	Nylon	For tear drops
	HPPE	Nylon Braided	
	Monofilament	HPPE	
HPPE	Composite braided**	Nylon	For tear drops
	Nylon	Nylon braided	
	Monofilament		
Polyester	Nylon	Nylon	
	Monofilament		

*** 0.021” (0.022”) on 14 strands, 0.025” (0.026”) on 12 strands ** 0.021” (0.021”) on 16 strands, 0.025” (0.026”) on 14 strands**

Part 2

Part 2 Preparing the string making tools, including choosing serving material In Part 1 we detailed popular string fibers. With this knowledge you can make wise choices between them depending on your bow type and use. If you are using a modern bow you can go with no fear to the newer ones, like HPPE or Composite Blends. These two fibers will give you better performance and, most important, higher scores. But, like everything, they have some draw backs – they are a little more difficult to work with.

What About Serving Choice?

The servings role is to protect the bow string from premature wear and, on the center serving, to give correct nock fit. Larry Wise has done a splendid job in his Nock Fit article, Archery Focus Vol. 3 No. 6, so I recommend paying careful attention to it to have a correct idea on what nock fit and nock fitting is. There are several serving materials on the market, but basically they come in following types:

Nylon serving

The first serving material available and still excellent for end serving and tying peeps. #4 – diameter 0.021"

Braided serving

Thinner than nylon serving, but weaker. #3 1/2 - diameter 0.019"

Monofilament serving
Several diameters 0.015", 0.018", 0.021", good for center serving and easy to match nock fit.

HPPE serving
Probably the finest end loop serving. Normally strong two-ply construction, excellent abrasion resistance. #2 – diameter 0.022"

Composite braided serving
Outstanding durability, excellent for center serving, ten times the life of monofilament. Expensive, several diameters are available, for example 0.018", 0.022", 0.026".

For more information on serving materials see Table 1.
Don't take this table as definitive, only as a guideline. Your experience will dictate the best combinations. Mine is: HPPE serving for loops; nylon (lighter than HPPE) for end serving; monofilament for center serving (without string loop) or nylon (with string loop) on composite blend strings. On compound cables always HPPE serving.

String Making Tools
Like anything in life you could have a countless number of tools to do the job, but there are always the basic and obligatory ones.

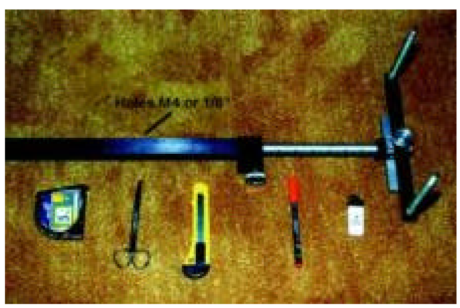


Fig. 1 The string jig. Note some simple tools you will need; measuring tape, scissors, X-acto knife, lighter, and marker.

The String Jig
If you have a Yellowstone string jig, go ahead, because it's the best on the market. There's nothing you could do to improve it. But if you, like me, have another make, with a few changes it will be almost perfect to make professional strings. First, do not rely on the jig scale. Always use a measuring tape to build all of your strings, see Figure 1.

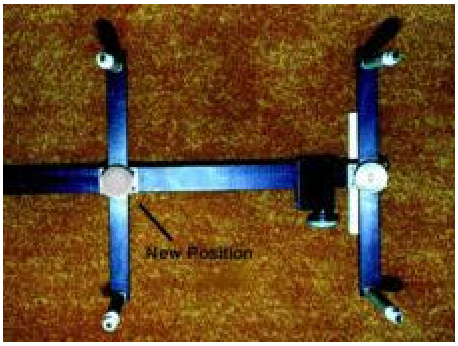


Fig. 2 To make very small strings, lengths between 10 and 20 inches, you must use optional holes with M4 or 1 1/4 8" threads to reposition the U-arm.

Next, the U-arms need to be as close as possible to each other (see Figure 2), if you want to make yoke strings or the small tip string needed if using the "Missing Link" (see Figure 3)

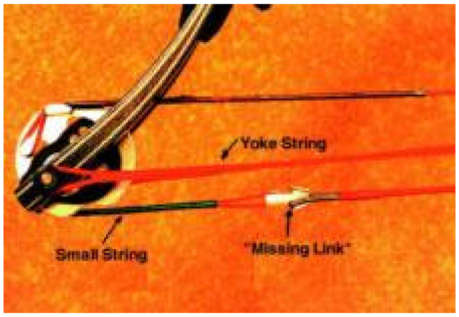


Fig. 3

This is the kind of work you could do by yourself. Note the small string and the "missing link" piece. Take a close look and you will see that with composite blends I don't serve the small string or the cable end loops. What you are seeing here is made from S4 fiber, Fast-Flite and nylon #4 serving.

Something very important. The best thing you could do to modify your string jig is to make moving tips for the U-arms (see Figure 4). It's easily done on a metal lathe by you or by a professional. I strongly believe that it's something that really has to be done. All of the needed pieces are of aluminum (7075). The moving tips will make the end loops a joy to do. Realize that the string's quality can't surpass the string jig's quality !

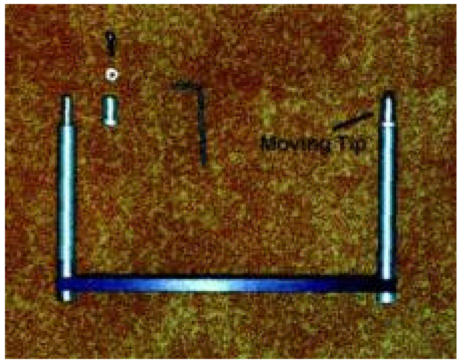


Fig 4

Serving Tools
There are various models on the market. Beiter makes the best one, but it will cost 2 or 3 times what a regular serving tool costs. Personally I use the Bjorn model. It is simple, easy to work with, and dependable. One draw back, though – it's difficult passing the thread through that very small final hole. Take a close look at Figure 6.

Fig. 5 Fibers, servings, serving tools, wax, a small rule, are all needed. Have them on hand.

A Bjorn serving tool with nylon serving. Note the way the thread is passed through the different holes. It's crucial to obtain a constant and correct resistance to make a perfect serving. If, for some reason, you need more tension, just tighten the nut. (see Fig 6)

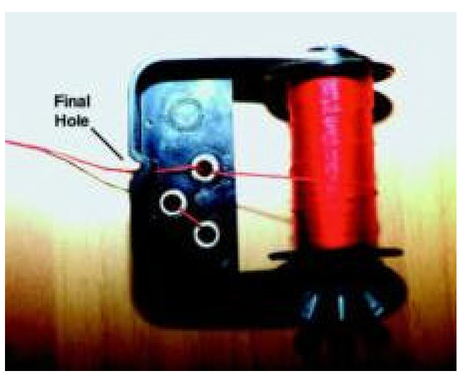


Fig. 6

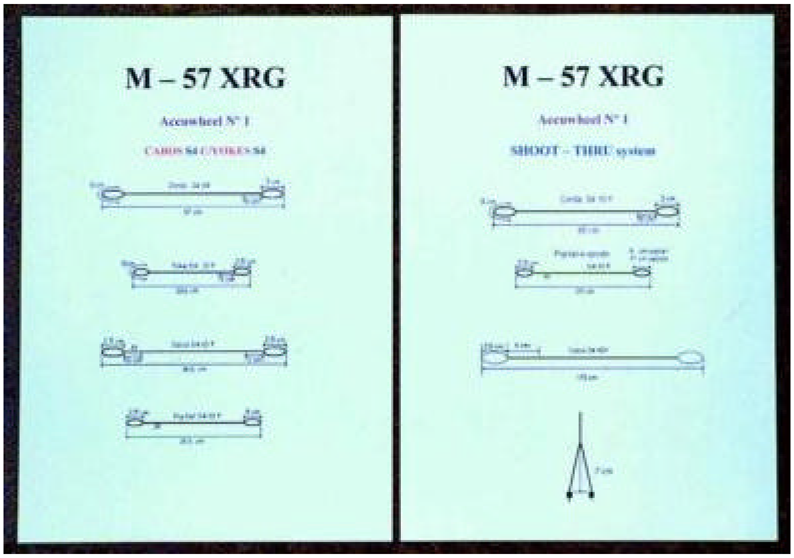
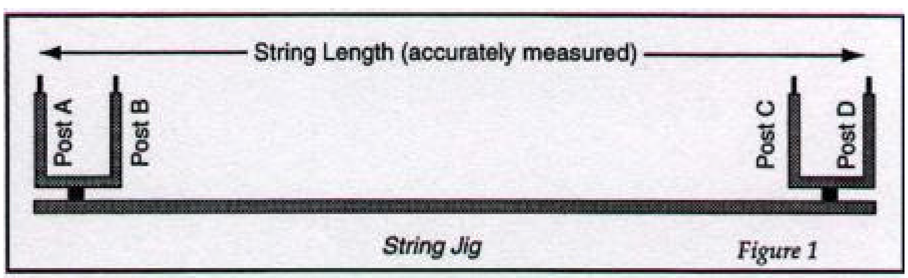


Figure 7 Make drawings of every string configuration you will have, with all marks and measurements written in. It will pay dividends in the long run.

Part 3

If you have read parts I and II, you should have the necessary knowledge to choose all the fibers needed to make your particular strings. If this is your first string, be patient and like everything worthwhile, it takes practice. Make your first two or three strings with Dacron, the least expensive fiber, and only when you feel confident make the final string with the chosen material. Now, everything is ready, let's make a bowstring; its easier than it looks.



String Jig Fig. 1

Part III – Making The String

First, take a good look at Figure 1 (right), because it's the starting point and all the rest is related to it.

If you want your string to be 106.5 cm (1 cm = 0.3937 inch) long, the jig must

measure 106.5 cm, see Photo 1. Remember that accuracy starts here.

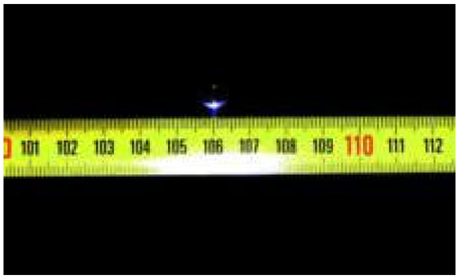


Photo 1

Start the thread by tying it (in this case Fast-Flight) to the bottom of the base of posts C and D, then wind up to the post C, then wind past on post D, see Photo 2.

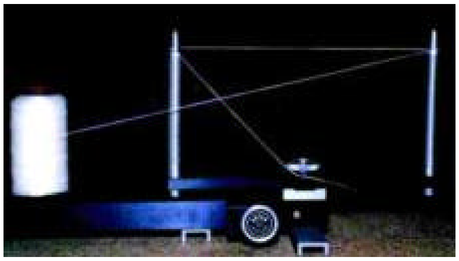


Photo 2

Now wind to the post A and then to the post D, half as many times as the number of strands. If you want a 16 strand string, you'll need eight passes, because each pass makes two strands. When the required number of strands is wound on, finish the thread by winding it again on the base of posts C and D, see Photo 3.

Photo 3

Pay particular attention when winding. To get the same pressure on every strand it is necessary that the strands lay side by side and not one above the other, take a close look at Photo 4.

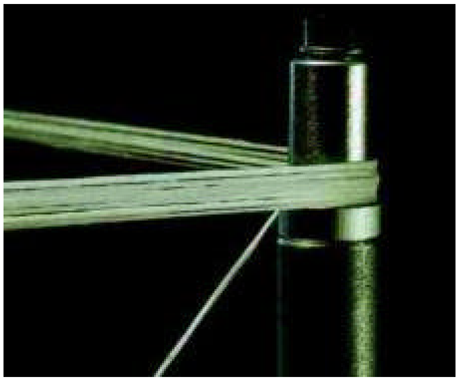
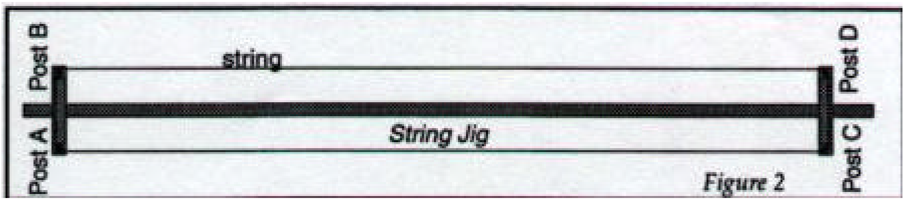


Photo 4



String Jig Fig 2

Next rotate both post bases—swing post B out and post C out (See the usefulness of rotating post tips?) exactly in opposite directions. You will end up with both arms parallel to each other and perpendicular to the base of the jig, as shown in Figure 2.

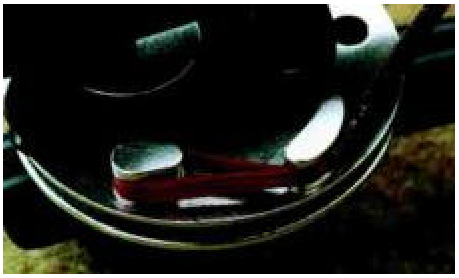


Photo 5

Make sure there is good tension on all strands, if not, loosen up the string jig a little, pull the arms so as to stretch the strands tight and then retighten the jig. Begin serving (in this case with Fast-Flight thread) the first string loop between post C and post D. Normally this serving is 12.5 cm long (5"), but it can be longer or shorter if needed. Sometimes I use no serving on string loops, like the ones that are attached on wheel pegs, see Photo 5.

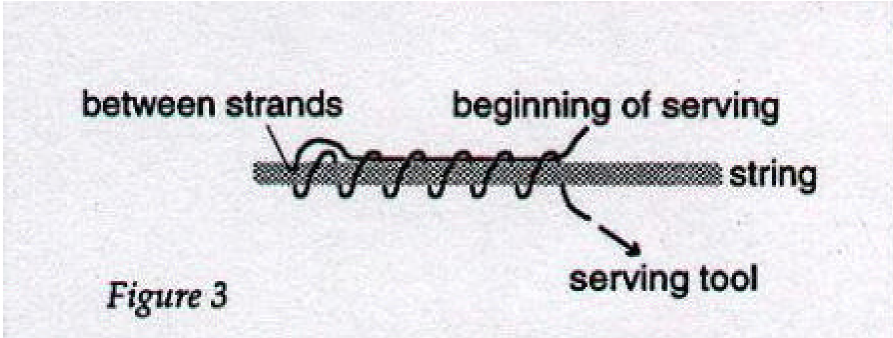


Fig 3

Start the serving as shown in Figure 3 (above)

Adjust the tension on the serving tool so that the serving is wound on even and with correct tension, as in Photo 6. If it is too loose, the serving will separate or slip; if it is too tight, it may break under stress. This takes judgment you can only get through experience, but you may be able to get a more experienced string buil-der to give you some guidance.

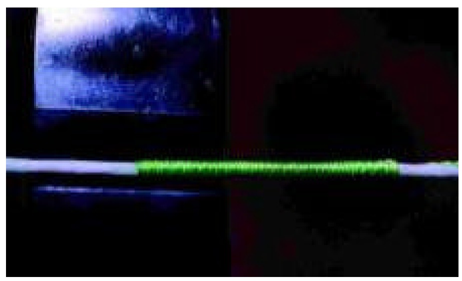
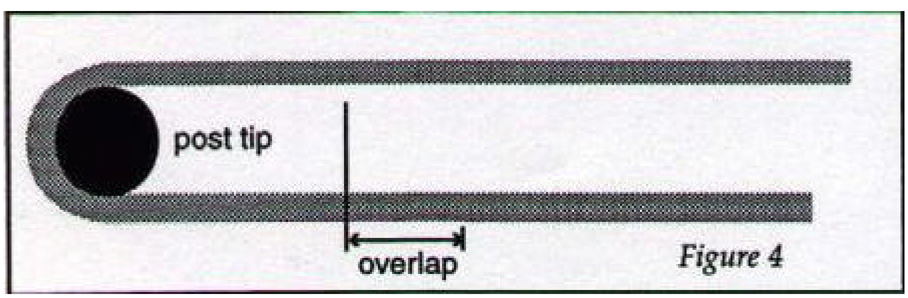
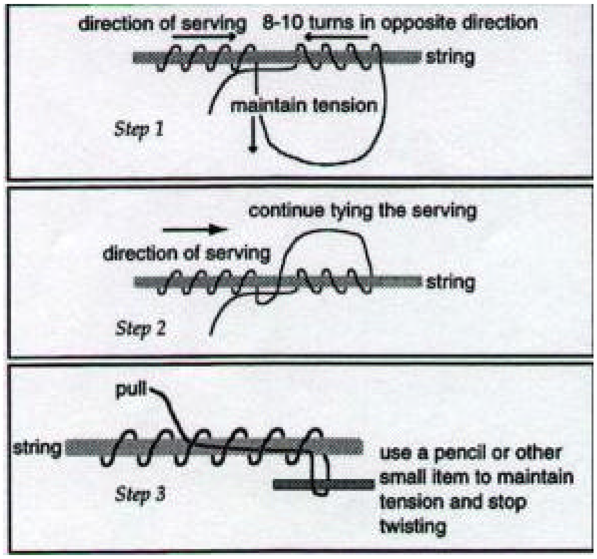


Photo 6

The 12.5 cm (5"), of serving is enough to make the loop and a small amount needed to make an overlap, see Figure 4.



To tie off the serving, follow the steps 1, 2, and 3.



Untie the beginning and the end strands and cut them off close to the ends of the serving. Now return the string jig to the configuration shown in Figure 1, and proceed to make the end serving, see Photo 7.

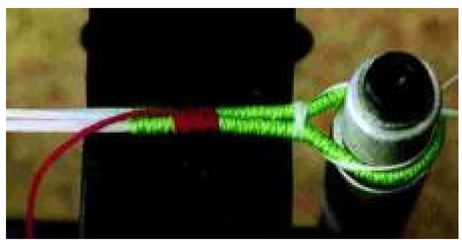


Photo 7

Take a close look at this photo. You'll see that the loop is tied on to the post. This will prevent the two arms from coming apart. Serve the serving (in this particular case with No. 4 nylon) as you have served the string loop. Normally this serving is 12.5 cm (5") long. Eventually you'll end up with something like that shown in

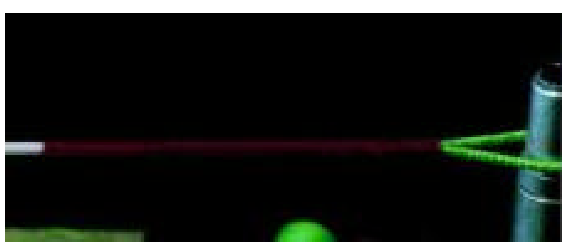


Photo 8

At this point you should have one loop complete. With the string jig like in Figure 1, turn to post A, to make the other loop. Mark the string 6 cm from the post, like Photo 9.

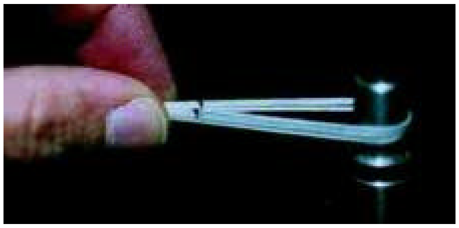


Photo 9

Line up posts C and D like on Figure 1 and put posts A and B like Figure 2. Now we are going to make the other loop, see Photo 10. You have the string marks that show you the correct loop place. Remember to allow for a small overlap on the mark indicated by my index finger in Photo 10. Repeat the procedure that you did to finish making the first loop. You should end with two loops.

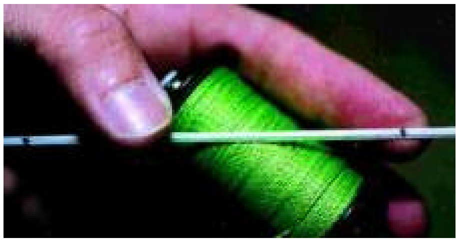
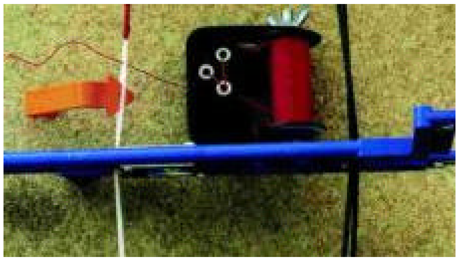


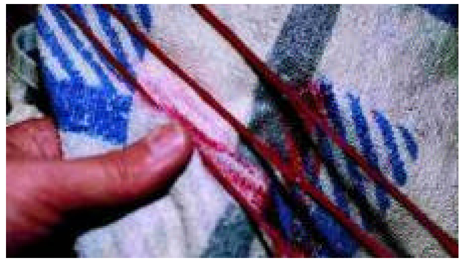
Photo 10

Take your proud new string from the jig. Yes, it's done—by you! Oops, is something missing? Yes, where's the center serving? Relax, the center serving should be done with the string on the bow (my way of doing things). Why? Simply because you can't put as much tension on the string in your jig as you can on the bow. (The limbs put hundreds of pounds of tension on your string.) Without that kind of tension when you make the center serving, the string will rotate so badly that it will be useless. Remember that the center serving must be applied very tightly, to prevent it coming apart.



The center serving is easy to do on recurve bows, but on compound bows you must spread the cables to make space for the serving tool. You will probably need some kind of a string spreader (remember Part II?) to make a big

enough space to pass the serving tool through, see Photo 12.



To spread the cables from the string, I use a Jim Dandy tool. On all my strings, because I use a special nock set, I use No. 4 nylon to make the center serving. But I recommend you use another serving material, especially on those slippery new synthetic fibers (like Dyneema or Fast-Flight or the new S4 serving). With a square ruler mark the nocking point and then measure 10 cm (4") above and 15 cm (6") below that point to show you the center serving position. I prefer this serving length, because it has proved to be the most "spread resistant." Making the center serving is like making the other servings (see Steps 1-3 above), except you must put much more pressure on the serving tool. Without experience I do not recommend melting the serving ends to finish servings, just cut them close to the serving.

Now that you have your string complete, shoot 50 to 100 arrows to let the string "settle down," and then put the necessary twists into the string to bring the brace height to your needs. My experience tells me that with the new low creep fibers this is almost not necessary, but I continue to do it. If you are making a spare string, put it into service just like the original one.

One final remark, some archers, like myself, "burn" the string to take out excess wax and place the strands close together, see Photo 13. The "burn" means to "burnish" the string, that is to rub the string hard with a rag or a piece of suede.

If you use a colored fiber expect to have some color come out on your rag, in this case a red S4 string and cables. After "burning" a string it becomes much softer to the touch and performs better.

Making your own strings and cables is a must in archery, because you can craft that special length, number of strands, and serving combination that best suits you.

Good shooting.

Several Corrections

Table 2

Product	Maker	Strength	Fiber Type	Flex Loss	Stretch	Creep	Ft/lb*
Fast Flight	Brownell	95 lbs	Spectra	5 %	+	++	8700
Dyna Flight	BCY	120 lbs	Dyneema	5 %	+	++	8900
Fast Flight 2000	Brownell	135 lbs	Spectra 2000	5 %	+	+	6750
Dyna Flight 97	BCY	120 lbs	Dyneema SK 75	5 %	+	+	8900
ASB	Angel	110 lbs	Dyneema	4 %	+	+	-
D 75	Brownell	130 lbs	Dyneema SK 75	5 %	-	+	7511

From a kind letter from Brownell & Company, I realized that several errors were in the Brownell fibers data. First, the values of string break strength of Fast Flight and Fast Flight 2000 were wrong. The correct vales are 95 and 135 pounds, respectively. So here is a new Table 2–Corrected.

Table 7

Product	Strands	Strength	Total Length	Weight	Spool Length	Strings from One Spool
450 Plus	12	1860 lbs	720 in	89.34 gr	1175 ft	19.58
S4	10	1600 lbs	600 in	87.03 gr	1005 ft	20.10
DF 97	16	1920 lbs	960 in	79.93 gr	1750 ft	21.88
FF 2000	16	2160 lbs	960 in	82.86 gr	1688 ft	21.10
FF	20	1900 lbs	1200 in	80.39 gr	2175 ft	21.75
B 50	12	600 lbs	720 in	97.67 gr	1075 ft	17.92
B 75	12	660 lbs	720 in	99.99 gr	1050 ft	17.50
PENN 66	12	684 lbs	720 in	97.67 gr	1075 ft	17.92
D 75	16	2080 lbs	960 in	74.50 gr	1877 ft	23.46

Since Table 7 was made using data from Table 2, some errors also occurred in that table. A corrected Table 7 is available.

In addition, Brownell has informed us that Fast Flight has only 1¼4 inch of creep and S4 only 1¼8 inch. We apologize for any inconvenience that these errors might have brought to Brownell & Company. Pedro Serralheiro

Brownell emphasizes that it is imperative to compare like fibers to like, such as polyethylene string fibers (Fast Flight and Dyna Flight for example) to other brands of polyethylene fiber and composited polyethylene to other composited polyethylene fibers (for example S-4 and 450 Plus).

It is difficult to find incontestable data since the archery industry does support independent testing, so the data must come from the manufacturers themselves. For This Magazine's part we will in future do a better job of fact checking, which companies, like Brownell, do admirably.

We add our apologies to Brownell & Company, a longtime supporter of This Magazine, for any upset we may have cause them. Steve Ruis, Editor

Web Site **http://www.archeryfocus.com**

SoCalArchery Home Page