UNIBOFFIN BLOG – APRIL 2019

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#TheWinningDouble

7 Moments to Ponder

You may be relieved to hear that there are only a couple of blogs left in this refresher course on dart flight dynamics, so let's make a dash for the finish line and dive straight in where blog number 6 left off, with how the weight of shafts and flights, light though that may be, still greatly affects the (transverse) Moment of Inertia, MI or just I, of a dart and hence its in-flight behaviour.

As we saw in blog 6, MI is in effect the equivalent of mass for rotational motion. It can be calculated by dividing a body up into tiny sections and multiplying the mass of each section by the square of its distance from the body's centre of gravity (CG). If you do that for a thin solid cylinder, which will do as an idealised approximation of a pencil-shaped dart barrel, the answer happens to come out (sorry to hit you with a bit of maths!) as the mass times the length squared divided by 12. Hence a 20gm 50mm long barrel would have an MI of the order of 20x50x50/12 = 4167gm.mm2.

Now let's consider a flight weighing, say, 0.6gms. On its own its MI value would be tiny, but when fitted to a dart it's a long way from the overall CG, around half the length of the barrel plus the length of the shaft plus just under half its own length. That could add up to as much as 90mm. Squaring that and multiplying by 0.6gms gives 4860gm.mm2 – more than the barrel itself.

That's a slightly exaggerated example, but I reckon most dart players would still find it surprising. Without such calculations it's certainly not obvious that using, for example, 0.1gm heavier flights could affect the in-flight yawing ("fish-tailing") motion of a dart more than adding 3gm to the weight of the barrel. So what does that mean in practice?

Well, apart from emphasising that lightness is an important quality in flights (hmm, where did I put my old feathered canes?) it means, for example, fitting a longer shaft to increase the stability of a dart could have almost the opposite effect. As mentioned last time, although longer shafts do generally increase the static margin (the distance between the CG and the CP, the Centre of Pressure of the aerodynamic stabilising forces) and hence that particular technical measure of a dart's stability, in practical terms they may still cause it to correct more slowly in flight. If that can be true for comparatively light plastic shafts (as is indeed shown on the next page), it will be even more the case for heavier aluminium shafts with their much higher values for MI.

That said, it's worth mentioning that all longer shafts do tend to increase a dart's "dynamic stability", which governs how far it takes any yawing angle to damp out, say by a half (it's not just radioactivity that has a half-life, yaw can too). A typical yaw half-life for a dart is around 3m, but the effects of any variation can be hard to notice, especially as it's only 2m or so to the board.

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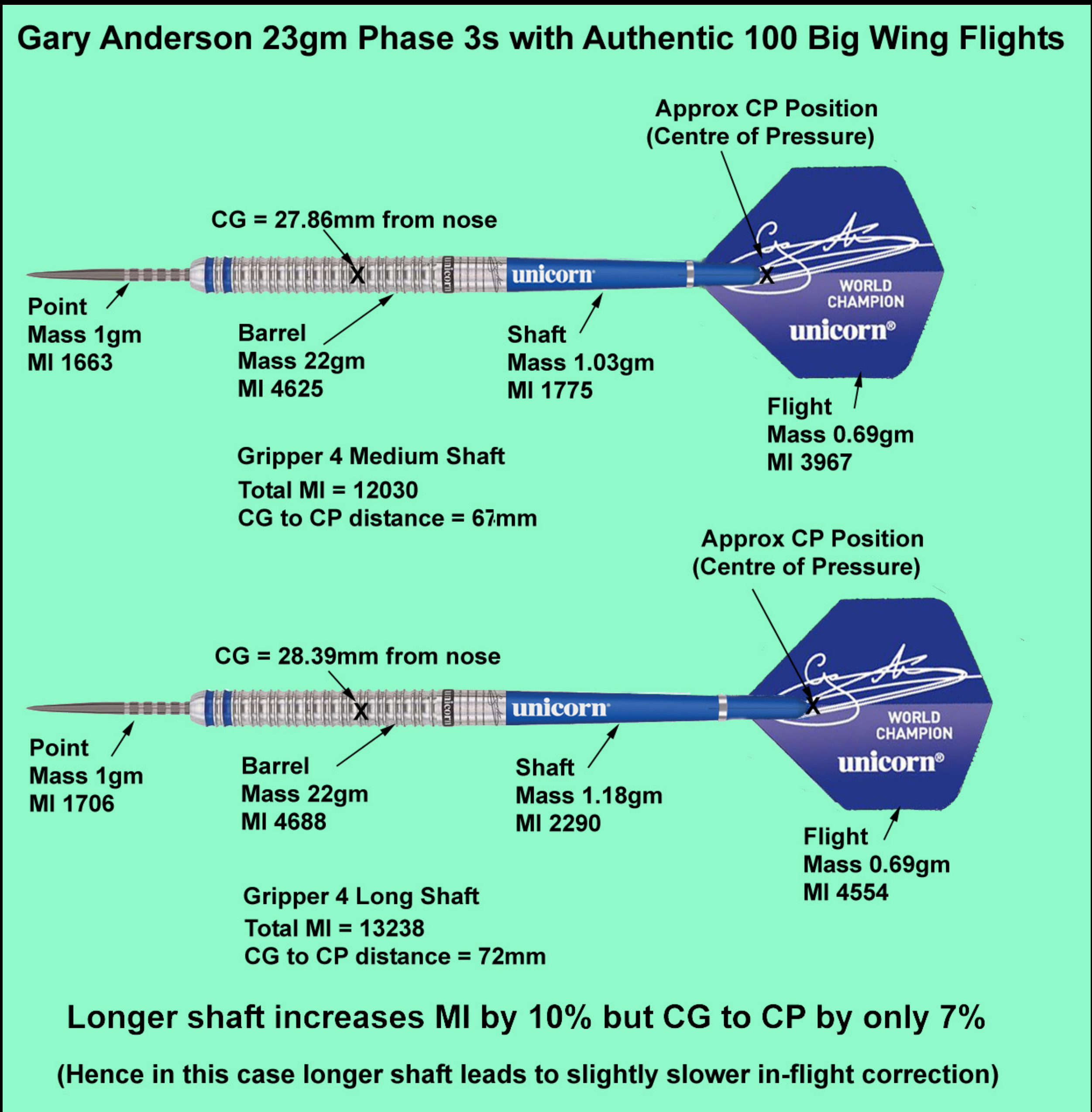
Back on the topic of static stability, below is a graphic showing how changing from medium to long Gripper 4 polycarbonate shafts on a Gary Anderson World Champ Phase 3 dart (note neither set-up shown is as sold) increases the dart's MI more than it increases its static margin, thus causing it to correct more slowly in flight. The effect isn't much, probably not even noticeable in practice, but it does show once again how dart aerodynamics can sometimes disobey what might seem like common-sense rules. And with that thought, I'll leave you with some moments to ponder!



PS: Found them!
Hope to see you again next time!