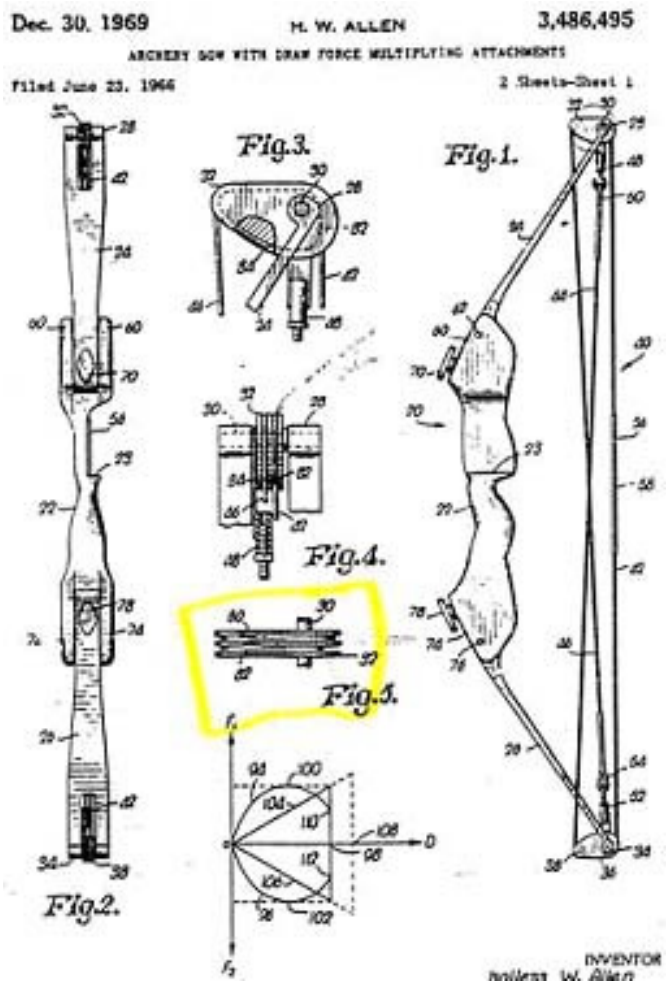
MODERN ARCHERY

Now, into chapter four, the newest bow in this series, the Compound Bow. Again, this is a development of the Composite Bow, but what a significant development it is. The changes compared to earlier bows, really does make this a significant step in bow design.

I had intended this to be the final piece in this series of articles, but once I had started it expanded and would have overloaded the system. I have therefore, split the article up, this first part explaining just the history and some of the technology. This leaves the selection of bows, accessories and shooting for another article.

The **Compound Bow** as we know it is really of quite recent origins, the late 1960s. The earliest patent was issued to Holless Allen, an American of course, in 1966. I have not been able to locate a copy of his original patent, but a copy of a later one, issued in 1969 is shown below.



This is clearly for a two cam bow, with what appears to be a wooden riser (handle), so is easily identifiable with compounds of 30 years later. The basic idea was to produce a hunting bow of real power, but without the need for a high full draw load. Hunting bows of the time were frequently of 100lbs full draw weight, often even more. This made it very difficult to hold and aim when hunting with a flat bow or even a Recurve hunting bow, so alternatives were sort.

It is worth remembering that this was a period of rapid developments in technology, such as Formula 1 racing cars sprouting “Wings”, the construction of Concorde and the Space Race, with Saturn 5 rockets and men landing on the moon. It is no wonder then that developments in archery moved faster than they had for the previous 10,000 years or so. It was only in the early 1970s that the “Take-down” Recurve bow that we know today came into being and accepted by a large part of the archery world.

It is often said that the compound bow was invented to produce a short bow for the convenience of hunters, but as I mentioned in the earlier articles, composite and hunting Recurve bows were often less than 50ins (1.25m) long at this time. The earliest compounds were no shorter than this and quickly followed target bows in being made even longer for the target

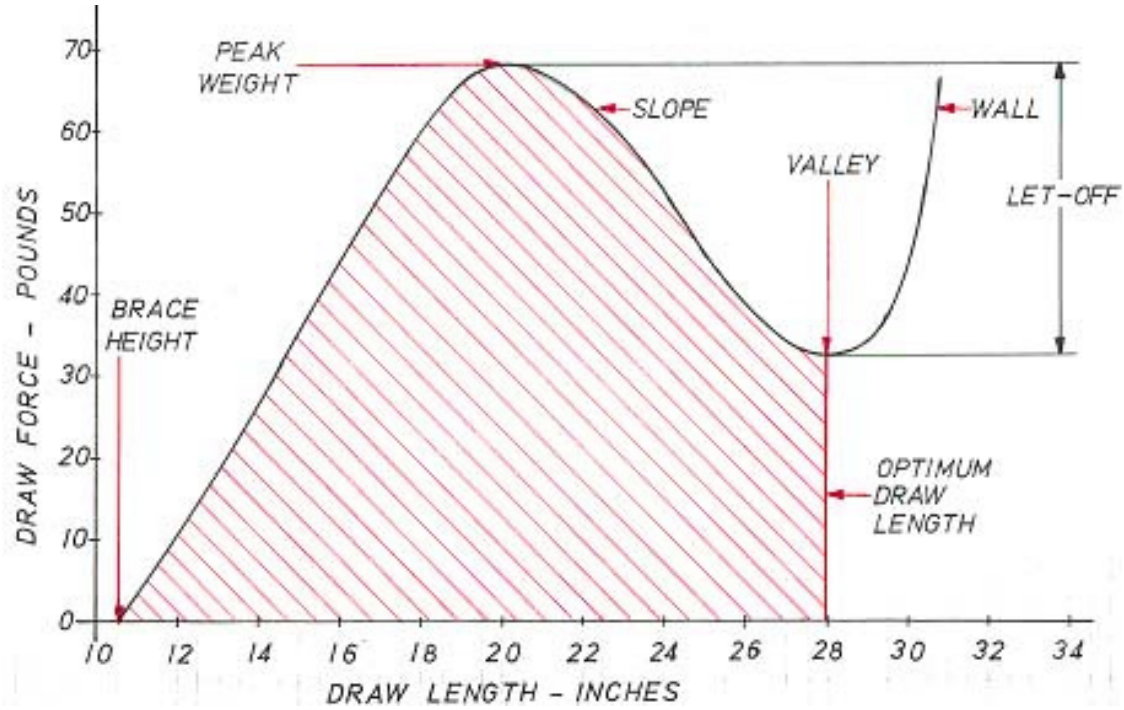
archer. One of the reasons for this of course, is that they were being shot off the fingers, release aids not being in general use at this time.

The concept behind the development of this type of bow was to shoot arrows faster and with a lower trajectory than current bows, but without the high peak loads of the then current bows. The idea was to “compound” the energy stored by the bow, by using pulleys to give a greater “Mechanical Advantage”, or multiplication of the force exerted by the archer. This is an old and well known principle in mechanical engineering, but needed some lateral thinking and updated technology before it could be applied to archery.

The design of the bows tended to follow that of the Recurve bows of the time. Many of them were one-piece wooden bows, or three-piece bows, with wooden risers and laminated limbs. Later they followed the Recurve path, with metal risers and either straight or recurved limbs.

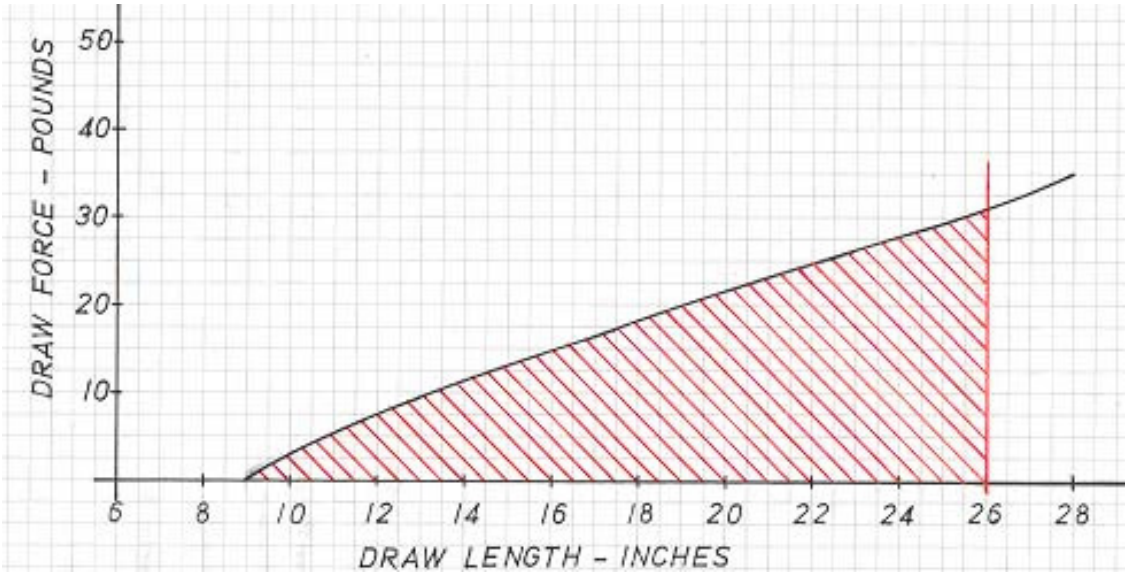
Their advantage is best explained by examining the “Force Draw” curves for various bows, which shows not only the way force is applied to the arrow, but also the amount of energy stored.

The energy has first to be stored in the limbs of the bow, before it can be transferred to the arrow and propel it to the target. The illustration below is a generic Force Draw Curve, explaining the terms used in describing the characteristics and operation of Compound bows .

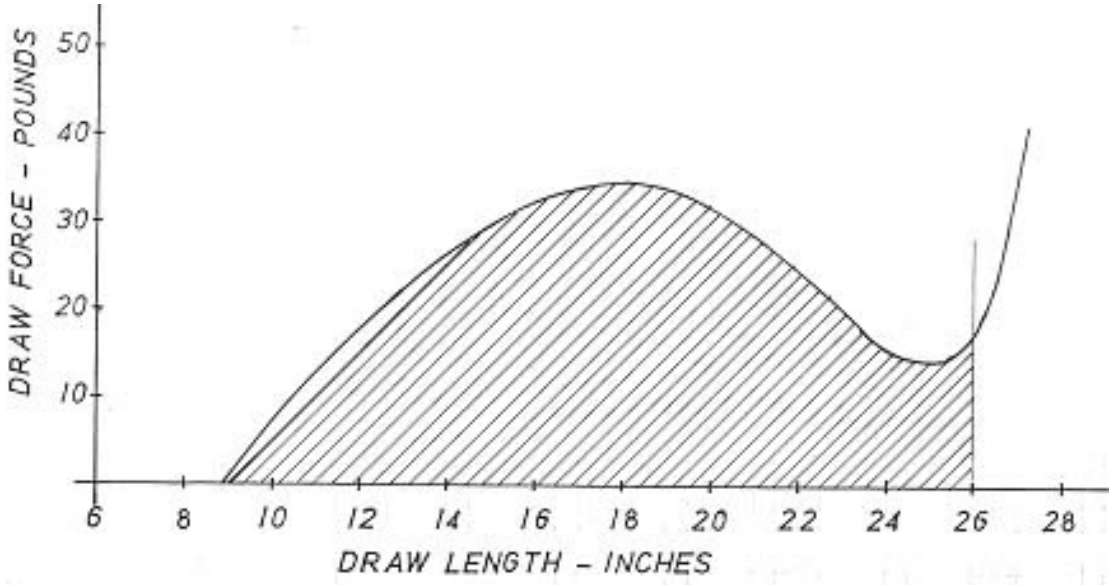


By plotting the Draw Weight up the vertical axis and Draw Length along the horizontal axis shows how the force increases as the bow is drawn, reaches a peak, then reduces as we approach the valley. The area under the curve can be calculated and shows the amount of energy stored by the bow.

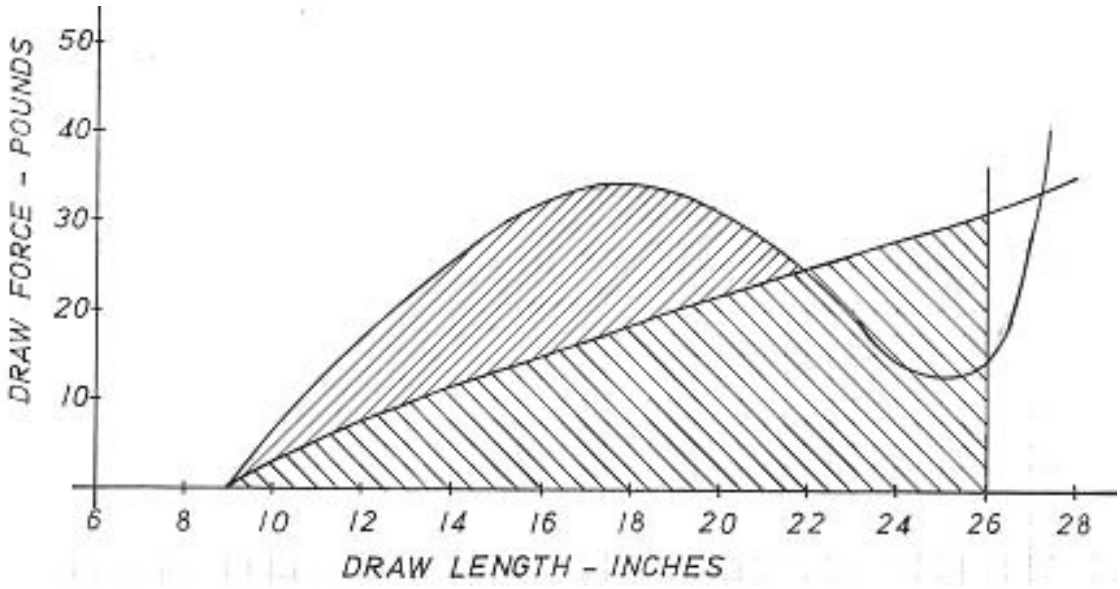
Below is shown the equivalent Force Draw Curve for a typical Recurve bow.



This is the Force Draw curve for a compound bow of about the same peak weight.

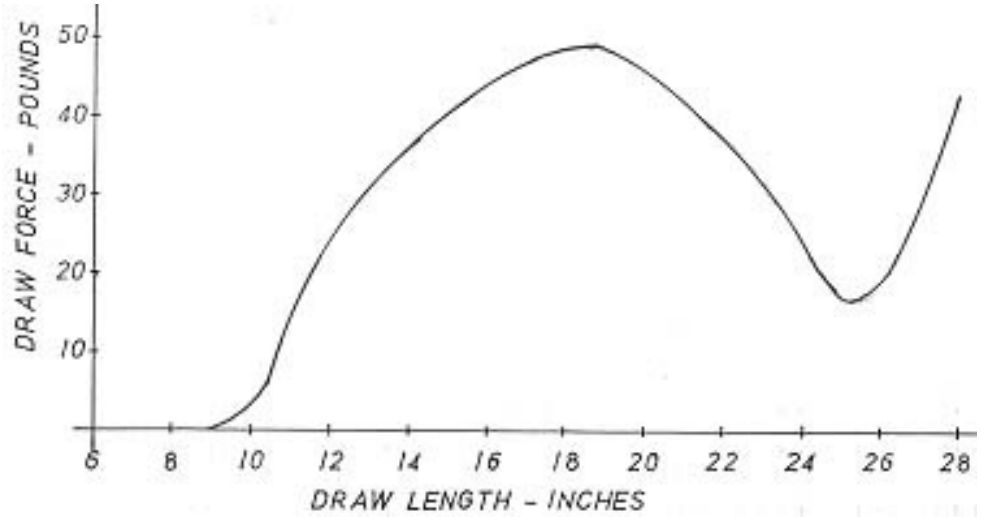


If the two Force Draw plots are put together, it easy to see that the Compound bow stores much more energy than the Recurve. This explains why the arrow will be launched with a much higher acceleration and ultimate speed.



However this is not the end of the story; because the “Let Off” characteristic of the compound bow means that the archer is holding much less weight at full draw. Therefore, the peak load, which will only be held for a very short time, can be much higher.

Below is the Draw Force plot for a bow which could be used by an archer who would otherwise be shooting the Recurve bow shown earlier. This shows a Peak weight of nearly 50lbs, but a holding weight of less than 20lbs. This of course, increases the energy stored, further increasing the speed of the arrow.



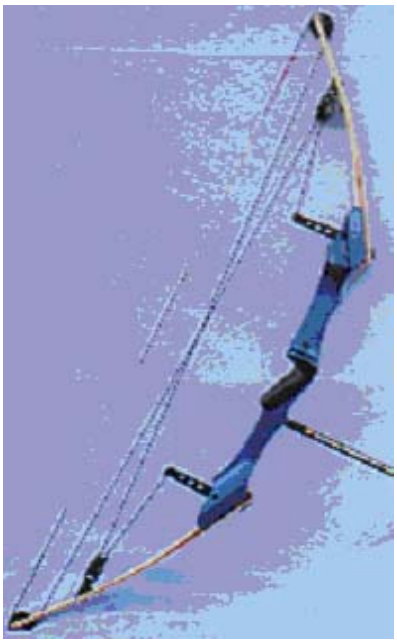
More advantage is gained, because the load on the arrow at launch is also reduced, allowing the use of a whippier and therefore lighter arrow.

With all these advantages it is no wonder that Compound bows gained so much support in such a short time, particularly amongst the American bowhunting fraternity.

Once the basic principal had been accepted, many variations of application appeared

These variations varied from two wheel/cam, single cam, pulleys in the cables and multi-wheel bows. The cams were located in various places on the bow, the ends of the limbs, as in the original patent, the ends of the riser (handle) and the middle of the riser.

Target versions evolved which were much longer, generally around 47 to 52ins Axle to Axle length and by the mid eighties were generally of 4 or 6-wheeled design.



The bow to the left is typical of the popular 4-wheeled design of the mid -nineteen eighties. As can be seen it has a cast aluminium riser and laminated wood and fibre glass limbs, very similar to Recurve bows of the same period. The string wraps around round pulleys at the end of the limbs, over pulleys (at right angles) on the limbs and fastened to pylons on the riser. Often the pylons would have another pulley on each, to make a 6-wheeler, the cables being fastened further down the riser. This system had a number of advantages, it enabled a wide variation of draw lengths and loads to be covered with one bow and it kept the cables out of the path of the arrow without needing a cable guard.
It was still popular for these bows to be shot as one would a Recurve, i.e. with a finger tab, so the bow is 48ins long, typical for a target Compound bow of the time

This evolved by the early 1990s into a two wheeler of similar overall dimensions, draw length adjustment being achieved by the use of “Tri-draw” wheels which allowed the string to be shortened or lengthened by locating it in different notches in the cams/wheels. These wheels or cams were generally located at the ends of the limbs and because this brought the strings and cables into the same alignment, the cable guard had to be introduced to keep the cables to one side to provide the clear path for the arrow.

The bow shown here is a 1996 model, 47ins long, but notice that the limbs are recurved, again a characteristic of target compounds of the period, said to give a “smoother shot”.

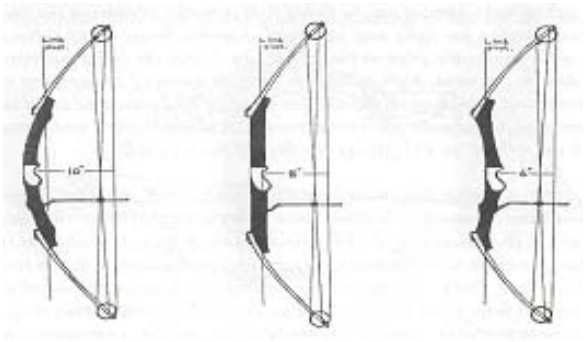
Whilst initially, Compound bows were shot along-side Recurves, they were quickly separated into category of their own because of the record breaking scores they were achieving in competition. Putting them into a class of their own meant that many of the restrictions could be ignored and innovations in equipment quickly followed. Some of these were borrowed from other sports, such as the telescopic sight from rifle shooting. This evolved into a magnifying lens in the front sight and a “peep sight” in the string acting as the back-sight. This gave further improved shooting accuracy. Another innovation was the adoption of a “release aid” to hold the string during the draw and to give a quicker and more repeatable release action. These had been used

in flight shooting and by the disabled for many years, being developments from the thumb rings and other aids used for thousands of years by Eastern and Middle-Eastern archers with their composite bows. At this time, the late 1960s, they were being experimented with by some Recurve archers, before being banned in competition.

Up to this time the ideal target compound was generally regarded as having an axle to axle length of around 45 to 48ins, recurved limbs, round wheels or mild cams, a brace height of 8 to 10ins and a deflexed riser. These last two items being very similar to a Recurve bow of the time.

Below are three designs of compound riser which might explain the terms better, from left to right they are:-

Deflex Riser Straight Riser Reflex Riser



The deflex gives a high brace height and greatest stability, but lowest speed, most popular for target shooting.

The reflex gives a low brace height, is less stable, but generates highest speeds, so is preferred by bowhunters and some field archers.

The straight riser is a compromise, giving middling speed and stability, ideal for those who want to switch between target and field shooting.

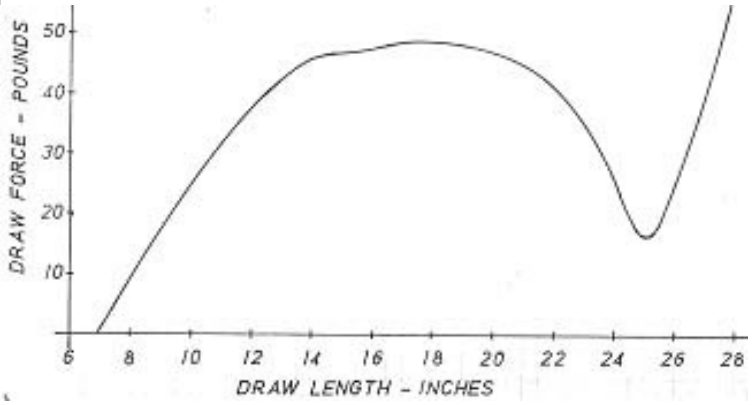
The mid 1990s seems to have a watershed, for from this time design variations started to proliferate and ideas on the ideal bow changed.

New technology, in the form of CNC (Computerised Numerical Controlled) machines and the wide availability of carbon fibre matting were important drivers. Also important was the decision of GNAS and FITA to put an upper limit of 60lbs on the peak draw weight of compound bows used in their competitions.

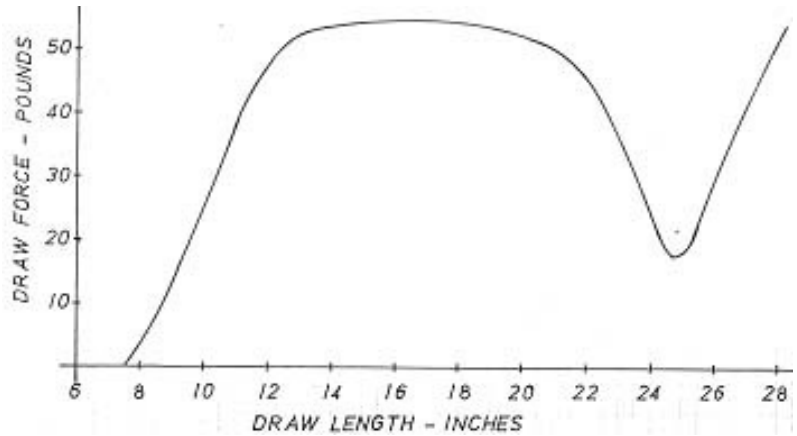
The first two enabled designs to be changed more cheaply and more often and the third caused target archers to look to the hunters for ways to increase arrow speed within the new peak weight limits.

This resulted in bows becoming shorter, with reflexed risers and more aggressive cams. The use of high grade aluminium for the riser, carbon matrix based limbs and synthetic fibres for the strings and power cables allowed the bows to sustain much higher stresses, reliably. Power or “Buss” cables had mainly been made from plastic covered steel wire, similar to bicycle brake cables. The availability of high strength synthetic fibres made the bows faster and gave greater flexibility to the cam designers.

Design innovations such as split limbs to improve stability and reduce limb splitting, were also reintroduced. (They had been tried several times in earlier years, but manufacturing problems had prevented their general adoption). At the same time limb mounting accuracy was improved, so that target archers found that they could use hunting bows - with lowered poundage - successfully for their style of shooting.



Above is an example of a short bow, 32ins Axle to Axle, with a single cam together with its Force Draw plot. As you can see this is much fuller and therefore stores more energy than the longer target bow with mild cams. Notice also that the “Valley” is now shorter and more clearly defined, improving shooting consistency.



This is another example of a bow developed initially for the American hunting market, but designed to appeal to target archers. This is 38ins Axle to Axle, has twin cams and a brace height of 7ins. The Draw Force plot gives it even more stored energy and can propel a carbon target arrow at nearly 300 feet per second, with a peak weight of only just over 50lbs. Notice the short, straight limbs, set at a much sharper angle relative to the riser, to reduce vibration and increase stability.

This is a photograph of the three bows used as examples above. From this it is possible to see how bow design has changed in less than 10 years.

If anyone wants to find out more about Compound Bows, the following references should make a good start:

Martin Archery's "Archery History" web site
The Compound Bow from the beginning, by K. R. Duff
Tuning Your Compound Bow, by Larry Wise
Any Manufacturer's Catalogue or Owners manual

Mitch Vaughan October 2005