

The Modern Guide To Shaft Fitting

Featuring The Dynacraft Shaft Fitting Index™

The Golf Industry's Most
Comprehensive Study of
Shafts and Shaft Fitting



Dynacraft

BY
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Second Edition

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Chapter One

THE EVOLUTION OF SHAFT FITTING

“This question of the selection of the shaft is really one of enormous importance for it is infinitely easier to get a head to suit you exactly,.... than it is to get a perfect shaft.”

James Braid; “Advanced Golf,” 1908

“A fine steely spring is what the golfer wants to feel, a spring that will bring the club back, quick as thought, to the straight. Then it feels, in his hands, like a living thing, full of energy - of controlled, obedient energy - to do his service.”

Horace Hutchinson; “GOLF, The Badminton Library,”

New Edition, 1902

That golfers have been fascinated with their equipment is a fact that has been well documented throughout the history of golf. After researching the game over the last 150 years, it becomes very obvious that our modern day attachment to “high-tech” and the accompanying advances in golf club design is anything but new. Since the early days, the clubmakers and the manufacturers of golf equipment have constantly been in search of golf’s equivalent of the Holy Grail; an improvement in golf club or golf ball design that would pave the way to a better score.

When researching the development of golf equipment, the real flavor and enthusiasm of golf club development comes pouring out of the pages of the old books and magazines related to the game. After spending time reading the old publications, the contrast in their respective formats presents a full complement to the overall picture. Books have the luxury of time. They show the countless hours spent canvassing numerous sources in the quest of tracking the changes in golf clubs, while magazines report the evolution as it happened, complete with the existing sentiments of the time.

Over the past 150 years, the game of golf is fortunate to have been chronicled in quite a large number of books and magazines. Within their pages can be found the events, the developments, the perceptions and the beliefs, as they are remembered, or as they actually happened. To a historian of the game’s equipment, recreating the development of golf clubs over the past two centuries is a captivating assignment, made even more fascinating when it becomes evident that despite the time, certain aspects of the game have never changed.

The intrigue that golfers have had with the shafts in their golf clubs is just one of these interesting analogues that can be seen over the course of the history of golf equipment. Despite our seemingly recent preoccupation with shafts, clubmakers of the past also experimented continually with shaft materials and designs, and likewise, debated the principles of advising the right shaft for golfers.

While it is a well-known fact that wooden shafts proliferated in early golf clubs, perhaps the earliest reference to the shaft as an individual part of the golf club is chronicled in Ian Henderson and David Stirk’s 1979 book, “Golf In The Making.” Quoting a passage from their research into the early shafts, “Thomas Kincaid of Edinburgh, (in) 1687, said that the shafts were made of hazel.”

From this earliest testimonial on the makeup of shafts through to the eventual domination of hickory in the latter half of the 19th century, a wide variety of native hardwoods were used by clubmakers to form the shaft in golf clubs. Since the concept of wholesale supply did not exist in the early days of golf clubmaking, craftsmen had to rely on materials that were indigenous to their local region. Because clubmaking was a craft restricted to Great Britain in the 17th through the 19th centuries, many of the hardwoods from which the shafts were made bear names, which are largely unfamiliar to American golfers today.

Danga wood, greenhart, lemonwood, lancewood, purpleheart, ironheart, bulletwood, washaba, split cane, orangewood, ash and bloomahoo; the curious names of the old hardwoods used to make shafts conjure up visions of clubmakers trudging the hills of England and Scotland, scouring the forests for just the right species of tree, as if the wood might possess the magical characteristics desired for a better playing shaft.

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But just what were those magic qualities required of the shaft? What did the old clubmakers look for when selecting a suitable wood from which to make the shaft? As Hutchinson expressed so colorfully in the "GOLF" volume of "The Badminton Library:" "A fine steely spring is what the golfer wants to feel, ... a living thing, full of energy ..." In 1896, the famous golfer and clubmaker Willie Park, Jr. wrote, "The words 'good shaft' have a world of meaning. The wood must be light in actual weight. ... It must be supple and yet not wobbly and have a fine steely spring without being too stiff." Or as reported in a 1911 issue of The American Golfer magazine, "... it should be as light and thin as possible, and such little spring as there is in it - should be of the hard, steely kind."

Such undefined expressions of "feel" offered in the opinions of the respected players of the day became the guidelines not only for shaft making, but for shaft fitting as well. As a result, each clubmaker had his own opinions of the best wood from which to make the shaft. So much of the early writing about shafts indicates that a material had to be selected which would allow the golfer to "feel the clubhead" during the swing. Because swingweight or any sophisticated type of shaft to clubhead matching by weight was yet to come, very early clubmakers would often pair shafts from different hardwoods with different clubheads in a set. Willie Park Jr., expressing his opinion on shaft hardwoods of the era, said "... ash is quite good but too supple for anything but a light head, greenheart was too heavy for any clubs but niblicks and putters, (while) lemonwood or lancewood makes a good shaft but is somewhat heavy ..." So it went among the clubmakers, each with his own preference, each with his own carefully protected supply of the "right" type of wood.

Numerous printed sources reveal that by the first half of the 19th century, clubmakers had generally settled upon lemonwood, lancewood and ash for shaft making. Not until the discovery of hickory did there come widescale acceptance of a material that could, in one shaft, satisfy the clubmakers' requirements of lightness, the right degree of springiness and equally important at the time, durability and resistance to warping. No definitive answer can be given to the real question of how and when hickory came into common use. An accepted theory among historians is that the first hickory may have arrived from Russia, in the form of ballast, on a ship that docked at Dundee, just north of St. Andrews. A generally more widespread belief is that the hickory worked its way into the hands of clubmakers from shipments of ax or rake handles which first came to Britain from America in the early to mid-1800s.

The first known reference to the use of hickory for making shafts comes from an entry in the August, 1828 issue of The Sporting Magazine (Britain), in which is offered "A Description of The Scottish Game of Golf." Describing a drawing of a golf club, it is stated, "At No. 1, it is covered round with list, as far down as is necessary for the two hands, when striking. The upper part above No. 2 (indicating the shaft) is generally of some very pliant tough wood, as hickory, and is joined slantingly to the head by strong glue, and strengthened by well-resined cord."

J.B. Farnie, writing in The Golfers Manual in 1857, stated, "The timber best adapted to driving shafts of all descriptions is red hickory. This wood is particularly tough yet at the same time possesses a powerful spring without the drawback of too great flexibility, qualities which give it an infinite superiority over ash, which is generally too supple and not nearly so strong as hickory."

While hickory in general had completed its rise to dominance in shaft making by the 1890s, clubmakers began to refine their use of the hardwood by professing shaft superiority within particular sources of the hickory or in one species of hickory over another. A number of British clubmakers bragged that their hickory came only from Tennessee in the USA, or was selected only from second growth, more matured trees. From studying the old magazines in particular, it is quite interesting that today's common advertising claims for superior playability on behalf of one shaft over another is not a new page in the book of clubmaking promotion. The old clubmakers did their best to confuse golfers of their day by starting and perpetuating myths about the wood that were based strictly on personal sentiments and opinions.

The argument between clubmakers about the different types of hickory can perhaps best be seen from an article found in Golfers Magazine (England); "Brown hickory is by far the choicest wood for the shaft, though it is commonly believed - by many pros and clubmakers - that white hickory is the first choice. Brown hickory has a 'kick' never found in white hickory."

Henderson and Stirk reveal another view from a conversation with the daughter of famous English clubmaker Charles Gibson, proprietor of Westward Ho! near Devon, "(My father said) the best shafts were of 'ring hickory,' these made from laths cut from the centre of the hickory tree where some of the grain had an appearance of a ring around the shaft; such shafts were said to be unbreakable."

Not only were claims of superiority issued on behalf of hickory's variations, but myths of the origin or location of the best trees became widespread as well. Continuing with the article from Golfers Magazine (England), "Hickory trees that grow on hillsides facing to the north create the best wood for shafts. And (on them) the wood from the north side of the tree makes the finest hickory for golf shafts."

Despite the circles of thought concerning which species, or which particular "cut" of the hickory was the best, there still was the fact that the wood had to be split or cut from the tree and hand formed into the shaft. Hickory shaft fitting, or rather, a golfer's search for the right hickory shaft for his game, became a form of black magic that was chiefly driven by the clubmakers' individual sentiments. As evidenced by James Braid's quote at the beginning of this chapter, almost all golfers of the time felt it was much easier to secure a playable clubhead than a playable shaft. Clubmaker Charles Gibson's daughter went on in her story to Henderson and Stirk to tell how her father would sort through as many as 20 or 30 laths of wood before choosing the right shaft for the club he had in mind.

So difficult it was to find the right playing hickory shaft that golfers routinely kept two sets of golf clubs, one for playing important matches or for playing only in good weather, and another for practicing or for use in poor weather. Because of the somewhat fragile nature of the shafts, golfers of the hickory era did not hit practice balls in the manner of today's players. They worried such repeated use would accelerate fatigue in the springiness of the shafts and require the golfer to once more search for the right feeling shaft, a prospect that was feared among all accomplished players.

If a shaft broke in play, very little hope was ever held in being able to duplicate its feel. Perhaps one of the most interesting stories to illustrate this fact is related by golf professional and clubmaker J. Victor East in his 1956 book "Better Golf in Five Minutes." Born and raised, both in life and in golf, in Australia before emigrating to the U.S., East enjoyed a long career in golf as an accomplished teacher and clubmaker from the days of hickory through the 1960s.

In the 1920s, East was asked by Bobby Jones to produce a complete duplication of Jones' entire set of golf clubs. To express just what a difficult job it was in the days of hickory shafts to complete such a task of duplicating the feel and performance of the clubs, hear East's description of the painstaking detail required just to copy Jones' Driver.

"The (Jones') Driver had been made by Jack White, one of the great clubmakers of the day and winner of the British Open in 1904. Although the exact reproduction of all parts of the Driver was important, perhaps of more concern was the duplication of the feel Jones had for this club. Fortunately, I had previously reshafted this Jack White Driver for Bob, and so I knew the exact requirements of the shaft, both in its rough and finished state. Even so, I had to go through 5,000 pieces of hickory before I was able to narrow my choice down to four shafts. By test and measurement, these shafts were the four most likely to reproduce the playing characteristics of the original. They were worked down to exact micrometer measurements of the original, weighed for duplication and tested for torsion, deflection and recovery.

Of the four, two proved to meet the deflection curve of the original, and, since they also matched the torsion requirements, were processed into finished clubs. (These two) were checked under various atmospheric conditions and one proved to be the exact duplicate of the original in every respect. It became one of Jones' new set. I still have the other one as a memento of a pleasant task. I call attention to part of my worksheet on Bobby Jones' Driver:"

Chart 1-1 J.; Victor East's Worksheet for Bobby Jones' Driver

Club	Shaft	Shaft Deflections	P.O.B.*	Shaft Diameters			Grip	Top
				6"	16"	26"		
DR (Driver)	H-R	93 - 105 - 46 - 89 Red Hickory	12.5"	.48"	.55"	.63"	.65"	.74"
East's Copy	H-R	93 - 109 - 46 - 89 Red Hickory	12.5"	.47"	.56"	.63"	.65"	.74"
Rough Shaft (From which the duplicate was made)	H-R	96 - 107 - 41 - 71**						

* Point of balance
** Had to be files, sanded and worked down to achieve Jones' desired deflection readings

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It is possible that between the time the job was done and the time East included details of the task in his 1956 book, the number of raw shafts needed to find the four candidates may have been slightly embellished in East's mind. Such is the often the practice with noteworthy memories that are later recalled. However, there is no doubt that countless hours were required to make the duplication for a golfer with such a sense of feel as Bobby Jones was said to possess. Still, the point is well made. In the days of hickory, shaft fitting or replacement was an all but impossible task, most likely because of the minute differences of natural grain and spring within different pieces of the wood.

Shaft fitting in the hickory era was strictly a matter of trusting the clubmaker, or of the golfer somehow being able to relate his thoughts or desires with regard to "feel" to the clubmaker. If the golfer was a beginner, the matter of shaft selection and fitting was left in the hands of the clubmaker. But if the golfer had developed a particular touch through years of playing experience, the shaft selection and fitting was worked out through trial and error, a task that required numerous visits of the golfer to the clubmaker. By sanding a little more here, scraping a little more there from particular areas of the shaft, the right feel could (hopefully) be achieved.

Still, within the craft of hickory shaft making, there were beliefs not only that the shafts should have particular overall flex properties, but in a precise location of the position of bending as well. Within some of the old reports the first indications of bend point as a matter of shaft fitting also can be found. Continuing with Hutchinson's descriptions of the shaft in the late 1800s found within the pages of "The Badminton Library": "And not only is the amount of spring a matter of import, but also the location of the spring. It ought not to make itself felt too far up the club, 'under the hand,' as it is called, but ought to be situated chiefly in the six or nine inches of shaft just above the whipping which binds head and shaft together. Yet the spring must not be there, and nowhere else, so that one can point with the finger and say the spring comes up so far and no farther; but it must gradually and imperceptibly die away into the comparatively unyielding upper part of the handle."

While other references can be found to dispute such an exact location of shaft bend point in pre-1900 hickory shafts, it is a common fact among almost all of these reports that the preferred shafts were limber in overall flex, with the point of maximum bending located low on the shaft, close to the clubhead. It is believed that clubmakers matched this particular type of shaft feel to golfers not only because of the need to better feel the clubhead's often variable weight whip through impact, but because of the hard gutta percha ball that was in use at the time. Molded gutta percha golf balls transmitted an extremely hard feel back to the golfer at impact. By shaving the hickory thinner in the area just above the clubhead, clubmakers could, as Hutchinson seems to relate, soften the flex and position the bend point low on the shaft. This, in turn, would make the shock of impact die away as it reached the golfer's hands.

Just after the turn of the century, the softer feeling and much livelier rubber core golf ball displaced the gutty ball. At approximately the same time, the range in weight between all the heads in a set decreased and became more consistent. This change in ball and clubhead weight design brought with it a change in the form of hickory shafts with regard to bend point. In a 1909 issue of the British Golf Illustrated magazine, it was reported, "The shafts of modern clubs are thicker and not so tapered and they are in consequence much stiffer than the old playclubs. The suppleness or give in the shafts occurred 3-4 inches above the whipping in the old clubs, but in the modern clubs, if the shaft has any give at all it is much farther up and, as a rule, is more evenly distributed throughout the shaft. The old clubs were made for the swinging blow whereas the modern ones are adapted more for hitting and suppleness has therefore given way to steeliness."

While flex and bend point appear to have been shaft specifications that were able to be customized in the manufacture of hickory shafts, one other less than favorable aspect of the wood that was not entirely controllable by the clubmaker also had been recognized. Torsion, or the shafts' inherent characteristic of twisting during the swing and in response to impact with the ball, was an unfavorable side effect of wooden shafts which caused golfers of lesser ability and skill no end of grief.

Students of the evolution of the golf swing are well aware that the excessive torsion of hickory shafts forced players of the day to swing at the ball in a flatter, almost "roundhouse" plane to be able to properly hit the ball. Robert Browning, writing in his book "A History of Golf," related, "... the hickory shaft tended to make the toe of the club twist outward as the club was taken back and twist back again as the club came down. (So undesirable was this excessive torsion) that a bad player who got his timing wrong would sometimes bring the toe of the club forward so quickly that it caught the ground before it ever got to the ball."

By the late 1800s, four negative aspects of hickory shafts had been identified; susceptibility to fatigue from overuse, warping from play in bad weather, a lack of consistency from shaft to shaft and poor resistance to torsion. Perhaps taking a lead from the accepted feeling that a proper shaft should exhibit a degree of “springiness and steeliness,” at this time golfers began to speculate about the possibility of using metal for making shafts.

One of the first references to the use of metal in any form in a golf shaft came on November 14, 1890, when the British magazine GOLF reported the development of a hickory shaft with a steel rod placed down the center to restore or enhance flexibility. Subsequently, in the Aug. 11, 1893 issue of the same GOLF magazine, in a section of the publication dealing with new ideas and happenings in the game, credit is given to an accomplished amateur golfer, one Professor Tait of St. Andrews, for proposing an idea for a thin, tough, steel tube for a shaft.

While there may have been several other early experiments with metal shaft making not yet uncovered by students of the game’s history, credit for the invention of the first all metal shaft is given to a golfing blacksmith from Scotland named Thomas Horsburgh. Apparently realizing that his idea could prove to be more than a personal experiment in game improvement, Horsburgh filed, and was subsequently granted a patent (UK #8603, May 1, 1894) for metal golf shafts made of a solid, iron rod.

In making the first metal shafts, Horsburgh immediately recognized the first problem in bringing such shafts into existence - producing a metal shaft that was as stiff as, but yet as light as, hickory. Because little was known at the time about forming small diameter, thin-walled steel tubes, Horsburgh was forced to fashion his shafts from thin solid iron rod, just in an effort to keep the clubs’ weight at a range reasonably close to existing hickory-shafted clubs. In trying to conform to this weight requirement, Horsburgh’s shafts were extremely small in diameter, which had the effect of making the shafts far too flexible to be playable. As a result, the Horsburgh steel shaft was never accepted.

However, Horsburgh’s experiment did open the floodgates of creativity in using steel to overcome some of the disadvantages of hickory shafts. In 1902, the Foster Brothers of Derbyshire, England, advertised and sold shafts made from hickory that were supported by a series of steel wire ribs running up and down the shaft. The famous golfer and clubmaker Willie Dunn, runner-up in the first U.S. Open Championship in 1895 was reported to have tried out a type of steel shaft as early as 1904. While nothing is known of the type or construction of the shafts, Dunn was quoted as saying he found the new metal shafts to be too heavy.

Through the early 1900s, several attempts were made to create a hollow steel shaft. Perhaps the most noteworthy was a steel shaft design patented by Alan Lard which called for a steel rod to be bored through the center and milled on six sides into a hexagonal shape with some 1,100 holes drilled through the shaft in an effort to reduce weight. The Lard shaft was used by some U.S. golf companies in the 1910s, but never met with much success due to its very stiff and still very heavy nature.

The first real breakthrough, which paved the way for steel shafts to displace hickory, was identified in a patent issued to an American, Arthur Knight of Schenectady, NY (US #976,267, Nov. 22, 1910). Knight’s efforts were centered on his goal to make a golf club in which the line of flight of the ball would more truly conform to the direction of the blow as delivered by the player. In so stating, Knight recognized the primary playability shortcoming of hickory - its inability to resist the twisting influences placed upon it during the swing.

The key element of Knight’s club and the heart of his patent was a tubular steel shaft, made as he described, to a desired suppleness so as to enhance distance while achieving the primary goal of torsion resistance. Of extreme importance was the fact Knight’s patent allowed for the hollow, steel shaft to be made in such a way that the metal could be distributed about the shaft in an orderly fashion to create different bend points.

Although the preferred embodiment of his patented design was a shaft made as a straight, tapered, seamless steel tube, Knight did go on in the patent to describe a way to distribute the metal and form the shaft through a “stepped” change in the tube’s diameter, in the process utilizing a number of step downs in the design.

A.F. Knight was an inventor, not a manufacturer. Through subsequent negotiation his patent was assigned to the Horton Manufacturing Corp. of Connecticut, which utilized Knight’s steel shaft technology in manufacturing their line of Bristol seamless steel golf shafts.

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In the early days of steel shaft manufacture (1910s), it was extremely difficult to produce a seamless shaft because the tube had a tendency to break during the process of tapering under the force required to form the reduction in shaft diameter. This was primarily because the fabrication of alloy steels was in its infancy and the only steel available was low carbon content steel. To taper a seamless tube under existing forming methods required a soft tube, and a soft tube was not what was required or desired for proper shaft performance. Methods of increasing the carbon content (carburization) of the steel had to be improvised to keep the shafts from developing a permanent “set” or bend during manufacture, and to allow the shafts to achieve even a modest level of strength. To increase tube strength, shaft makers experimented with a number of other configurations for their products, forming shafts in oval, hexagon and even flat-sided shapes. In the end, however, the original circular hollow tube emerged as the design of choice.

As the carbon content was eventually increased in the steel, shaft manufacturers found they had to turn to welding flat strips of steel to form the tapered tubes. This was because the seamless tapering processes just wouldn’t work with the stronger, higher carbon content steels. Problems in the manufacturing process still persisted because the technology at the time just did not allow the adequate welding of high carbon steel. Spearheading the breakthrough was the Horton Co., who solved the problem with the development of a new type of welding machine. By brazing the ends of the steel strip together to form the tapered tube, Horton was able to corner the early 1920s market on steel shafts through the development of a number of different Bristol welded shaft designs.

All through the 1910s and early 1920s, the debate between the merits of steel and hickory shafts raged on. Hickory shaft supporters claimed the new steel shafts were too heavy, too stiff and lacked the ability to transmit any feeling of the clubhead to the golfer. In addition, hickory shaft followers decried the harsh feel of impact from steel shafts when compared to the much softer feel imparted by the hickory shafts. In a sense, the debate was very similar to the differing opinions offered in the early 1970s, when graphite first began to surface as an alternative to steel.

At the same time, two other factors came about which played a significant role in the evolution of steel shafts. First, acting on a passage within the Rules of Golf which stated new golf club developments must conform to a traditional form and make, the Royal and Ancient Golf Club of St. Andrews banned the use of the steel shaft from competition in the early 1920s. Second, the tremendous growth of the game in the U.S. in the 1910s, which saw the number of American golfers grow from 350,000 to 2 million, created a shortage in top quality hickory for shaft making. Almost every golf magazine of the time published one or more articles identifying this shortage and stating that golfers must be wary of lower quality hickory shafts. Perhaps acting as a result of the shortage, or perhaps even in a bristling expression of retaliation against the R&A for a 1909 ruling which had effectively banned the American-made Schenectady putter, the United States Golf Association broke ranks with the R&A in 1926 and officially approved the use of steel shafts. Refusing to bow to the pressure, it would be three more years before the R&A reversed itself and allowed the use of steel shafts in competition.

The USGA’s authorization of steel shafts had the effect of multiplying the various steel shaft makers’ efforts to continue the advancement of their designs. Other than the Accles & Pollock Co. (predecessor to Apollo Shaft Corp.), whose 1913 British patent for seamless steel tubular shafts had been a milestone in steel shaft design in Great Britain, all of the steel shaft manufacturers were located in the United States. Just as the R&A ban on steel shafts effectively curtailed the developmental efforts of Accles & Pollock, the USGA’s acceptance had the opposite effect for the U.S. steel shaft industry.

Still faced with the problems of forming a hollow, tapered steel tube and then turning it into a reasonably lightweight shaft (steel shafts in the early 1920s all weighed between 5 1/4 oz. and 6 1/4 oz.). By 1924 the U.S. steel shaft makers had not yet been able to gain a wide base of support for their product. Working to overcome the problem of shaft forming, engineers from the American Fork & Hoe Co. (forerunner company to True Temper) came up with the idea of tapering the body of the shaft through a series of successively smaller diameter “step downs” formed along the length of the shaft.

While such a step down design had been outlined in the 1910 A.F. Knight patent, Horton Manufacturing, as assignees of the patent, had never acted upon its conceptualization. In the initial process at American Fork & Hoe, step tapering consisted of placing a cut tube on a mandrel, clamping it in position, and forcing it through a series of dies, with each die forming one step. “Squeezing” the shaft down against the mandrel made it easier to work the steel without fracturing the metal and enabled the company to achieve a more uniform wall thickness and better concentricity. From this work, American Fork & Hoe was awarded a patent for the step tapering process in 1927.

The product of the step-tapering patent became known as the True Temper Stepdown shaft. Despite this breakthrough, the world's golfers still did not immediately accept steel shafts. In an effort to sway the more traditional-minded golfers, the steel shaft makers began to market their product on the basis of how much their steel shafts "felt like hickory". To combat the pressure from steel shaft makers, in 1928, nine American hickory shaft manufacturers banded together to form the Hickory Golf Shaft Association. Through the late 1920's and early 1930's, the HGSA lobbied both the golf industry and the nation's golfers on behalf of their shaft through numerous advertising, all which touted hickory's torsion characteristics as a positive benefit to shotmaking.

Interestingly, the HGSA also enlisted the assistance of the U.S. Bureau of Standards to help in its campaign to halt the advance of steel. On June 14, 1929 a meeting of hickory shaft producers was held in Memphis, TN to set up and define production standards for the manufacture of the wooden shafts. Their actions were made effective on Nov. 1, 1929. On March 20, 1930, the U.S. Department of Commerce issued Commercial Standard CS18-29; a manual of recognized standards for the manufacture of hickory shafts.

With improvements in steel shaft production and performance made possible by the American Fork & Hoe step-down patent, steel shafts slowly began to increase in popularity. Followed by continual advances in steel quality, and improvements in manufacturing and heat treatment techniques, the quality of steel shafts further improved and in response, more and more golf club firms adopted the shafts for use in their lines of golf equipment. By the middle 1930's, the battle was virtually over; through their vastly superior shaft-to-shaft consistency and increased resistance to torque, steel shafts had effectively replaced hickory as the shaft of choice among manufacturers and golfers.

Despite the improvement steel brought over hickory, fitting golfers with the new steel shafts was still a matter of trial and error. Because these new shafts were difficult to produce, in the 1920's golfers were only offered a choice between regular and stiff flex. As a result, essentially all the advertising behind steel shafts was designed to capitalize on the shaft's decrease of torque over hickory.

In the minds of the clubmaking community, very soon the limited choice between two steel flexes and the improvement in torque over hickory was not enough. Competition between the clubmaking firms for an increased share of the overall equipment market triggered a demand for more design variety from the steel shaft makers. Attempts were made to engineer particular different bending properties in the shafts and develop a variety of new shaft finishes and configurations, all in an effort to increase consumer appeal and shaft performance.

Chrome plating, as a coating and a form of rust prevention for the carbon steel shafts, was in its infancy in the 1920's. To provide adequate protection against corrosion, shaft companies turned to a number of alternatives, including copper plating, black nickel plating and parkerizing, all with lacquering applied over the top. In an early effort to establish a market share against the hickory shafts, in the early 1920's some of the shaft companies developed a cellulose acetate sheathing to cover the steel, with many of the sheaths created to simulate wood grain. Through the 1930's, before chrome plating improved, golf club companies asked the shaft manufacturers to produce sheathing in a wide variety of colors and textures, all in an effort to establish a cosmetic appeal on behalf of the shafts.

To offer different bending properties within the shafts, golf club companies began to request all sorts of different configurations to be formed on the steel shafts. Bell-bottom shafts, spiral-grooved shafts, and doubled-grooved shafts were just a few of the odd shapes that began to show up in the steel shafts of the 1930's. While touted by the golf club companies as a means of controlling bend point, according to retired True Temper executive Gurdon Leslie, all these various and sundry "corkscrews" and "grooves" had little, if any, effect on the performance of the shafts.

Starting in the early 1930's, engineers from the American Fork & Hoe began to realize that the key to altering flex and pinpointing bend point was through specific diameter changes formed at precise locations along the shaft. During this time, two major breakthroughs occurred which made such changes possible. A German heat treating development called austempering made it possible to achieve a level of consistency in shaft hardness never before possible. In addition, the creation of much harder and more durable tungsten carbide drawing dies allowed a more precise forming of the diameters along the length of the shaft. Coupled with better drawing lubricants to allow the shaft to pass smoothly through the reduction dies, True Temper was able to produce shaft with more flexibility and different bend point locations in the late 1930's. From a fitting standpoint, these breakthroughs allowed ladies flex shafts to make their debut along with a new extremely flexible shaft for slower swinging golfers called the True Temper Limbershaft.

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While World War II effectively halted the production of golf shafts, the metallurgical and production control achievements originated by the needs of the armed forces contributed to even more specific shaft refinement in the late 1940's. Not only did each golf club manufacturer offer a variety of different flexes and bend points in their shafts, in addition the companies began to identify which types of golfers were best suited for each type of shaft. Shaft pattern descriptions from MacGregor Golf Co. catalog of 1950 specified no less than 14 different types of shafts from which golfers could choose!

Through the 1950's virtually all golf club manufacturers adopted the practice of matching one particular type of shaft with one specific clubhead design. Today's practice of offering different shaft patterns and flexes within the same clubhead model was not done since the companies were in effect, recognizing the entire golf club fitting needs for the golfer within each model. As a result, the more flexible and low bend point patterns were paired with shallow face woods for slower swinging men, while the deep face, strong-lofted woods were matched with higher bend point, stiff shafts for the low handicappers.

In all, the fitting of shafts had come a long way in a short 20 years since steel shafts became popular. Some key points in shaft fitting that had been recognized by the late 1940's were:

- As swing strength decreased in the golfer, shaft stiffness had to decrease
- Rigid, or firm tip section shaft were best suited to strong swinging golfers
- What limited decrease in shaft weight that was possible in shafts of the 1950's was aimed only at slow swinging men or lady golfers
- Shafts could be made to "in-between" traditional flexes to recognize the fact that some players had a very discrete feel and more precise need for proper flex fitting
- "Swingers" were advised to play with softer flex shafts; "Hitters" were directed toward firmer flex shafts

While all steel shafts made at this time were standard weight (@ 5 oz. average) in nature, as early as the 1930's shaft manufacturers envisioned that playability advances might be possible through the development of lighter weight shafts. Visualizing such a possibility, in the early 1930's, True Temper tried but failed to make such a lightweight shaft from aluminum! The thought behind such an attempt was a very futuristic concept for its time. True Temper engineers theorized if a shaft could be made lighter, more weight could be placed in the clubhead, thus allowing for a lighter total weight and greater shot distance from the increased head mass. In theory, the concept was sound. The only problem was that manufacturing technology of the time, as well as the strength of existing shaft materials, just didn't allow the theory to be put to test.

Technically, the golf industry's first lightweight shafts came as a result of experiments in making steel shafts with increased flexibility. In the 1930's, by drastically reducing the butt diameter, True Temper created an ultra-flexible line of steel shafts it marketed under the name of Limbershaft. Both versions of the Limbershaft, one made with a .375" butt diameter and the other, a slightly stiffer version with a .435" butt, were lighter than conventional shafts, simply because the greatly reduced diameters meant less steel was used in the shafts. Since a natural offshoot of making such a flexible shaft was the weight reduction, slow swinging golfers of the time were the first to test the benefits of a club that was lighter in total weight.

The first true lightweight metal shafts did not come into being until 1965, when LeFiell Products of Sante Fe Springs, CA made the first production quality shafts made from aluminum. Bearing a greatly increased wall thickness over steel shafts to provide the necessary strength and stiffness, LeFiell's non-stepped aluminum shaft weighed approximately 3/4 oz. less than standard weight steel shafts. Shortly after LeFiell's introduction, True Temper debuted its Rocket aluminum shafts, made with a conventional step down pattern from a high-strength Reynolds aluminum. An additional and interesting byproduct of the aluminum shaft came from the increase in wall thickness of the shafts. This design necessity, which was required to bring the shafts to the proper level of stiffness, and supposedly had the effect of slightly increasing the shafts' resistance to torque over that of steel.

Because this was the first significant reduction in shaft weight in some 40 years, experts of the day predicted despite their slightly higher cost, aluminum shafts would replace steel and completely take over the market. Led by the fact Arnold Palmer won two PGA Tour events in 1967 playing with the new shafts, aluminum did enjoy a great surge of initial success. However, the very soft feel of the shafts at impact, a point that many felt would contribute to the success of the lightweight shaft, proved in the end to be the downfall. Virtually to a person, professionals and low handicap amateurs all rejected the soft feel of the aluminum shafts. Joining in the domino effect of public opinion, average ability golfers soon joined the rebellion and by 1973, the aluminum boom had become a

total bust.

In the mid 1950's, another group within the golf industry was working on a totally different way to decrease shaft weight in an effort to improve golf club performance. In 1954, Golfcraft of Escondido, CA introduced a revolutionary shaft made from fiberglass that was laminated over a thin wall steel core. The Glasshaft, as it was called, was made through a patented process, which permanently bonded the glass fibers to the very light metal core. Decreasing the weight and retaining shaft strength through the substitution of the very light glass fibers for the reduction in the steel core wall thickness, the Glasshaft enjoyed only limited success through the 1960's. The introduction of such a non-traditional shaft at the time when the market was not prepared for such a change combined with the monopolistic effect of the company's patent, brought the life of the fiberglass-over-steel shaft to a halt.

Other shaft designers, who noted the Glasshaft's use of fiberglass as a means of reducing weight while not compromising strength, soon began to develop shafts made completely from fiberglass. First sold in the late 1950's in golf clubs manufactured by Burke Golf Co. and later developed by Columbia Products, Co. for use by the new Shakespeare Golf Co., the all-fiberglass Wondershaft drove lightweight shaft design in an entirely new direction.

Hailed as the shaft of the future due to its very, lightweight and exceptional impact absorbing qualities, the fiberglass shaft became the forerunner of all of today's composite type shafts. Made by double tube-forming process similar to fishing rods, the glass shaft soon proved to exhibit extremely poor torsional resistance as well as less than adequate tensile strength. Not only did the shaft twist badly at impact, but the poor tensile strength also contributed to a high level of breakage. As a result, fiberglass shafts were phased out of use by the early 1970's.

Despite the short life of the fiberglass shaft, the production of a shaft from lightweight fiber material did pave the way to the next generation of composite shafts. In 1968, officials of Union Carbide approached Frank Thomas (the former Technical Director for the USGA) of the Shakespeare Co., the industry's leading producer of fiberglass-shafted golf clubs. Looking for a market for its new high-strength carbon fibers, Union Carbide felt that the material was suitable for development into a golf shaft.

Realizing that the graphite fibers possessed a much greater tensile strength than fiberglass, Thomas began work on developing a way to form the carbon fibers into a playable shaft. In the late 1960's, thin layers of carbon fiber mixed with epoxy resin (pre-preg sheets) did not exist. Wrapping the fibers around a forming mandrel made what products that were made at the time with carbon fiber. As a result, between 1968 and 1970 Thomas began to utilize this process that is now referred to a filament winding to produce the golf industry's first graphite shafts.

When first released in a golf club in 1971, the Shakespeare graphite shaft generated only a ripple of intention. In fact, in one of the industry's published reviews of new golf equipment for 1972, the new Shakespeare graphite shafts were only given a short notice side by side with the company's improved fiberglass shaft.

By 1973, graphite shafts began to garner a little more attention, in part due to more heavily publicized entry of a second graphite shaft manufacturer, the Aldila Corp. of San Diego, CA. Partially backed by singers Glen Campbell and Andy Williams, and with tour players Gay Brewer, Gene Littler and Phil Rodgers lined up to use their shaft in competition, Aldila was the first graphite shaft maker to utilize pre-preg, sheet-wrapping method of shaft forming. Made from pre-preg graphite material supplied by Hercules Corp., the first Aldila graphite shaft was produced in 15 different flexes to allow golfers the chance to experiment with and choose from an assortment of "in-between" flexes.

Spearheaded by a marketing campaign that touted the use of the shafts on the PGA Tour, 1973 was the first year that graphite really took the golf equipment industry "by storm". Immediately, no less than six other companies jump into the graphite shaft business to join Shakespeare and Aldila in an attempt to capitalize on the overnight popularity in composite shafts. Triggered by reports of golfers gaining 30 yards from using their shafts, thousands upon thousands of golfers flocked to local pro shops to buy more distance for their games.

If 1973 could be considered the introductory year for graphite shaft, 1974 was the year the boom hit its peak. Due to a number of performance and quality-related factors, by late 1974 the shooting star of graphite shafts had begun to fizzle. A proliferation of low-quality graphite shaft making companies, many of whom put inferior products that either fractured or broke, was one reason for the quick demise of the shafts, while the other reason was related to the shaft's poor resistance to torque.

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While not nearly as weak as the fiberglass shafts in their ability to demonstrate torsional stability, graphite shafts of the early 1970's still lacked the necessary resistance to torque to be a completely playable shaft, especially when compared to steel. The majority of golfers who bought Drivers with graphite shafts found the clubs almost impossibly inconsistent with regard to shot accuracy. When the PGA Tour players rejected the shafts for the same lack of torque resistance reasons, the early demand for graphite shafts was effectively over. So fast was the demise that in a Golf Digest report published in 1980, Aldila admitted in 1976 that they had achieved on 30% of the sales level seen in 1974,

One other problem that turned the early graphite shafts into a "shooting star" phenomenon had to do with the manner in which the shafts were fit to golfers. By 1974, it had become an accepted fact that graphite shafts did not possess the same flex or stiffness feel as steel shafts of the same flex designation. In addition, because of the very light weight of the shafts, a general confusion over graphite-shafted golf club swingweight had surfaced.

During the early 1970's, many graphite shaft manufacturers did not take in account what effect the increased headweight would have on the flex of their designs. Having initially designed the stiffness to be essentially the same as steel shafts in the raw shaft form, after the shafts were installed into finished clubs, the increased headweight had the effect of softening the flex of the shafts. Within the first full year of graphite shaft distribution, shaft makers revised their original fitting recommendations and began to advise golfers to select graphite shafts one level of flex stiffer, and a swingweight one or two points higher than what had been customary with steel-shafted clubs.

Without a doubt, the motivation, which spawned the creation of the fiberglass shaft, was the shaft industry's desire to produce lighter weight shafts, which in turn would allow the use of heavier clubheads. While using fiber composites was certainly one way to achieve a drastic reduction in weight, in the late 1960's and 1970's the industry's shaft-formation technology was at best primitive and resulted in shafts with a number of negative side effects.

If the composite shafts represented the "hare" in the race to create lighter weight shafts, steel played the part of the "tortoise". Despite the fact that steel was inherently heavy, by the late 1960's shaft manufacturers had improved production techniques to the point that the formation of the thin-walled, lighter weight steel shafts became possible. True Temper's original Dyalite and the Ben Hogan Co.'s Apex (made by True Temper beginning in 1969) were both examples of how refined tube drawing techniques could allow a reduction of weight through the formation of thinner wall shafts. To make up for the drop off in strength caused by reducing wall thickness, both the Dyalite and the Apex were designed with slightly larger butt diameters. From the design changes, the Dyalite and Apex represented a net decrease of approximately 1/2 oz. in shaft weight, bringing steel shaft weight down to the 4.0 to 4.25 oz. ranges.

In the late 1970's, a few steel shaft manufacturers attempted to decrease shaft weight even more through the combined processes of further reducing wall thickness and increasing the shaft's diameter. The Ben Hogan Legend, a proprietary shaft first made by True Temper in 1978, as well as the True Temper's own Kinetic brand pattern were even 1/4 oz. lighter than any other previous lightweight steel shaft. However, to make up for the decrease in strength caused by the reduction in wall thickness, both designs were produced with an extra large .700" butt diameter. The enlarged butt diameter of these shafts, some .080" larger than any previous shaft, created the need for grips with a much larger core size. In turn, these thin-walled grips provided much less than a cushion to absorb the vibration at impact, and contributed to a harsh, dead feel of the shafts. While the Hogan Co. (with the Legend) and a few other manufacturers did use the shafts for a few years, the golf industry in general did not support the design. By the early 1980's, the large butt, lightweight shafts became a thing of the past.

Seeing the possible strength limitations in the diameter increase / wall thickness decrease type of design, combined with the clubmakers' rejection to the large core / thin grips required by such shafts, the shaft manufacturers began to realize the path to lighter weight steel shafts. First was through a decrease in wall thickness only in the low stress areas of the shaft. Secondly, through a decrease in the weight of the steel alloys from which the shafts were made. Following the later approach, in 1977 True Temper introduced the 3.45 oz. Superlite steel shaft, which made its appeal to golfers through its very light weight coupled with a return to more a conventional size butt diameter.

Drawing upon further developments in the production of lighter weight steel alloys, also in 1977 Union Hardware (now Royal Precision) employed a chrome vanadium steel alloy to make its 3.2 oz. model UCV-304 super lightweight shaft. The increased tensile strength of the chrome vanadium alloy over carbon steel allowed Union Hardware to make the UCV-304 with thinner walls and a conventional butt diameter. As a result, even though the Hogan Legend had “broken the ice”, the UCV-304 went on to become the prototype design for all very lightweight steel shafts which followed.

Standard Weight	Steel shafts weighing between 4.25 and 4.65 oz. (120 to 132 g)
Light	Steel shafts weighing between 3.9 and 4.2 oz. (110 to 119 g)
Very Light	Steel alloy and composite shafts weighing between 2.5 and 3.8 oz. (70 - 109 g)

By 1980, all shafts could be classified within three different groups, or “types”, the term most commonly used for expressing shaft weight classifications:

Within each group (type) could be found a host of different patterns and flexes, so the variety of different shafts from which golfers could choose was staggering. Up to this time, shaft fitting had focus primarily on just one specification - flex. Clearly, with the tremendous number of different shaft weights, shaft patterns and flexes, more information and better techniques for advising golfers to the correct fit was needed.

During the 1970’s, in addition to the development of different models of lightweight and very lightweight shafts, a wave of popularity in restoring older clubheads for modern use was beginning to grow. Followed by the lead of tournament professionals, thousands of golfers began to seek out old classic persimmon woods and sets of forged irons to be refurbished and put back in play with modern shafts and grips. Rare was the PGA Tour player who did not have a reshafted and refinished MacGregor, PowerBilt or other classic driver in his bag.

This classic club fad of the 1970’s generated a demand for club repair specialists to perform the work, which in turn created a market for tools and component supplies with which alterations on the old clubs could be made. Because the shaft was almost always replaced as part of the restoration, golfers again followed the lead of the Tour players, beginning to think of shaft selection more in terms of custom fitting. Instead of choosing a golf club and just accepting what the manufacturer had installed as their stock shaft, golfers began to look for shafts that fit their own individual needs. Thus, the classic club boom of the 1970’s, custom shaft fitting became a popular aspect of equipment selection.

Reacting to the move toward custom fitting, the shaft manufacturers began to offer more information about the shafts they produced. In addition to flex, now golfers began to hear more about bend point (pattern) and weight (type), and how their correct selection could bring about an improvement in shotmaking. Since each shaft manufacturer offered a wide range of flexes, types and patterns within the shafts it produced, guidelines were established for advising golfers of what the specification options would do for their game.

In addition, a few of the companies who offered the tools and shafts for the restoration work began to take an active role in dispensing information to assist in shaft fitting. “Golf Club Design, Fitting, Alteration and Repair”, a book written in 1974 by golf club specialist Ralph Maltby, began to gain somewhat of a cult following among club repairmen in the late 1970’s. Including extensive discussions of all the various specifications of golf clubs, the book became the most definitive work yet published about club fitting. Augmented by information from the shaft manufacturers, this book began to establish the traditional principles of shaft fitting; the idea of going beyond simply fitting for flex and establishing guidelines to fit each of the shaft specifications individually to the golfer.

Under these new principles of shaft fitting, flex was no longer recommended generically to the golfer in a “stiff for strong players, flexible for weaker players” type of approach. Charts matching clubhead speed and/or ball carry distance to flex became the primary tools for stiffness recommendation for the golfer. While this approach was far better than the strength judgments of the past, even the author realized its impression. During a 1977 roundtable discussion on shaft fitting sponsored by GOLF (USA) magazine, Maltby stated, “Clubhead speed (or) ball carry distance can get you ‘into the ballpark’ as far as flex is concerned, but the final determination has to be one of trial and error due to conflicting thoughts, (that is) some companies who preach stiff shafts, some

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(more) flexible (for the same player). Both could be right, so trial and error is necessary.”

Starting in the 1970's, shaft bend point, or what was called the pattern of the shaft, was said to be a factor that influenced shot trajectory. Three basic patterns with fitting descriptions were developed; low bend point (tip flexible/butt firm) for the less skilled golfer, mid bend point (tip medium/butt medium) for the average golfer, and high bend point (tip stiff/butt flexible) for the better player. The belief behind the principle lay in the premise that the better the player, the less help was needed to be the ball airborne. In addition, high speed photography research had shown that the better a player's swing - in particular, the more the golfer was able to hold the angle between the shaft and the arms prior to impact - the more stress was placed on the shaft tip. Hence, high bend point shafts were recommended to golfers with strong, solid fundamental golf swings, while other patterns were advised as swing fundamental ability diminished.

Shaft type, the term conceived to describe the various weight classifications of stand, light and very light shafts, was still fit to golfers in somewhat of a judgmental manner. Standard weight shafts were advised for strong, active golfers, lightweight shafts for average ability players and most ladies, and very lightweight shafts for seniors or people who had experienced a recent loss in distance.

While graphite shafts were beginning to make a slight comeback in the late 1970's, nothing was said about the time about torque as an additional parameter of proper shaft fitting. Golf equipment experts knew torque, or rather a lack of resistance to torque, had been a negative factor in the early composite shafts. Even though the graphite shaft companies that survived the late 1970's were doing their best to improve their shaft's ability to resist twisting during the swing, the shaft fitting principles paid no attention to torque. The general consensus among clubfitters was graphite shafts either had 'some' resistance to torque or 'no' resistance to torque, with little in-between.

Despite the attempts by Maltby and others of the time to upgrade shaft-fitting knowledge, their impact within the entire golf equipment industry, along with the popularity of reshaping, was limited at best. Major manufacturers of standard specification golf clubs controlled the industry and dominated almost 100% of the equipment sales market. Following the customary policy of product development, each company would select one or two different shaft patterns for its finished line of clubs and pre-build their clubs only to standard fitting specifications. As a result, what shaft fitting that was done for buyers of new clubs was simply a matter of fitting within one pattern and allowing for individual golfer needs through changes in flex only.

As shaft development moved into the 1980's, thanks to the pioneering efforts of Maltby and his followers to delineate the various shaft specifications into shaft fitting information, all shafts could be "pigeonholed" into nine descriptive fitting groups, each with its compliment of five basic flexes.

Standard Weight Shafts	Light Shafts	Very Lightweight Shafts
High Bend Point (L, A, R, S, X)	High Bend Point (L, A, R, S, X)	High Bend Point (L, A, R, S, X)
Mid Bend Point (L, A, R, S, X)	Mid Bend Point (L, A, R, S, X)	Mid Bend Point (L, A, R, S, X)
Low Bend Point (L, A, R, S, X)	Low Bend Point (L, A, R, S, X)	Low Bend Point (L, A, R, S, X)

Looking at each shaft specification individually gave the equipment industry a total of 45 possible shaft fitting variations from which to fill the needs of golfers. While there were some categories for which no shaft were made (due to limited market demand), by the mid-1980's at least 35 of the possible 45 shaft designs were represented by one or more actual shaft models!

For the first time, this form of pigeonholing shaft specifications by category gave clubmakers the opportunity to "definitively" compare one company's design to another. For example, it was now possible to use the categories to compare the True Temper Dynamic to a Brunswick UCV-304 and "know" the differences between the shafts. The Dynamic was a standard weight, high bend point design available in five different flexes, while the UCV-304 was a very lightweight, mid bend point shaft available in three flexes. By following the initial type of comparison with the newly developed shaft fitting principles, golfers could accurately fit with the proper shaft ... as long as the methods of measuring specifications of flex, weight and bend point were consistent among the manufacturers.

While shaft fitting in the early 1980's had become far more accurate than ever before, another problem began to surface, which was starting to affect the overall accuracy of the fitting. A flood of new shaft designs created the confusion in shaft selection. Beginning in the early 1980's, golfers experienced another tremendous boom in popularity. As the number of golfers and golf courses increase, so too did the number of companies engaged in the production of golf equipment. With the ever-increasing number of companies all competing for a share of the golf club market, more and more different designs of clubs and shafts began to appear. Due to the presence of several shaft manufacturing companies, each offering a whole array of designs, some of the previously described areas of shaft classifications became representative by 10 or more individual shaft designs! As if this weren't enough, the mid-1980s also saw the second coming of graphite, bringing with it not just a better product than previous composite shafts, but more confusion as well. Convinced that the path to better shaft design was through lightweight composite materials.

First, by gradually gaining access to higher quality fiber material, and second, through an increased understanding of how to change manufacturing techniques to improve torque resistance, the composite shaft makers began offering shafts with improved playability characteristics. Sheet wrapping layers of pre-preg graphite around a forming mandrel was the pre-eminent method of shaft production. Through experiments in realigning the pre-preg sheet of graphite/resin material around the forming mandrel, a solution to the torque resistance was discovered. In the early graphite shafts, to provide strength, all the layers were wrapped with the fiber aligned longitudinally on the mandrel. By altering the process and wrapping a number of the pre-preg sheets so the fibers lay at an angle on the mandrel, it was discovered that much greater resistance to twisting could be built into the shafts.

Yet, even with these technological innovations in composite shaft manufacturing, at first, no one seemed to pay any attention. Graphite shaft sales did begin to pick up in the late 1970's, but not significantly, and certainly not at the level that had been achieved in 1974 before the "crash". Despite the fact graphite shafts in the late 1970's were greatly improved over their precursors, it was as if the golf equipment industry was following the advice of the old adage, "fool me once, shame on you - fool me twice, shame on me".

In virtually any area of consumer products, nothing can combat popular opinion and form a reversal in attitude like a clever marketing strategy. In the early 1980's, Aldila's engineers designed a relatively inexpensive graphite shaft, which now can be described as one of promotional brilliance, the company's marketing staff named the Low Torque. Introduced in 1984, the Aldila Low Torque rode on the illusion of its name and triggered the second coming of graphite, immediately throwing golfers into a "high-tech" era of shaft development. Carrying a price in the range of \$20 for the shaft only, and said to possess "just" 4° of torque, clubmakers and golfers alike sought out the Aldila Low Torque as if all their prayers of greater distance, improved accuracy and affordability had finally been answered in one shaft. Almost overnight, thanks to the Low Torque, torque became the new "buzz" word of the golf equipment industry.

Because of the Low Torque from Aldila, shaft torque not only became an entity; it even acquired a measurable dimension. A question which can never be answered but poses an interesting thought is, why hadn't torque been measured and its dimension communicated to golfers before? Or, with torque now described in a quantitative measurement, what was the torque of other shafts, in particular steel? What had the torque been in the older, first generation graphite shafts? Amidst the frenzy and new interest in graphite shafts, nobody has asked the question "How many degrees is considered to be low?" There were a few graphite shafts of the late 1970's which had torque ratings in the area of 4° like the Low Torque, but they never hit the big time; was it just Aldila's Low Torque name that opened the floodgates?

What followed the introduction of the Low Torque was a mad dash on behalf of the graphite shaft manufacturers to try to find "how low could they go" in designing more torque resistance into their new composite designs. Huge rewards were at stake. Early experiments with graphite had shown golfers if they could stumble upon the right shaft, more distance could be possibly be achieved. Beginning to realize that decreasing torque could mean hitting more fairways, shaft makers began to tantalize players with visions of distance and accuracy together in the same shaft just by driving the torque lower and lower and lower.

Very soon, graphite shafts said to have as little as 2° of torque were introduced. Aldila's HM-40 shaft, perhaps the first truly low torque shaft designs, debuted in 1986 and quickly was seen in the Drivers of a number of significant touring professionals. Reacting to the use of the HM-40 among pros, thousands of golfers of all ability levels followed the "pied piper" and began to upgrade to Drivers that had been assembled with the HM-40 shaft.

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Unquestionable a shaft of “high-tech” design with its high price, high-strength fiber makeup and low torque, the HM-40 became the shaft that started to teach the industry what torque and the fitting of modern graphite shafts was all about. Tour players who used the HM-40 or other very low torque shafts had the luxury of being able to test hit a number of clubs with the shafts before making a choice. But the average golfer who paid \$150 for such a shaft “off the rack” did not have such an opportunity, nor did he have any idea what a very low torque dimension would do to the other specifications of the shaft. As a result, through 1987-88, many lesser ability golfers bought HM-40 shafted Drivers only to walk away from the experience with a bad impression of graphite in general.

Slowly, the golf industry began to discover that decreasing torque would have the effect of increasing the stiffness feel of a shaft. That decreasing torque in a shaft could improve accuracy was a fact; what wasn't known was how low any particular golfer could go before the performance results were disastrous. Compounding the problem was the cost of such mistakes. Lowering the torque of graphite shafts was expensive. The increased costs of production and the higher price of the higher strength fibers necessary to produce the low torque shafts made it a fact that by 1987 virtually all Drivers with graphite shafts of low torque carried a retail price of \$150 or more!

Although the first graphite shafts were made through the filament-winding process, in the middle and late 1980's, graphite shafts were made only through the process described as “sheet-wrapping”. One after another, layers of pre-preg (thin sheets of graphite fibers intermixed with resin) were wrapped over the forming mandrel. While these layers were compressed around the mandrel, as well as oven baked to blend the layers and materials together, allowing small air pockets (voids) to be created between the layers, which in turn, brought inconsistency in wall thickness of the shafts. Minute in nature, when present in the shaft, the voids and wall thickness variations could combine to create possible problems. A shaft produced to be an R-flex might not be an R-flex, or depending upon how the shaft was rotated into the final position during assembly in the golf club, might play stiffer or more flexible than its assigned flex designation.

From the rapid advancements in graphite shaft technology, coupled with the industry's ability to pinpoint torque dimension, perhaps the ultimate paradox had finally evolved; the greater the shaft industry's ability to conceive and create design variations, the more difficult it became to help golfers find the right shaft. With so many different shaft designs, clubmakers looked to the manufacturer's measurements of the various shaft specifications in an effort to make shaft-to-shaft comparisons. But what they discovered from studying each company's individual specification measurements made such definitive comparisons virtually impossible.

By the mid 1980's, flex, bend point, weight and torque were the shaft specifications most clubmakers wanted to use to guide their fitting. With this information, combined with the traditional fitting principles established in the late 1970's, the playing characteristics of golfers could be matched to particular specification options. For example, most clubmakers would point a 60-year old male golfer with an 80-mph Driver clubhead speed toward an A-flex, low bend point, lightweight shaft with approximately 4 - 5° of torque. Armed with this type of evaluation, the clubmaker would search the component clubmaking catalogs for such a product. If a shaft was found that matched the specifications, the club was assembled for the customer. If the exact specifications were not found in one shaft, the closest facsimile thereof was chosen. Of course, after the fitting, the golfer would walk to the tee and expect to hit the ball better. But unfortunately it did not work quite that well or quite that consistently.

Looking for an answer to explain the all too frequent inconsistencies of traditional shaft fitting, by the late 1980's many clubmakers began to realize that there wasn't so much the problem of the golfer evaluation as it was the depiction of the shaft's specifications. For pure shaft-to-shaft specification comparison, two things were required; one, quantitative parameters for each specification, and two, uniformity in how each of the specifications were measured. In the case of the shaft industry in the late 1980's, neither existed.

Torque and weight specifications that could be measured in quantitative form, but flex and bend point were not. For decades, flex has been expressed through a series of letter codes, with the exact determination of each level of stiffness left quantitatively undefined. Worse yet, bend point was defined in generic terms of high, mid and low, again with no real standard of definition. Were all R-flex shafts the same in stiffness? Where all high bend points located at the same place on the shaft? Clubmaker's for years had assumed such was the case, but was it?

To compound the problem of accurate shaft-to-shaft comparison, it was also discovered that the means of determining one of the two quantitative specifications - torque - was not uniform. The shaft makers used several different ways to define a torque value. One company's rating of 3° was not the same as another producer's 3° measurement. In truth, the only true comparable shaft specification was weight, and weight alone was not enough to help golfers choose the right shafts for their game.

Thus in the early 1990's, the stage had been set. In the minds of an ever-increasing number of clubmakers, a demand had been created for pure comparative information, which could be used to form definitive conclusions and methods for matching golfers with the right type of shaft.

Editor's Note:

Since the original publication came out in 1992, in the eight years ensuing, several historical developments occurred in the shafts industry.

1. In 1995, with the release of the Royal Precision Rifle, there was a rebirth of the stepless step shaft. Following suit, Apollo debuted the "Original" and True Temper introduced the "Rocket". Despite the fact step forming was developed to increase the consistency in wall thickness and allow for a lower reject rate in production, new forming techniques allowed the manufacturers to make stepless designs with the same consistency as stepped designs.
2. Raw length steel shafts finally broke the 100-gram barrier, most notably with the Royal Precision UCV-2000. Sub-70 gram graphite shafts were not only relegated to lady and senior flex shafts, but were made for stronger golfers as well. Newer materials from the aerospace industry enabled the manufacturers to create shafts much lighter, that could be produced in very strong flexes for the hardest hitting players. As of this publication, graphite shafts have finally broken the 40-gram barrier.
3. The decade of the 1990's saw the passing of two materials used in the golf shaft industry - aluminum and fiberglass. Easton, maker of aluminum sporting goods equipment, ceased operation of their golf line to concentrate on their core business, such as bicycle frames and baseball bats. Today, aluminum shafts are used only in the industry for putter shafts. Fiber-Speed, makers of the very flexible fiberglass shafts, departed the golf industry with hardly any notice. Fiberglass material is still used, but as an additive in low cost composite shafts or in junior shafts.
4. Tip heavy graphite shafts were introduced to create normal swingweights with standard weight heads and standard assembly lengths. As a result of a trend started by G. Loomis, clubmakers no longer needed to use heads cast to a heavier weight or the use of longer length clubs to maintain normal swingweights. More material was designed in the tip region of these shafts, thus shifting the balance point closer to the tip.
5. In just the complete opposite trend as the tip heavy graphite shafts, graphite shafts were manufactured with much larger butt ends (primarily .865"). With the use of very thin-walled grips (or in some cases no grips at all), the lack of a counter-balance made the clubs feel more "head heavy". It was not uncommon that a club assembled with one of these larger butt end shafts, would have a swingweight in the upper D or low E swingweight range. The graphite was a natural dampener of vibration, thus the thinner walled grips did not produce the very harsh feel as the larger butt steel shafts from the late 1970's.
6. The term "dampening" became a fitting consideration in the 1990's. Although, aluminum, titanium and graphite shafts are excellent dampeners of vibration, steel shaft manufacturers made inroads to shock dampening. At first, heavy graphite (or the term Tour Weight) was introduced to the golf industry in the mid 90's to reduce shock for golfers who suffered hand, wrist or joint stress. Mimicking the stiffness and weight of steel for control, the thicker walls of the graphite, dampened the shock at impact. The Rifle shaft, with its stepless design internal ribs during production, was the first steel shaft to state the benefits of vibration dampening. In 1996, True Temper debuted the "Stratus", a lightweight steel shaft with an insert inside the shaft that filtered vibration before it reached the golfer's hands. This insert was named the SensiCore.
7. The 1990's could also be designated as the decade of the geometric shaft. Repeating what happened in the 1930's with steel shafts, graphite shafts were produced with "bubbles", "humps", "bulges", octagonal shapes, etc., in an effort to control the bending profile or weight distribution of the shaft, or at least create a great marketing story.

What will be the future of the golf shaft is hard to predict. However, if there is one lesson we have learned is history does repeat itself.