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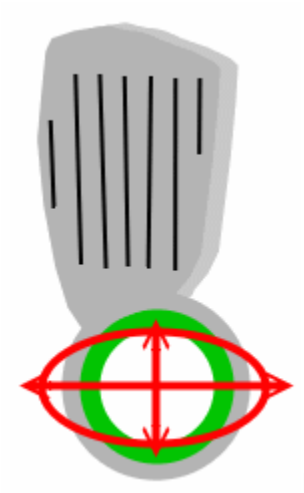
All About Spines

15-19 minutes

Why do we care about what a spine is and where it lies? Because a big enough spine has been shown to adversely affect the shot (performance and/or feel). Most of that evidence is anecdotal. If it weren't for the sheer overwhelming amount of anecdotal evidence, it might be worth ignoring. There is no doubt that *something* is going on -- but what, why, and how much?

What is spine alignment?

Before we get into the why of spine alignment, let's quickly review the what.

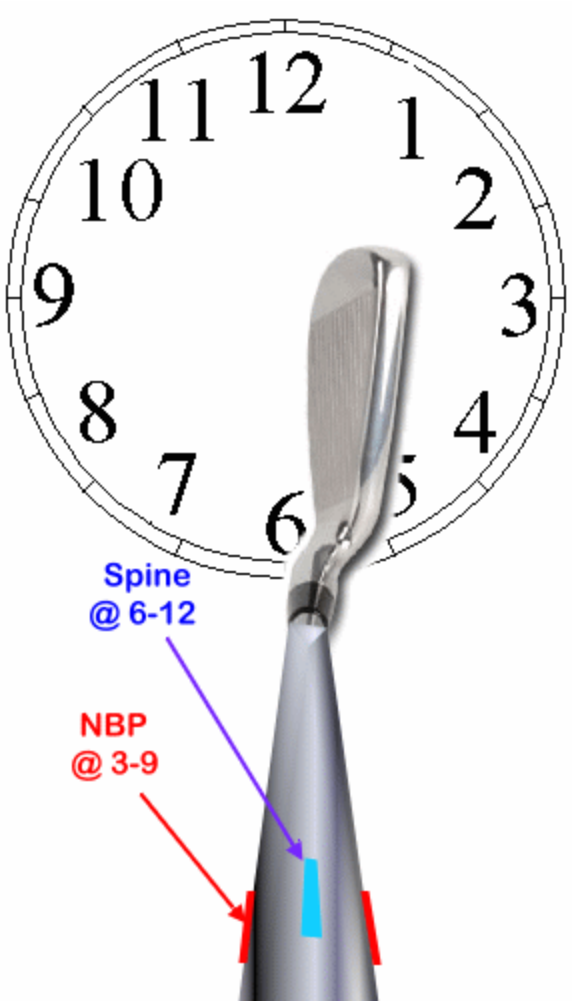


Remember that elliptical stiffness graph as we go around the shaft? The one where the major axis is the spine and the minor axis is the NBP? When we epoxy the shaft in the

clubhead, it might matter how we orient that ellipse.

In fact, there is quite a bit of evidence that it does matter, at least if the size of the spine is big enough. But there is still a lot that isn't known -- or at least not universally agreed -- such as:

- What is the best way to orient the shaft?
- How big does the spine have to be to make it worth orienting the shaft?
- Why does orienting the shaft help? (John's original question that started this discussion.)



When clubmakers talk about spine alignment, they often describe a specific alignment using the metaphor of a clock face. When describing an alignment, the

spine or NBP is at some "o'clock". For instance, the alignment in the picture shown could be described as "spine in the 6-12 plane" or "NBP in the 9-3 plane".
You sometimes see recommendations like "NBP to 9 o'clock for accuracy and 3 o'clock for distance." (I have actually seen that one.) Such a prescription is clearly nonsense based on a mistaken notion from feel finders -- the notion that you can have an NBP facing 9 o'clock without also having an NBP facing 3 o'clock.

But wait! Maybe there is something there. Remember that feel finders measure an unspecified mix of spine and residual bend. What if residual bend is also performance-affecting. Well, it's not! John Kaufman has done that test, which is described below.

Anyway, in the discussion that follows, we will describe alignment in terms of the clock face.

Studies of effectiveness of spine alignment

There is a lot of anecdotal evidence that large spines do something to performance or feel, but very few scientific studies -- even semi-serious studies -- to confirm or shed more light on spine effect. I will cover what I know about the studies I know, and even mention the more significant anecdotal evidence.

SST and Butler

In the late 1990s, Howard Butler conducted a study funded by SST that demonstrated that PUREd drivers hit the ball better than non-aligned drivers. At the time Butler was a consultant,

having left his former position as R&D chief of TrueTemper. Dick Weiss, the head of SST, was trying to spread the gospel of spine alignment -- in particular, trying to get the USGA to recognize spine alignment as legal. So SST was a lot more open and forthcoming about the study than most golf companies (including SST) are today about their technology findings. They published some details of the study on their web site. (It has long since been removed.) At the time, I took the opportunity to analyze mathematically some of their experimental results.

The study was conducted with real, live golfers hitting drivers. I don't know how many golfers nor how many drivers were actually used, but results were presented for three golfers using three drivers. Here is what they did:

- The golfers were a low-handicap, a mid-handicap, and a high-handicap. (I have lost my notes, but I recall that the handicaps were something like scratch, twelve, and twenty.)
- The three drivers were identified by number. They were not #1, 2, 3. Rather, they were something like #2, 3, 6. I know the highest number was #6. This leads me to suspect that there were at least six driver used in the study, and SST chose to present the three that they did. I can imagine why; I'm sure you can, too. That casts some suspicion on the results, but let's continue with the analysis as if it didn't -- mostly because there is so little good data around.
- Each golfer hit with each driver, first oriented in an unidentified position (might have been "random", but was more likely a known or suspected worst-case orientation), then re-oriented to a "PURED" location. At the time, SST was fairly open that PURED

meant oriented with the FLO-found spine oriented in the 9-3 plane. (They are more secretive about their strategy now, or at least they use words not congruent with the terminology common among custom clubmakers. They are clearly trying to establish a product differentiation, now that almost everybody can do some sort of spine alignment.)

- Each golfer made enough hits with each driver in each alignment so that there was a statistical distribution of results. That probably amounted to 6-12 hits apiece, but I don't remember the exact number. The data was presented as 18 distributions (3 golfers times three drivers times two alignments). The distributions included:
- Distance.
- Directional dispersion of the shot.
- Impact point on clubface, both horizontally and vertically.

The results I noted include:

- The impact pattern on the clubface was measured. There was a statistically significant increase in the size of the pattern if the shaft was not aligned.
- The distance differences among the clubs are more or less consistent with the differences in impact-point dispersion. I determined that by the following mathematical procedure:
- I took the mean and standard deviation of the measured impact-point distribution, and assumed the distribution to be Gaussian (classical bell curve).
- I applied this to a curve that equated loss-of-distance to the

square of the impact point "miss". (The miss is the distance between the actual impact point and the sweet spot.) Interestingly, that formula comes from a 1993 article in Clubmaker magazine, written by the same Howard Butler.

- The loss of distance measured when the shaft was realigned is what would be predicted by the measured increase of impact dispersion on the clubface.
- The size of spine was not reported. This is significant in that it stands to reason that a bigger spine in a shaft implies a bigger premium associated with aligning the shaft. (This is true under any of the theories of why spine alignment helps.) Conversely, if the spine is small enough, it isn't worth aligning the shaft; there is nothing measurable to be gained. And nobody has yet done any experimental study to determine the dependence on the size of spine, nor the point at which alignment doesn't help.

Mike Dalecki

Mike Dalecki is a custom clubmaker from Wisconsin. Here's what he reported to me in an email in April 2001:

> *RE: Spines. (I don't like that name; better would be something like "assymetries in shaft performance.")*
> *Anyway, I've been testing this idea, starting out with simply trying to demonstrate there's an effect. I made up 3 clubs w/ identical shafts and heads, although the heads ended up being equalized by lead powder in weight ports. One is spine aligned, 12:00 position, FLO; the others are 9:00 and 4:30, neither FLO.*
>
> *I sent them to an RSG friend in Virginia to test, w/o telling him which was which (the closest I could get to blind testing). His*

> *results: The 12:00FLO club is the best one; the 9:00 club is ok, but wild from time to time; the 4:30 club felt "wimpy." This after 20-30 shots with each, hitting 4-5 balls w/ one then switching to another.*
>
> *Anecdotal? Sure. Evidence? Enough to keep me interested in the idea. The guy who hit them is an engineer; he was greatly skeptical about spines' effects. He's not as skeptical any more, although he can't figure out why it should matter that much. (Join the club, eh?)*

Turns out that Mike's friend from Virginia is also a clubmaker I know, Kenny Stultz. I have a bunch more information about that test from Kenny. Mike's email is a fair summary of the results, but here are a few additional points worth mentioning:

- The tests were conducted not just by the aforementioned golfer hitting balls, but six golfers (including Kenny and his wife).
- The tests were conducted double-blind. That is, Kenny administered the tests without knowing which were "supposed" to be good. For the tests, he gave the clubs neutral labels: Paul, Geoge, John, then relabeled Larry, Moe, Curly for re-tests.
- Mike did not measure how "big" the spines were, so we don't know how big they need to be to produce these results. Moreover, we don't know if the spines were comparable on the three drivers.

  Anecdotal, yes. But so much better than almost all the other data around that I choose to view it as a "study".

Tim Hewitt

Tim Hewitt is the proprietor of MyOstrich golf, which does clubfitting and repair as well as retailing of components to othe clubfitters. In January 2009, Tim posted to SpineTalk the following report on a study that he has had ongoing for several years:

> *N/FLO to target is the most stable alignment we've seen in testing. We set up three otherwise identical drivers on three shafts with nearly 10 cpm spines to exaggerate the problem. N/FLO to target was the most stable of the three for all handicap levels - resulting in the best center face contact for the three alignments we tested.*
> *We tested N/FLO to target, S to target and N at 45* to target. Though not an exhaustive test, it was within budget and justified what we had been doing for years as a very stable alignment.*
>
> *There are certainly other opinions on the subject, but I do not know of anyone else who has has nearly 1000 golfers hit their test clubs and recorded the results. We use demo days and the chance to win a driver in a drawing as avenues to run double-blind tests on real golfers. Though not exhaustive, and generally only confirmation testing - it's the best I've seen on the subject.*
>
> *We ignore where the "strong side" ends up in favor of N/FLO to target.*

Studies with unavailable data

Phil Talamonti and Advanced Shaft Dynamics
Advanced Shaft Dynamics (a company started by Phil Talamonti

when he left SST) conducted a test to see what the value of spine alignment was to a robot golfer. No details of the test were ever made public.
(I am unable to find recent information on ASD, and their old web site no longer works. I assume they are out of business.)

Harrison Robot Spine Test
Harrison Sports commissioned a team to determine, through robot testing at GolfLabs in San Diego, how large a spine had to be in order to make a difference in performance. Mike Cheng (the president of Harrison) asked me to head the team. Though we did a lot of discussion and preparation, much of it with public participation, the actual testing never got done. There were several reasons for this, but the major problem was that I'm not nearly as good a manager as an engineer and I didn't cope well with the management part of the job. I'd like to thank the team for its work, especially Alan Brooks and Don Johnson.

Anecdotal evidence

True, I generally don't pay much attention to anecdotal data. But there is a lot of it out there about spine alignment. Some of the themes repeat often enough that they are probably true. Let's remember, though -- this is a scientifically unreliable way to draw conclusions, so we'll be careful in the "theory" section about how dependent we are on these points.
First let's address the various proposed alignments:

- The majority of independent clubmakers advocate the NBP in the 9-3 plane. A lot of this data is unfortunately based on NBP determined by feel-finding, so it might not be correct. But there

are also quite a few such opinions based on FLO.

- I have also seen recommendations orienting the spine in the 6-12 plane. That is actually the same prescription as the previous one, given what we now know about the mechanics of spine.
- A significant minority prefer the spine in the 9-3 plane. This is also the original SST recommendation.
- There are no serious recommendations for any other orientations, even though at least one anecdotal test came out with a 10:30-4:30 orientation winning for some golfers. The vast majority view 10:30-4:30 or 7:30-1:30 as worst-case alignments.

In any event, here are some other pieces of anecdotal common wisdom about spines:

- Alignment does affect performance and/or feel, as long as the spine is big enough.
- We still don't know how big spine has to be to affect shots. The threshold is probably between 3cpm and 7cpm, based on reported anecdotal experience from clubmakers on web forums. There is some analytical support for this estimate. But there are also "outliers". Some are people who report very sensitive golfers who could tell a 2cpm difference. Others report that anything under 10-12cpm of spine makes no difference.
- There are anecdotal advocates of "supershafts": shafts with very large spines which, when aligned, give better performance than a shaft with little or no spine. Harry Schiestel has on occasion hinted that he has done a study on supershafts, but has declined to give any details. Until I see strong data supporting it, I'm a skeptic.

What about residual bend?

Some are unwilling to abandon the easily-understood and easily-used feel finder. When I run across such diehards, their rationale is often that the combination it finds of actual spine plus residual bend are really what should be aligned. In order for that to be true, residual bend by itself would have to affect performance or feel, and in the same amount (as measured by a spine finder) as actual spine. Their rationale is a testable theory. Does it hold water?

There have been some studies of the alignment effects of residual bend alone. I know of some that show no effect, and none that show there is an effect. John Kaufman has done two significant studies in this regard, summarized here in his own words (reported in email to the SpineTalk Forum in 2005-2006):

(1) Residual bend does not affect the FLO plane.

> *I wrote a paper for the PCS Journal some years ago in which I tried to see if residual bend effected FLO, among ohter things. I took a 1/2" aluminum rod and machined a hunk off the side of the rod down most of its length. I think it had a diff. frequency of about 30cpm after the surgury. Nearly zero before. I found the FLO planes very carefully and then bent the rod about an inch. I was careful to be sure the bend wasn't in the FLO planes I had just found. I re-FLO'd and got the same planes. Therefore I don't think modest bends have any effect on FLO.*

(2) Residual bend does not affect the golfer's shot nor feel.

> *Some years ago I got interested in this residual bend issue and ran a little experiment. I picked up 4 DG S300 steel shafts that all*

> *measured the same frequency with no significant differential frequency. They FLO'd everywhere. They all had significant residual bends however. I build four identical drivers with the bends in the four shafts pointed at 12, 3, 6 and 9 o'clock. I had a number of low handicapers and a few pros hit them. Nobody could detect any difference bewteen the four clubs. I stopped worrying about type 1 shafts.*
> *I ran a similar experiment with shafts that had an 8cpm differential variations. It was easy to tell the difference in the alignment. N1-N2 in the 9:00 3:00 plane worked the best for me.*
>
> *I admit it was a pretty small test but the results seemed pretty significant to me.*

Let me add that John has said elsewhere that the shafts used for the straightness test all had residual bends of 1/4", which is pretty hefty.
So the feel finder defenders are in denial, if they insist that the shaft should be aligned per the feel finder results. The feel finder can have valid uses, as long as one recognizes that it only gives the spine for alignment in relatively few cases. Those cases are instances of a strong Type 2 shaft, where the spine is large enough and residual bend small enough that the spines are opposed, the NBPs are opposed, and they are at 90º to one another.

Now we have enough background to move on to John K's question: What are we hoping to do by aligning the shaft to the club?

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