

Why and How We Continue to Make Our Own Throwing Knives

After months of throwing commercially made knives, adjusting for different balance points, weights, form factors, etc., we decided to design and make our own knives based on our throwing styles and experiences. To this end, we developed a detailed spreadsheet for accurate determination of proper dimensions, weight and balance. We then set about to establish design goals based on our experience—good and bad—with commercially available knives. I prefer to make a knife that fits my style rather than change my style to fit the knife. The following are some of our design criteria and comments, refined as we continue to throw:

- **No ear damage and angry neighbors.** While throwing commercially made knives, we observed that weight alone was not the reason for ear shattering ringing on bad throws. We determined that the weight to length ratio is a major factor. We found that a minimum weight to length ratio of 25 grams/inch does the trick. Our Neon green powder coat dampens ringing and also, glows brightly when hit with UV light.
- **Material:** O1 tool steel and 5160 spring steel, so far. We evaluated S7 due to the hype over its supposed toughness, but found that O1 tool steel is tougher when heat treated at HRC 51 ± 1 (good range for a throwing knife) than S7 at any hardness. We wrote a paper to address the issue of toughness comparison of tool steels.
- **Thickness:** min. 0.25" and max. 0.375". We have since decided on an upper limit of 0.312".
- **Length:** $10.5" \pm 0.5"$. We have made larger and smaller knives, but this is our the normal size range.
- **Weight:** min. 250 grams (10" knives) and max. 305 grams and > 25 grams/inch for reduced ringing.
- **Establish proper balance for our two basic styles of instinctive knife throwing.** Although experts can throw a fork (Tom-Tom) and make it stick, we aren't even close. Over time we've determined from testing that meeting two criteria made our knives feel and perform better for us. The combination of the following two balance point references allows us to pick up any of our knives, no matter weight, length, thickness or design (Standard vs. Offset) and throw consistently with little or no adjustment to our styles.
 1. A balance point no lower than 38% and no higher than 40% provides what we believe is the best balance range for no spin throwing. We find that $39\% \pm 0.5\%$ works best for us.
 2. A balance point located approximately one (1) inch behind the handle/blade interface provides the best feel for us. All of our knife designs are now within $\pm 0.2"$ of this requirement.
- **Robust tip that still provides great penetration.** This required several considerations:
 1. Tip angle of 16° for deep penetration (originally 20°).
 2. Two offset (asymmetrical) 20° tip bevels with a 3° taper, to increase tip strength without reducing penetration. All other throwing knives that we've seen use symmetrical two or four-bevel tips.
 3. HRC of 51 ± 1 for O1 tool steel and 5160 spring steel. We continue to perform destructive testing (hitting other knives, unintentionally) to observe the effect of different levels of hardness on tip performance—bending vs. chipping. We found O1 tool steel to be extremely tough at this hardness.
 4. Broad ($\sim 0.100"$), rounded and polished tip instead of narrow or blunt. The broad tip increases tip strength. Rounding and polishing the broad point reduces the effect of hard surface (another knife, sticking slightly sideways) impact. We learned this one the hard way, chipping a bit of each extremely pointy tip when striking other knives that stick sideways.
- **Other considerations:**
 - ◆ Beveled handle to reduce probability of impact on handle from successive throws at the same target, when not sticking sideways. Also, on a really bad throw the handle will stick—embarrassing!
 - ◆ Distinct blade/handle interface for consistent acquisition for finger placement on the knife spine instead of having to find the balance point for proper finger placement.
 - ◆ We now use an electric furnace, instead of the original gas forge. This allows for heat treating of the entire knife, instead of just the blade. My paper on electric vs. gas addresses other issues we had with gas, but we also eliminated torn fingers caused by burs from tip-to-handle impacts.

Knife Making Spreadsheet: Inputs and Outputs

Example: My New Heavy Darts

Sweep angle =	8 degrees	.140 Radians
Tip taper =	8 degrees	.140 Radians

Metal Thickness =	0.312 inches
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New 10.35" knife design: "The Heavy Dart"						
	In inches					
	Length or dia	Thickness	Width	Cubic inches	Weight (oz)	Wgt (gms)
handle	5.050	0.312	1.200	1.89	5.191	244.4
blade	5.300	0.312	0.68	1.12	5.191	145.4
				0.00	0.000	0.0
				0.00	0.000	0.0
Total length	10.350			Total	13.921	389.8
Minus the following						
Tip taper	2.419	0.31 inches	0.34	0.26	1.185	33.18
Handle sweep	1.85	0.31 inches	0.260	0.15	0.693	19.40
Round end	1.2	0.31 inches		0.048208157	0.223	6.23
handle wedge				Measured	0.33	9.24
Tip bevel*				Measured	0.51	14.28
Handle hole	0.312	0.31 inches		0.023853585	0.110	3.08
				expected knife wgt	10.870	304.36

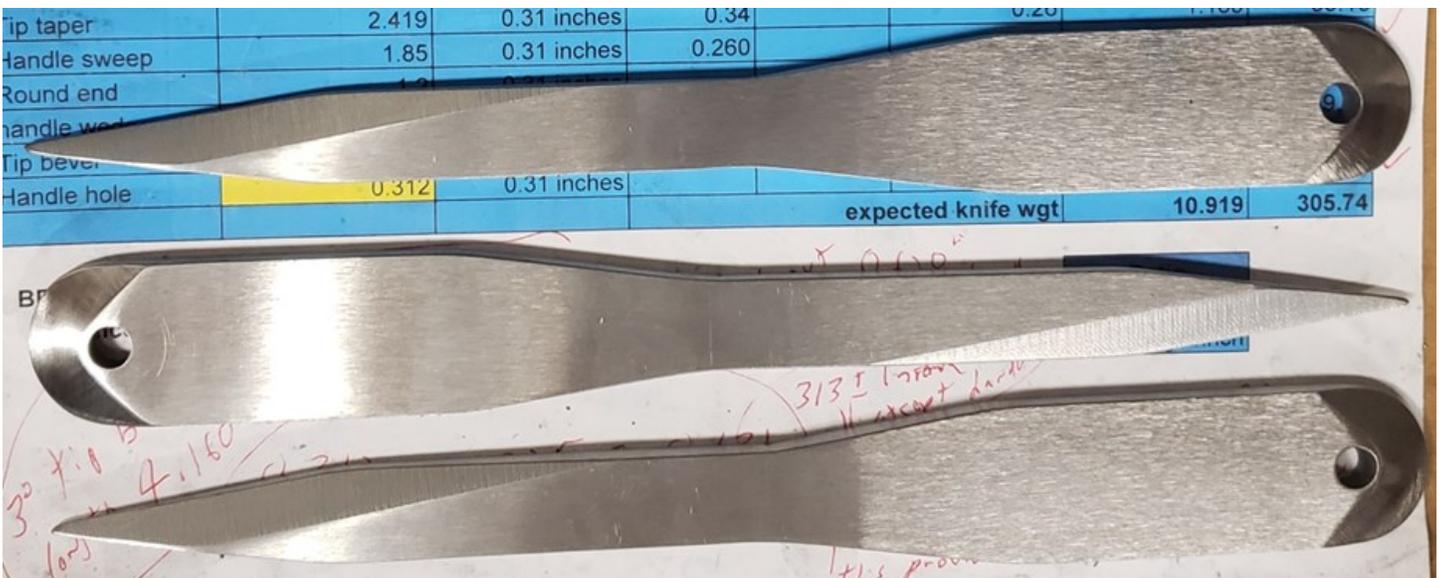
As built spreadsheet: Blunting and rounding reduced length by 0.050" and weight by 2 grams from original design.

Key Parameters	
BP dist to blade:	1.04 inches
Balance Point:	38.72%
BP to end of handle:	4.008 inches

Ratio
1.050 oz/inch
29.4 gm/inch

Inputs are the Yellow cells. All others are outputs.

My new Heavy Darts, ready for heat treat, powder coat and abuse!



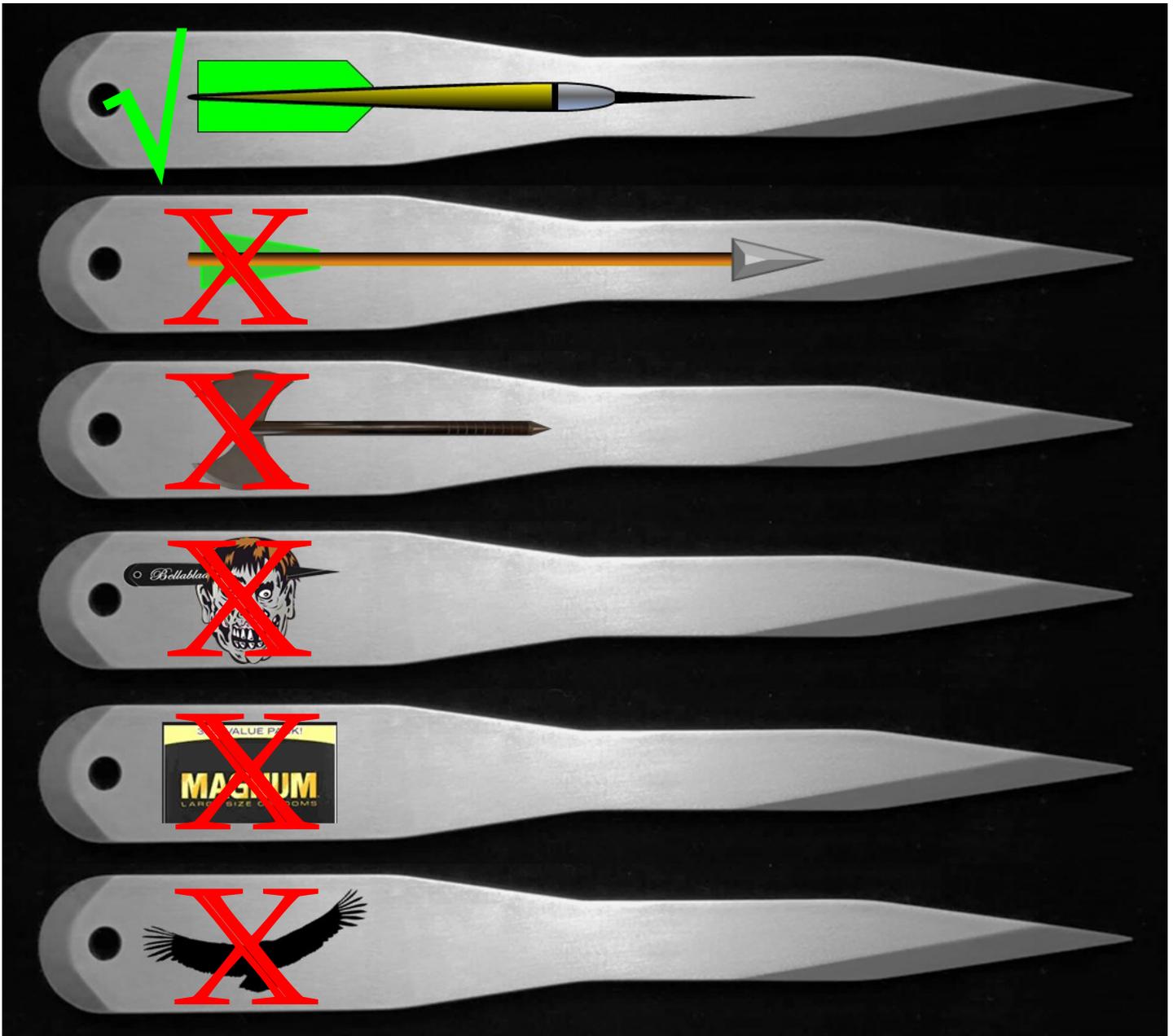
Early Efforts (1)



Improved Dart (3rd Gen Improved Dart shown):

- Original Dart was the second knife style we made—this is the improved version
- BP = 39.1% (1.15" from Handle/Blade interface)
- Length = 10.4"
- Weight 9.49 oz. (266 grams)
- 16° tip (same as Original Dart)
- Thickness = 0.250"
- Improvements—Beveled handle, longer tip bevel taper (3°) and broad (0.100"), rounded and polished tip.
- This is the one that I use and it's the one we sell as a Standard Dart.

Why Do We Call Them Darts? Why Do They Call Them Arrows?



What's in a name?

Some categories of knife names that I have seen:

Descriptive—Conceptually similar in shape to another object that is not a knife.

Examples: Dart (Oh yeah, I see it now!), Arrow (I hear good things about these.), Axe (No, I don't get it.)

Symbolic—Conjures an image of strength, power, size, performance, etc.

Examples: Zombie Killer (Makes sense!), Magnum (Could also represent protection!), Condor (Could also represent carrion eater or endangered?), Sure Balance (Obviously well balanced!)

Knife Style—Bowie, Dagger, Spike, Tanto, Kukri, etc. Makes the most sense to me!

Examples: What I just called them!

So, it's a Dart!

A Brief History of Our Improved Darts

Dart: Dec 16, 2016*



*The date when photo was taken.

The reason for calling them “Improved” was the rear bevel. It did fit the hand nicely, but its main function was to reduce the probability of an impact on the back of the handle from another knife. The one above was the first attempt at improvement. The primary variable over time has been the tip bevel taper. The 5° tip taper was also used on all of our previous knives, as well.

Dart: Feb 28, 2017*



*The date when photo was taken.

In order to further improve penetration, we tried a 4° tip bevel taper, shown above. We made several of these before testing a 3° tip bevel taper. We still prefer 4° for our thicker knives. These were also the first knives to be heat treated in our electric furnace.

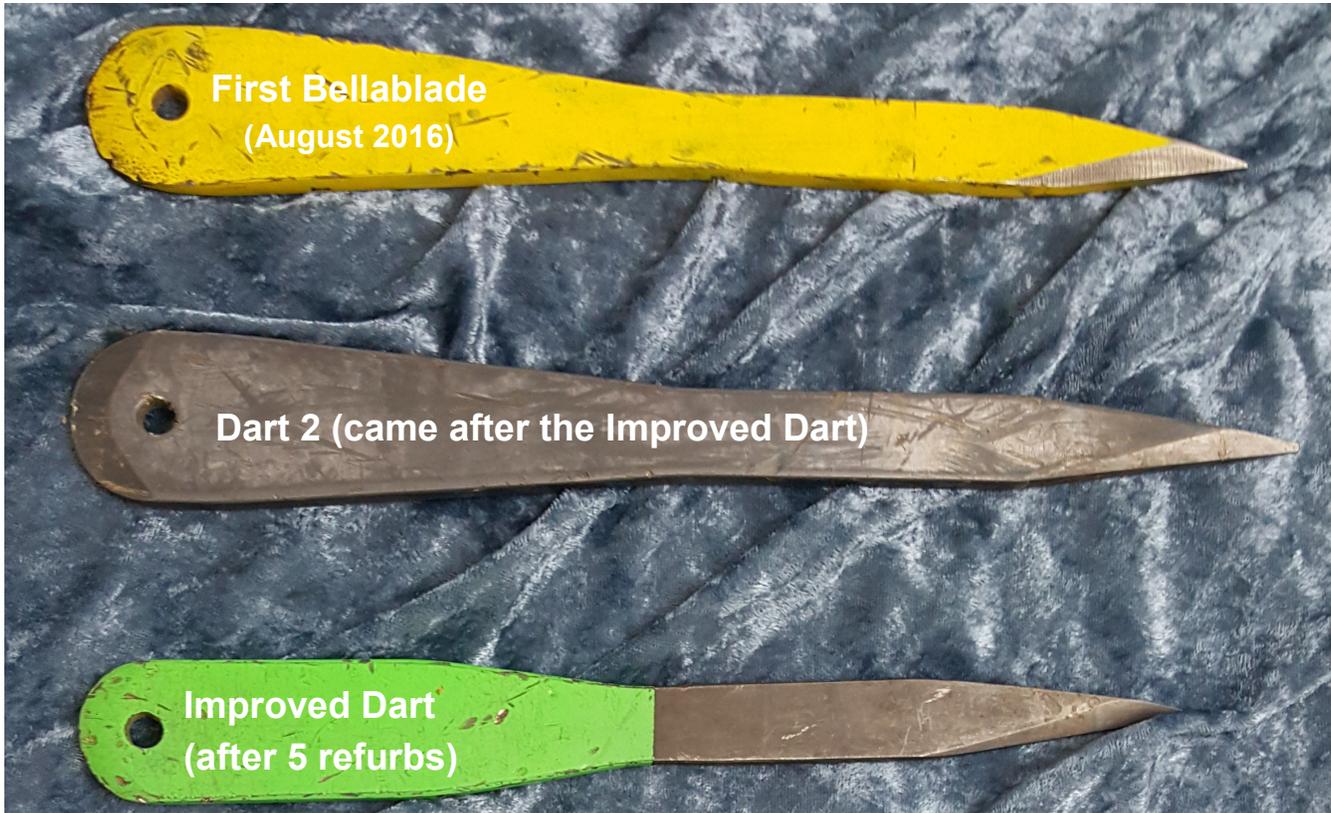
Dart: Aug 11, 2018*



*The date when photo was taken.

Experimenting over time, we settled on a 3° tip bevel taper (shown above) for all of our 0.25” thick Darts. These are the Standard Darts that we decided to offer first. No matter which generation or size of dart, they all have the same balance point: 39% ± <1%. They also have a broad, rounded and polished tip for extra strength.

Early Efforts (2)



First Bellablade:

- BP = 39.8% (0.73" from Handle/Blade interface)
- Length = 10.5"
- Weight 10.95 oz. (306 grams)
- 20° tip (1st asymmetrical tip)
- Thickness = 0.281"

Comments:

- Feels good in the hand, but handle/blade not distinct enough.
- Just over 1 oz. per inch—a tad on the heavy side.
- Feels good for any type of instinctive throw. Still in use.
- We believed that yellow would be good for visibility when searching for lost knives—neon green is better.

Dart 2:

- BP = 38.4% (0.93" from Handle/Blade interface)
- Length = 11.125"
- Weight 12.04 oz. (337 grams)
- 16° tip
- Thickness = 0.281"

Comments:

- We wanted to try a bit longer knife, but realized we prefer shorter, lighter knives.
- Feels good in the hand, but a bit too heavy for us.
- Handle/blade interface not distinct enough for indexing
- Still gets occasional use, but not from me.

Improved Dart (after 5 refurb):

- Length = 9.9" (original 10.13")
- Tip was reduced by refurb more than by chips.

Comments:

- Replaced by my new Improved (3rd Gen) 5160 Darts.
- Refurbs were originally required due to tip and handle damage caused by sideways knife collisions. Gouges in the soft handles, due to hardening of only the blade, caused numerous finger injuries upon releasing knife.
- Two of these finally snapped at the hard/soft interface. This prompted the design of an electric furnace to totally harden our knives. No more issues with breakage or damaged fingers!

Early Efforts (3)

First "Shorties"

- Closely resemble my prototype thrower.
- Shown here (yellow) after two refurb.
- Went to yellow, for better visibility, after the original copper powder coat (below).
- Originally had no handle bevel. It was added, using our bevel jig, during second refurb.



Second "Shorties"

- Same as the originals, but with (free-hand) handle bevel done after 1st refurb.
- We liked the first ones so much, we made this set about two weeks later.
- Shown here (neon green handle) after three refurb.
- Originally there were four, but we lost one in the woods after I stupidly Parkerized them during second refurb.



Shorties (original specs with bevel added):

- BP = 39.7% (0.76" from Handle/Blade interface)
- Length = 9.05"
- Weight 8.25 oz. (231grams)
- 16° tip
- Thickness = 0.250"

Comments:

- Great little throwers!
- Still in use today.
- Apparently too small for no spin competition. They require a minimum of 10".
- Feels good for any type of instinctive throw that uses smaller knives.
- Bearded RAT really enjoys throwing these instinctive half spin.

Some Dead End Knives

Experimental—only one ever made



Mini-dart:

- BP = 39.4%
- 7.9" long
- Throws well, but too small
- Nine inch "Shorties" are as short as we go now.
- Still fun to throw, though.

1st Offset Knife:

- BP = 36.3%*
- 10.5" long
- Too handle heavy
- Tip angle = 12°
- HRC = 46—too soft
- Narrow, soft tip broke (~1/8") in a

hard part (knot) of target! I have since come to realize that the tip failure was most probably due to burning the narrow tip in the propane forge during the hardening process.

Experimental 12" Offset:

- BP = 39.4%
- Too light (22.2 grams/inch)
- Rings like a bell on a miss—painful
- 0.218" thick—shipped by mistake—we ordered 0.281"
- We decided to use it anyway, that was our mistake.

* I assumed that if a little handle-heavy is good a lot handle-heavy should be better. **I was wrong!**

Knives We Like

These later knives were all heat treated using the electric forge (oven, furnace, whatever). This allowed for heat treating of the entire knife. We found this to be important for throwing knives, especially when thrown by RATs.



Fat Boy (in the white):

- BP = 39.3% (0.8" from Handle/Blade interface)
- Length = 10.36"
- Weight 10.6 oz. (297 grams)
- 16° tip
- Thickness = 0.250"

Comments:

- Improvement on the original Bellablade.
- More distinct handle/blade interface.
- Feels good for any type of instinctive throw, but especially for instinctive half-spin.
- Bearded RAT's primary throwing knife.



Offset Dart:

- BP = 39.3% (0.97" from Handle/Blade interface)
- Length = 10.5"
- Weight 9.5 oz. (266 grams)
- 16° tip
- Thickness = 0.250"

Comments:

- May be thrown from flat or slope side.
- Feels good for any type of instinctive throwing.
- Young RAT retired his original Bellablades for these. He throws from the flat side of the spine.

Needle 1:

- BP = 39.3% (1.04" from Handle/Blade interface)
- Length = 10.95"
- Weight 9.04 oz. (253 grams)
- 16° tip
- Thickness = 0.281"

Comments:

- Rings like a bell on misses—too loud—23.1 grams/inch.
- Nice weight, but feels a bit too light for its length.
- Feels good for a thorn style, acceptable for a finger spring.
- Eric, the Brew RAT uses them quite well!



Needle 2:

- BP = 39.2% (1.0" from Handle/Blade interface)
- Length = 10.35"
- Weight 9.17 oz. (257 grams)
- 16° tip
- Thickness = 0.312"

Comments:

- Feels good in the hand.
- Feels almost too light, but still throws really well.
- After more time throwing , we considered 250—300 grams to be an excellent range for 10—10.5" knives.
- Feels good for any type of instinctive throw.



Offset Needle:

- BP = 38.5% (1.1" from Handle/Blade interface)
- Length = 10.35"
- Weight 10.97 oz. (307 grams)
- 16° tip
- Thickness = 0.375"

Comments:

- Great weight (almost too heavy) and feel.
- Rear bevel really sits well in the hand.
- The combination of offset and increased spine thickness allows for finger spring technique without slips.
- Penetrates too deep and really reduces target life.
- I still occasionally throw these, they feel great!

5160 Dart:

- BP = 38.12% (1.14" from Handle/Blade interface)
- Length = 10.65"
- Weight 9.28 oz. (260 grams)
- 16° tip
- Thickness = 0.250"
- Handle Width = 1.25"
- Blade Width = 0.65"

Updated comments (November 8, 2018):

- Made in August 2017.
- Still using and abusing these Darts!
- Three refurbis, so far, for powder coat.



- < 0.12" loss in length after 3 refurbis!

- I still enjoy beating the hell out of these.

- I also like to throw my 3G and Heavy Darts.

These are actually pictures of the 5160 Darts after the first refurb. I forgot to take pix when I made them, but they still look like new. Check my paper on gas forge vs. electric furnace for further info.



Original Heavy Dart:

- BP = 39.08% (0.97" from Handle/Blade interface)
- Length = 10.30"
- Weight 10.72 oz. (300 grams)
- 16° tip
- Thickness = 0.312"

Comments:

- Feels great in the hand.
- More forgiving than 5160s (above) due to extra weight.
- This is my new upper weight limit for this size knife.
- Feels good for any type of instinctive throw.
- Went to 10.35" (303 grams) on newer versions.
- I often switch between these and my 5160s.



Perfect Dart:

- BP = 39.00% (1.00" from Handle/Blade interface)
- Length = 10.16"
- Weight 10.28 oz. (288 grams)
- 16° tip
- Thickness = 0.281"

Comments:

- My design numbers fell perfectly into place, especially the BP.
- Feels really nice in the hand.
- Heavier than my 5160 Darts, but lighter than my Heavy Darts.
- I Liked it so much that I Decided to polish the blades, Garnet blast the handles and hot blue them.
- They'll be easy to find when I miss the target. Yeah, right!

I don't plan to throw these at the same target, at least not right away.



Bearded RAT's New Thick Offset Shorties (TOS)

Thick (.281"), Offset (Offset handle), Shorties (Less than 10")

The Bearded RAT really likes throwing "Shorties" with his instinctive half-spin style. Having observed, over time, that heavy knives are generally more forgiving than lighter knives, he decided to make a set of "Shorties" that had more heft than our standard "Shorties". He went with an offset design just for fun.

The results of our design efforts are below, ready for heat treatment, blasting, powder coating and finally, throwing! He'll probably throw them immediately after heat treating. Update: He did!

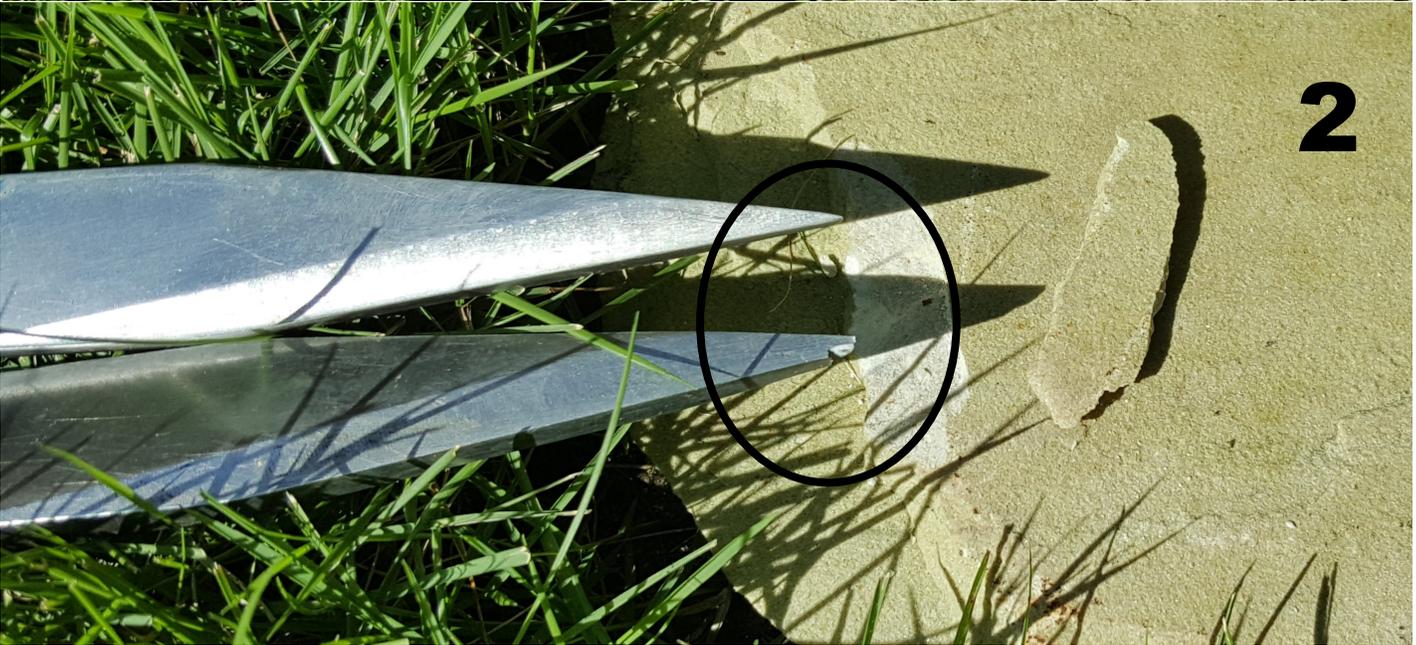


Thick Offset Shorties:

- BP = 39.09% (0.85" from Handle/Blade interface)
- Length = 9.1"
- Weight 9.03 oz. (253 grams)
- 16° tip
- Thickness = 0.281"

Comments:

- Shorter than most of our knives, but still feels great in the hand.
- Nice weight for a 9" knife.
- Heavier than many commercially made 10+ inch knives!
- I'm looking forward to no spin throwing them. Update: I did!
- Due to short length, Bearded RAT prefers to throw them from the flat side. Since I throw no spin, I prefer to throw them from the sloped side.



Old Tip Failure: Additional Information

1. Tip fracture of "Fat Boy" after instinctive half spin throw missed the target and hit a stone pad, very hard.
2. Compared to undamaged tip.
3. Closer examination of the original post impact tip, showing fracture lines.

After the original impact, we simply reshaped the tip, grinding it to a point. About eight months later, after removing the knife from a hardwood target, we observed a second minor tip failure of the same knife.

Taking a closer look at the original post impact tip, we observed small fracture lines which we should have reground past to eliminate any potential weak spots. Oh well, we live and we learn.

