

By Vadim Kraichuk

Edge Stability in Butcher's and Kitchen Knives as a Function of Edge Angle and Initial Sharpness

Structural Edge Tester (SET) is a method and device developed by [Edge On Up](#) for testing edge stability. In a nutshell, the edge is subjected to controlled rolling, the extent of which is quantified.

Edge sharpness tester used in the study: PT50A Industrial.

Laser protractor: CATRA HobbiGoni Knife-Edge Protractor.



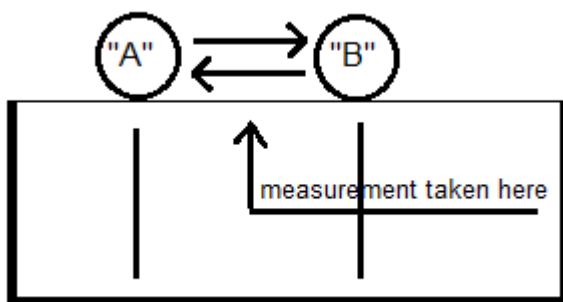
Impact cycle explained

The impact roller is a linear bearing slant at 10° to the horizontal base or in other words at 80° to the plane of the blade clamped vertically.

Standard impact assembly weight is 150 grams.

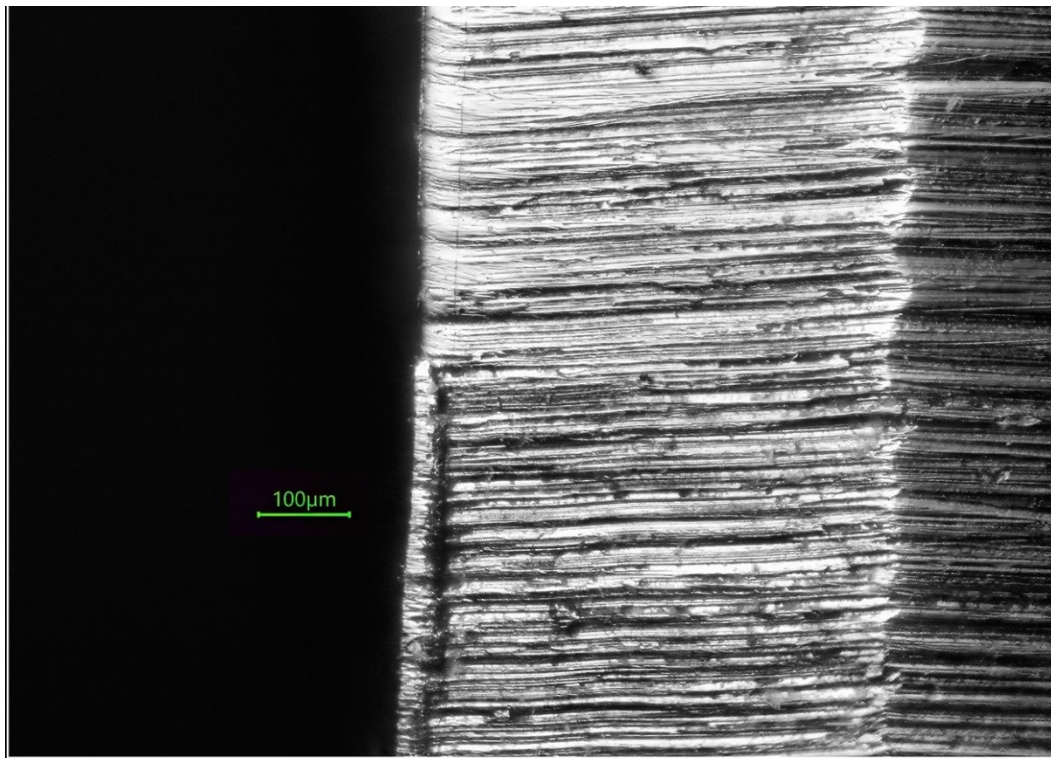


The impact roller is lowered at "A", then moved (rolled) over to "B" and then back to "A".
A-B-A is one cycle.



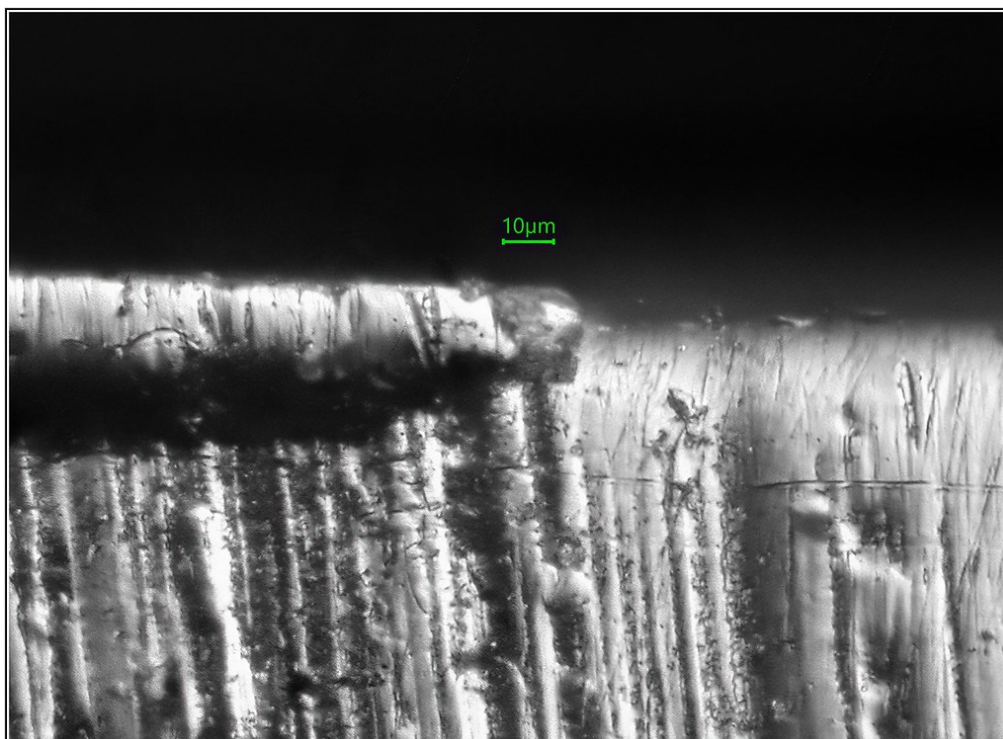
See our video on YouTube <https://youtu.be/EdGOSWjrMOE>

Metallurgical microscopy of the edge after a single roll by the **Structural Edge Tester** follows. Sampled is a mainstream knife subjected to 1 rolling cycle.



The microscopy by Tony Spielberg, USA

The upper portion of the micrograph shows an untouched region of the edge apex. The edge apex is lightly convex from honing. The lower portion of the image shows where the edge has been rolled over. The rolled region has been pushed towards the viewer.



PLAN

The plan is to use SET to test edge retention in butcher's and mainstream kitchen knives sharpened in the "very sharp" range of 50 BESS, 100 BESS, 150 BESS and 200 BESS for edge angles 8, 10, 12, 15 and 20 degrees per side.

The initial sharpness of 50 and 100 BESS represents the sharpest edges nearing a DE razor, while the initial sharpness of 150 and 200 BESS – just sharp knives in the range of utility blade sharpness.

Edge angles of 8 and 10 degrees per side (dps) are more typical of high carbon Japanese knives, while edge angles of 15 and 20 degrees are common in Europe (30° included) and the USA (40° included).

Mainstream kitchen knives are commonly produced with the edge angle of 30° included.

Meat processing plants usually sharpen their knives at 35-40° included.

These edge angles have become common through the sharpening tradition, and our research is to validate the tradition or challenge it.

Another aspect of our study is to see whether there is any relation between the initial knife sharpness and edge retention. Traditionalists say that to hold the edge well the knife should be just working sharp, while enthusiasts say “the sharper the better”; this is the least researched area.

KNIVES

We started the testing with Victorinox/Wenger SWIBO professional meat processing knives of HRC 56-58 and Carbon content 0.5%, new out of the box.

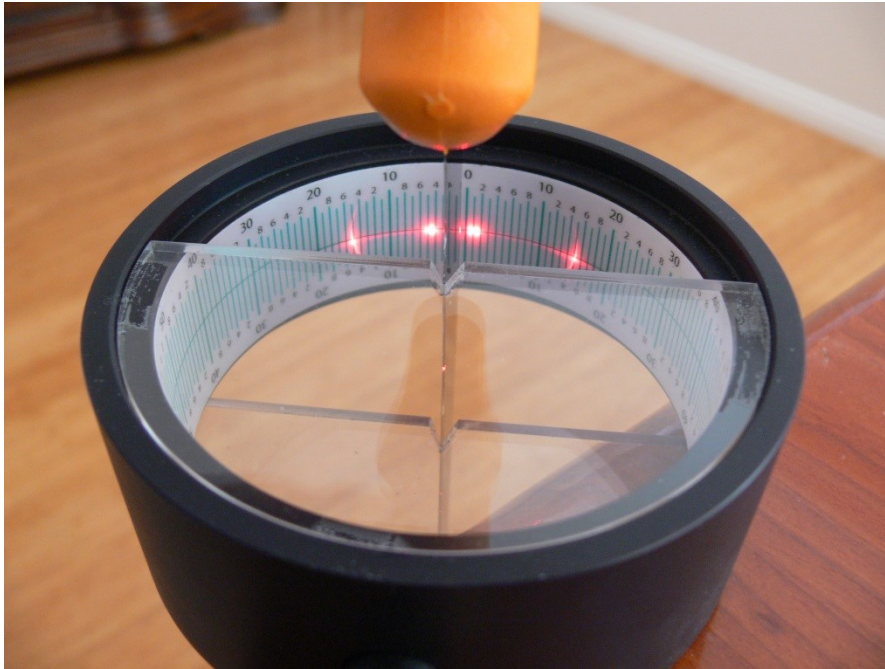
To minimise change in the blade profile due to repeated sharpening, for each edge angle we used a separate new knife; all knives are identical, Victorinox Catalogue # 5.8401.14



Though steel of these knives best matches Victorinox kitchen knives X50CrMoV15, they can represent butcher's and mainstream kitchen knives of other brands as well.

SHARPENING METHOD

Edge angle was ground on Tormek T-8 with the help of [our computer software for Tormek](#), and verified with a CATRA laser protractor in each case.



Sampled knife edge is 15 dps (30 degrees included)

CBN wheels 254mm in diameter were used: edge bevels were ground on CBN grit #400, and the edge set on CBN grit #1000.

The CBN wheel was chosen over the Tormek or Japanese wheels for the precision it offers, as the CBN wheel diameter never changes, while the stone wheel diameter drops with grinding due to the consumption of the abrasive, slightly increasing the grinding angle in the process.

The target edge sharpness was set by controlled-angle honing on paper wheels with a fine diamond paste within +/- 10 BESS of the target.

The honing angle was controlled with the help of [our software for paper wheels](#).



DATA

Data numbers in the charts is the number of the impact roller cycles with the resultant sharpness. E.g. "x1 = 150, x2 = 300 " means after 1 impact cycle the edge sharpness is 150 BESS, after 2 cycles 300 BESS, and so on.

For the purpose of this study, we measured the edge sharpness after every cycle for the first 5 cycles (Phase I), then after every 5 cycles to 50 cycles (Phase II), and then (i.e. from the 50th to 100th cycles) after every 10 cycles (Phase III).

This way we've covered the two checks that have been agreed as checkpoints for all field testers: sharpness value after 5 cycles - Phase I checkpoint for "elastic deformation"; and number of cycles causing "permanent rolling" - Phase II checkpoint for "plastic deformation".

VICTORINOX/WENGER SWIBO BUTCHER'S KNIVES

Stainless steel, Hardness HRC 56-58, Carbon 0.5%

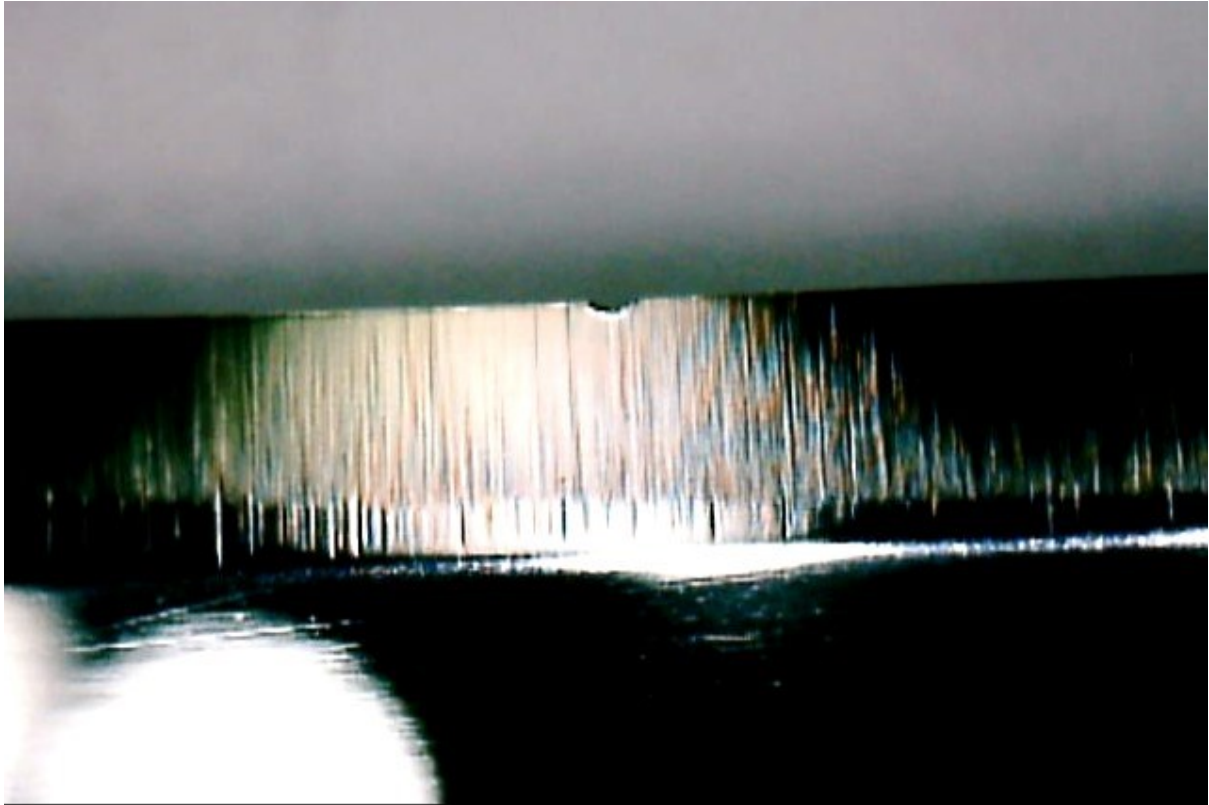
Raw Data

Graphs I build on these numbers later on are a tad more comprehensible.

EDGE ANGLE (dps) → INITIAL SHARPNESS ↓	8°	10°	12°	15°	20°
50 BESS	Dented by test media line	Dented by test media line	x1=264 x2=311 x3=205 x4=287 x5=340 x10=338 x15=329 x20=333 x25=395 x30=364 x35=339 x40=387 x45=412 x50=468 x60=462 x70=448 x80=435 x90=426 x100=451	x1=269 x2=311 x3=339 x4=349 x5=389 x10=413 x15=426 x20=387 x25=435 x30=419 x35=416 x40=443 x45=418 x50=376 x60=429 x70=422 x80=526 x90=541 x100=494	Cannot get on this steel at this angle
100 BESS	Dented by test media line	Dented by test media line	x1=251 x2=287 x3=324 x4=344 x5=386 x10=385 x15=392 x20=351 x25=408 x30=395 x35=376 x40=377 x45=394	x1=323 x2=345 x3=364 x4=344 x5=411 x10=375 x15=401 x20=431 x25=390 x30=426 x35=426 x40=440 x45=453	x1=261 x2=337 x3=365 x4=383 x5=384 x10=375 x15=420 x20=398 x25=464 x30=483 x35=466 x40=515 x45=574

			x50=475 x60=462 x70=501 x80=463 x90=519 x100=485	x50=481 x60=512 x70=531 x80=529 x90=551 x100=586	x50=465 x60=485 x70=497 x80=607 x90=636 x100=527
150 BESS	Dented by test media line	Dented by test media line	x1=219 x2=305 x3=281 x4=385 x5=368 x10=384 x15=394 x20=390 x25=485 x30=429 x35=483 x40=500 x45=453 x50=520 x60=430 x70=525 x80=391 x90=545 x100=584	x1=238 x2=313 x3=285 x4=354 x5=368 x10=371 x15=429 x20=460 x25=438 x30=478 x35=451 x40=494 x45=567 x50=481 x60=550 x70=618 x80=641 x90=680 x100=616	x1=319 x2=371 x3=406 x4=399 x5=418 x10=481 x15=515 x20=509 x25=564 x30=530 x35=598 x40=632 x45=512 x50=631 x60=695 x70=696 x80=646 x90=644 x100=720
200 BESS	Dented by test media line	Shallow dent by test media line	x1=262 x2=305 x3=322 x4=339 x5=394 x10=419 x15=418 x20=405 x25=449 x30=454 x35=481 x40=458 x45=469 x50=489 x60=458 x70=505 x80=568 x90=536 x100=538	x1=283 x2=338 x3=330 x4=354 x5=449 x10=430 x15=471 x20=487 x25=495 x30=489 x35=510 x40=558 x45=558 x50=587 x60=564 x70=634 x80=592 x90=617 x100=647	x1=364 x2=371 x3=407 x4=438 x5=425 x10=471 x15=422 x20=548 x25=561 x30=596 x35=587 x40=626 x45=652 x50=674 x60=614 x70=687 x80=743 x90=561 x100=608

An 8 dps edge (16° included) collapses on the test media line – see the microscope image.



I had to estimate sharpness by alternative methods described in our [Sharpness Chart](#):

Around 50 BESS – splits a hair but won't cross push-cut Tally-Ho cigarette rolling paper;

Around 100 BESS – won't split or cut a hanging hair, but longitudinally push-cuts Tally-Ho cigarette rolling paper and violin hair sign is positive;

Around 150 BESS – won't longitudinally push-cut Tally-Ho cigarette rolling paper and the violin hair sign is negative, but shaves forearm;

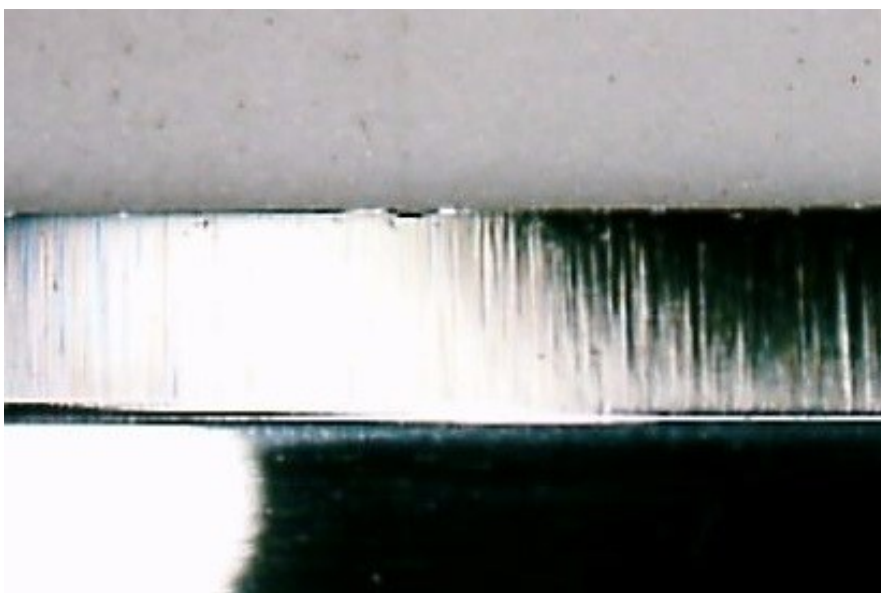
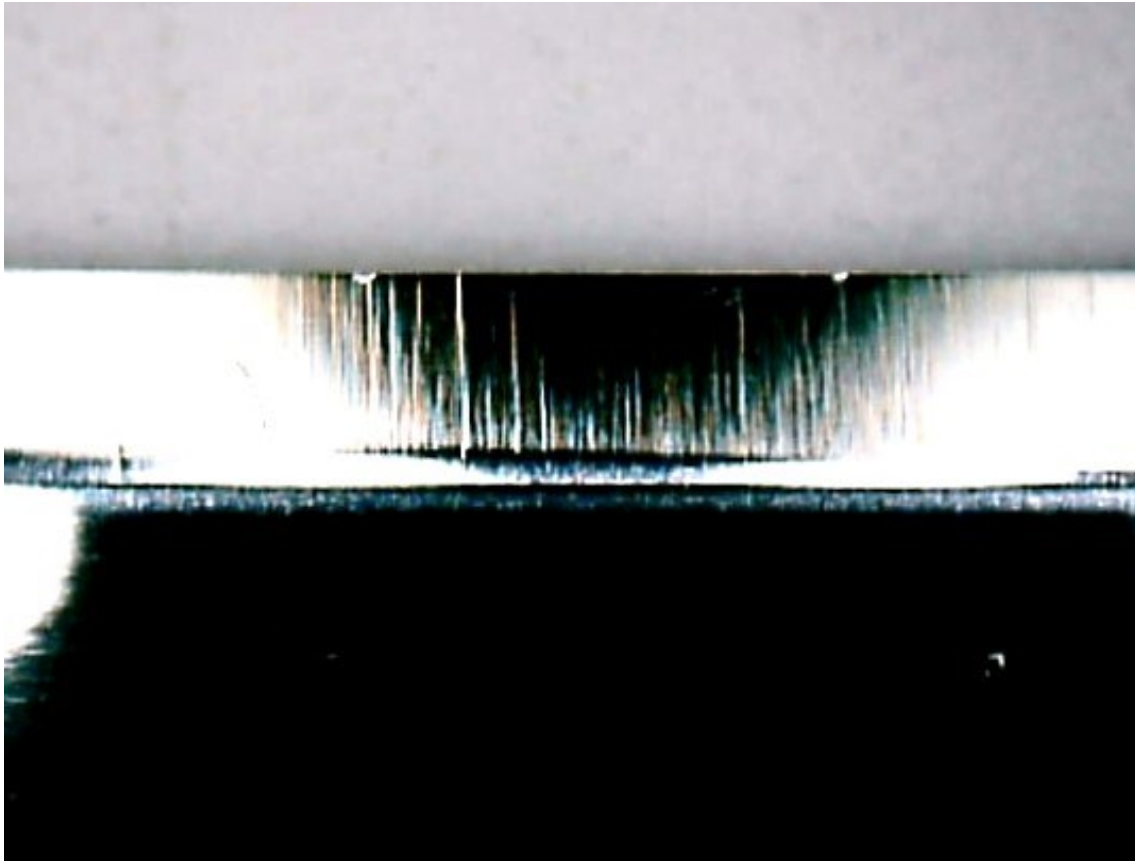
Around 200 BESS – won't shave forearm, though force-scrapes off the hair, and slices a sales docket.



While measuring the 8dps blades on the Edge Sharpness Tester, the test media line dents edges sharpened to 50, 100, 150 and 200 BESS, rendering further SET tests both impossible and meaningless.

Just for the protocol, the score in the dents is 800-1500 BESS.

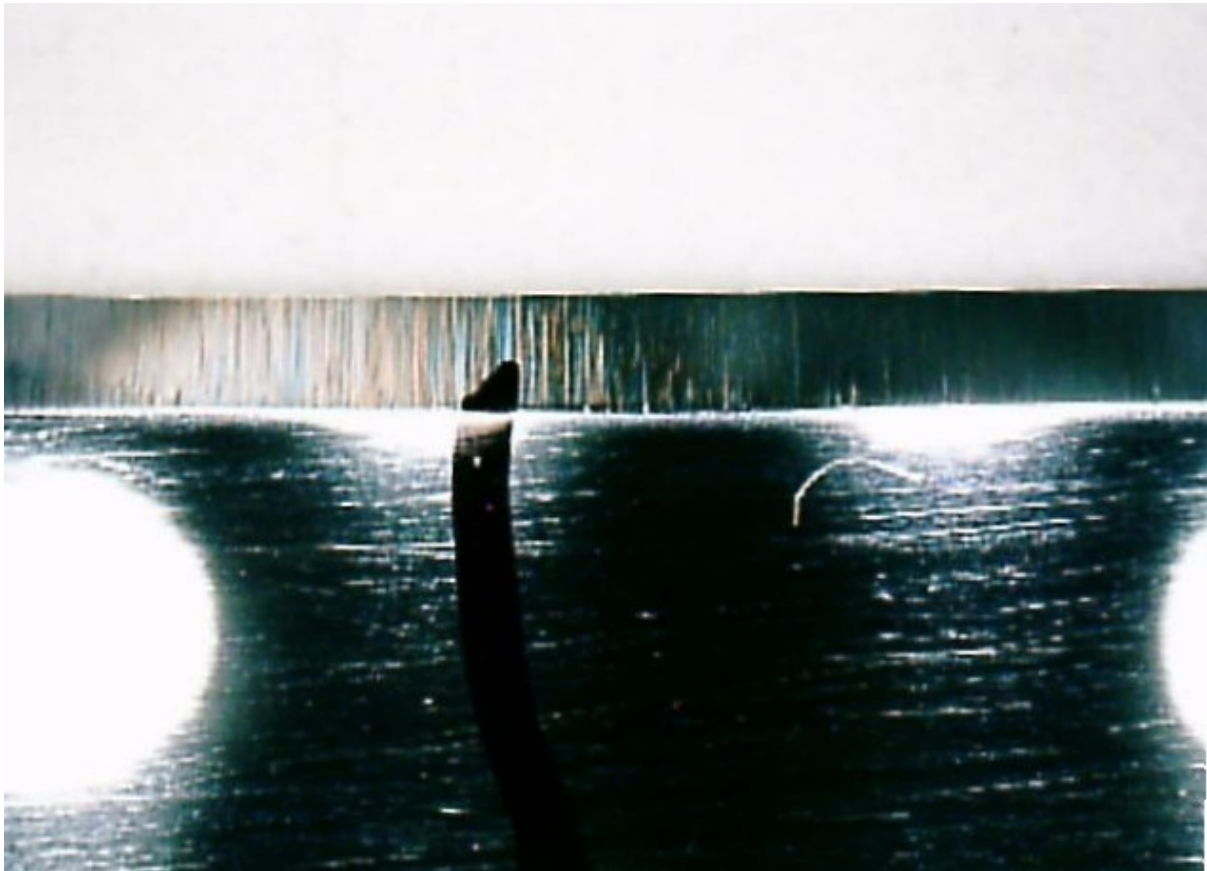
A 10dps edge (20° included) is also dented by the test media line, though to a lesser degree than the 8dps, so that the dents can barely be seen naked-eyed but nevertheless rendering further SET tests meaningless for practical purposes – the next microscope image shows 2 dents left by attempts to measure sharpness of an 80-100 BESS edge, followed by an image of a shallow dent left by the test media line on a 10dps edge sharpened to 180-200 BESS.



The score in the dents is within 200-600 BESS, which we interpreted as promising of a better edge stability in edges sharpened at a higher angle, and further experiments proved this.

12 dps edge (24° included) is stable

The following microscope image shows the 12dps edge of initial sharpness 50 BESS after 20 SET measurements taken at the same spot – the black mark is where the sharpness was repeatedly measured, and as you see this point is undistinguishable from the rest of the edge.



To make sure the test media line itself does not effect the edge as it was the case of 8dps and 10dps edges, after 100 impact cycles we took an additional sharpness measurement a few mm away from the mark, on an edge segment that had not been measured for sharpness but was still in the impact area, and the sharpness score was virtually the same as in the point used for measurements.

At 12 dps knife edge response to the test load remotely resembles that of a slow wear, whereas at 10dps and lower it is an immediate deformation.

I say “resembles” because a rolled edge and edge blunted by abrasive wear behave differently: the bent springy edge shows fluctuating sharpness scores up and down as the edge deteriorates, while abrasive wear shows more linear blunting.

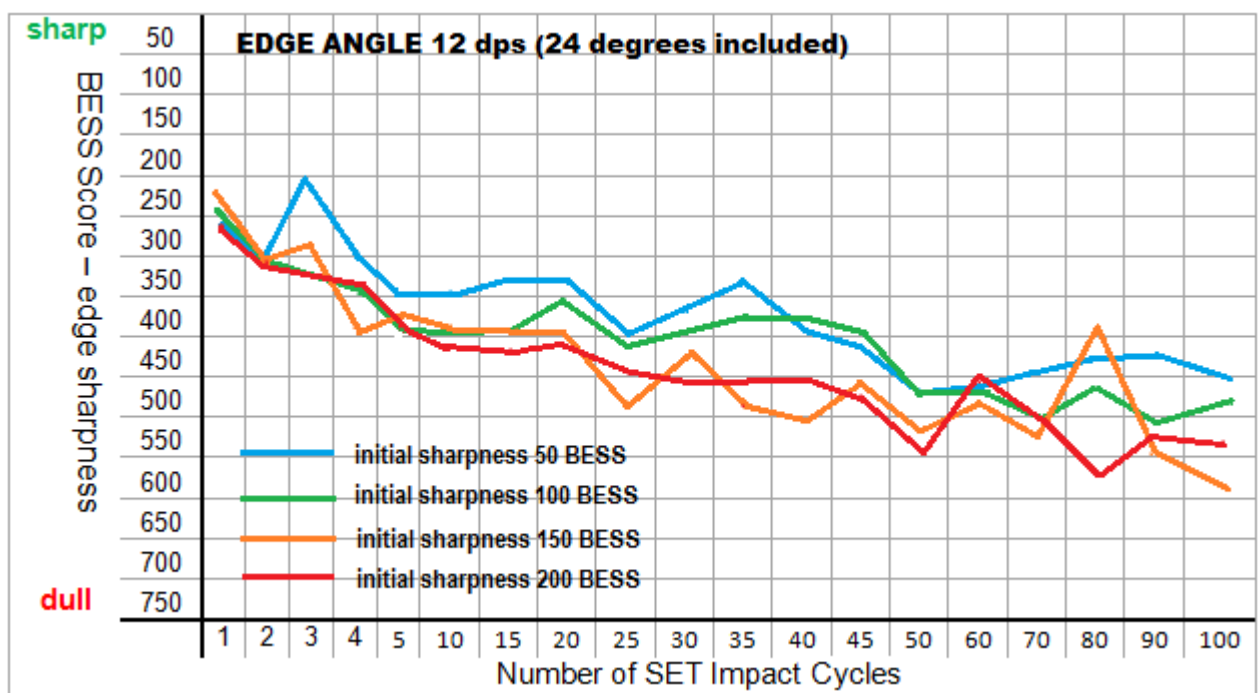
EDGE RETENTION

The following graphs show **edge retention as a function of initial sharpness**.

12 dps (24° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
50 BESS	368
100 BESS	399
150 BESS	425
200 BESS	435

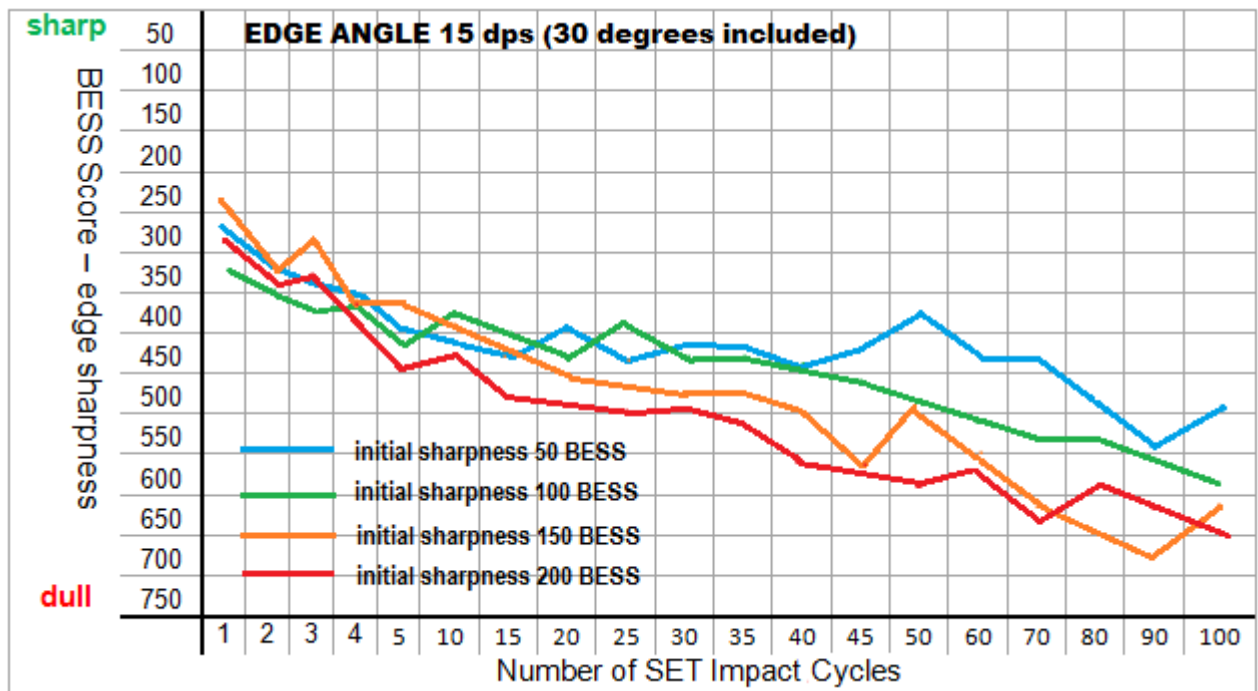
The sharper is the edge the better is retention.



15 dps (30° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
50 BESS	411
100 BESS	438
150 BESS	465
200 BESS	494

The sharper is the edge the better is retention.



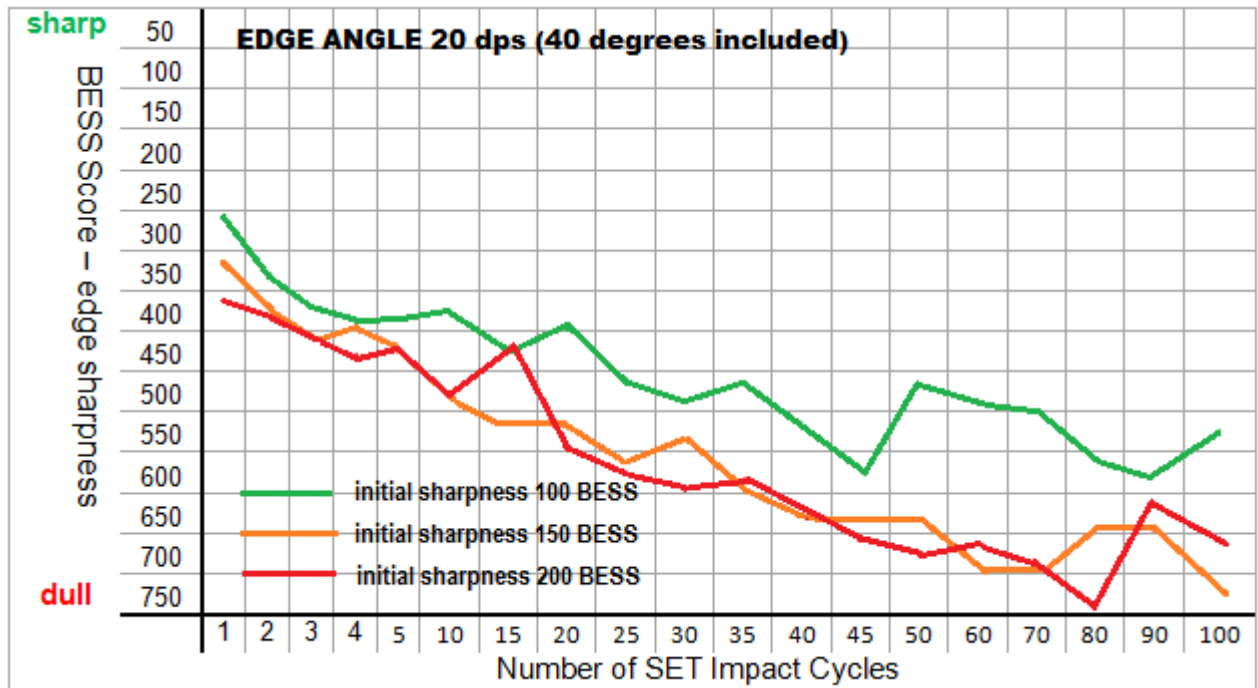
500 BESS is where the knife turns blunt.

At 15 dps, knives sharpened under 100 BESS (i.e. near razor sharp) stay sharp twice as long as knives with the initial sharpness of 150-200 BESS (i.e. utility blade sharpness) – 80 impact cycles vs 40.

20 dps (40° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	455
150 BESS	541
200 BESS	545

The sharper is the edge the better is retention.



500 BESS is where the knife turns blunt.

At 20 dps, knives sharpened to 100 BESS (i.e. next to razor sharp) stay sharp twice as long as knives with the initial sharpness of 150-200 BESS (i.e. utility blade sharpness) – 40 impact cycles vs 20.

By the far-famous Cliff Stamp’s concept and his experimental data, an edge of 12 dps should outperform those of 15 and 20 dps. Cliff Stamp advocates that knives should have the thinnest edge possible for a given blade steel and task.

If our SET tester data are in line with Cliff Stamp’s concept it would prove the SET can be an alternative to cutting tests that Cliff used to prove his concept.

To see what our SET tester shows in this regard, we’ve **averaged sharpness data** across all initial sharpness for each edge angle– this way we abstract from the initial sharpness and focus on the edge angle.

For example, average sharpness after 10 Cycles was calculated for 12 degree edge as: $(338 + 385 + 384 + 419)/4$, where 338 is the score for the initial sharpness of 50 BESS, 385 is the score for the initial sharpness of 100 BESS, 384 is the score for the initial sharpness of 150 BESS, and 419 is the score for the initial sharpness of 200 BESS.

Averaging this way not only better reveals the tendency, but also boosts trust in the data we’ve obtained, because the sets of data for each initial sharpness can be treated as a retention test for a

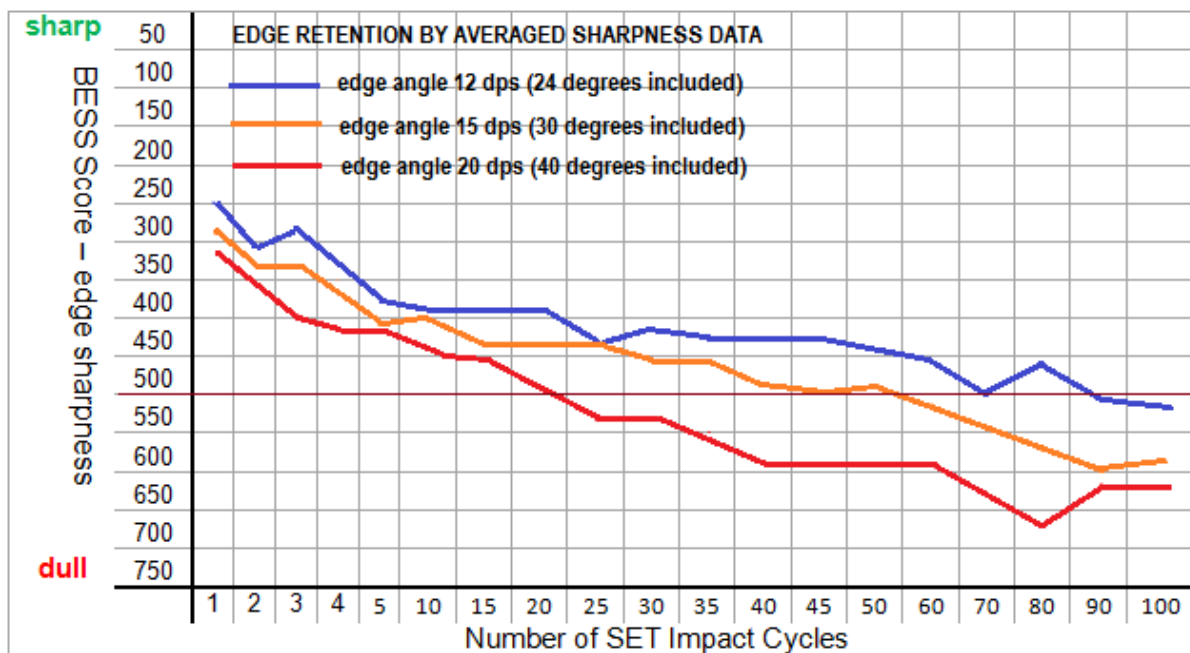
given edge angle repeated on 4 different knives to confirm reproducibility of the results; in confronting reality people cut with varying initial sharpness.

The following chart and graph show **edge retention as a function of edge angle**.

EDGE ANGLE (dps)	12°	15°	20°
AVERAGE SHARPNESS	407	452	514

The thinner is the edge the better is retention.

EDGE ANGLE (dps) →	12°	15°	20°
AVERAGE SHARPNESS	x1=249	x1=278	x1=315
	x2=302	x2=327	x2=360
	x3=283	x3=330	x3=393
	x4=339	x4=350	x4=407
	x5=372	x5=404	x5=409
	x10=382	x10=397	x10=442
	x15=383	x15=432	x15=452
	x20=370	x20=441	x20=485
	x25=434	x25=440	x25=530
	x30=411	x30=453	x30=536
	x35=420	x35=451	x35=550
	x40=431	x40=484	x40=591
	x45=432	x45=499	x45=579
	x50=488	x50=481	x50=590
	x60=453	x60=514	x60=598
	x70=495	x70=551	x70=627
	x80=464	x80=572	x80=665
	x90=507	x90=597	x90=614
	x100=515	x100=586	x100=618



These averaged data tell us the best retention has the edge sharpened at 12 dps, and we already know that at this edge angle the best performing is the initial sharpness of 50 BESS i.e. razor sharp. Knives sharpened at 20 dps turn blunt (500 BESS) by the 20th impact cycle, knives at 15 dps outlast

twice as long, and knives at 12 dps over 3 times longer.

The edge angle has clearly a more definitive effect on the knife performance than the initial edge sharpness, unless this sharpness is ≤ 100 BESS.

Our SET data are in line with Cliff Stamp's cutting tests and concept.

COMPARISON TO EDGE RETENTION AT A MEAT PLANT



SWIBO knives similar to those used in this research were used in a separate research on edge retention at a meat plant.

Overall 8 boning operators used four SWIBO knives for two days: 4 operators on the day 1, and another 4 on the day 2; the edge sharpness was measured every 1.5 hours throughout the work shifts.

These knives were sharpened at 40 degrees with the initial sharpness about 100 BESS.

The meat plant averaged data are shown below:

Sharpness through the work shift (BESS)

Knife Brand	Initial sharpness	In 1.5 hours	In 3 hours	In 4.5 hours
SWIBO 5.8404.16	115	308	316	324

Compared to the knives sharpened at 40 degrees with the initial sharpness of 100 BESS in our SET research, the meat plant edge retention numbers fall within the range of the first 5 impact cycles.

CONCLUSIONS

The testing regimen had been designed right, because sharpness of all knives neared or exceeded 500 BESS i.e was rendered blunt by the 100th impact cycle.

The SET method has proved a valid and better alternative to cutting tests for edge retention, providing the researcher with precise data suitable for quantitative and statistical analysis.

“The sharper is the edge the better is retention” appears to be a rule for all edge angles.

The optimal edge angle for butcher’s and mainstream kitchen knives is 12 dps (24° included), sharpened to 50-100 BESS (i.e. nearing a DE razor in sharpness), though the edge angle is clearly a stronger determinant in the edge retention compared to the initial sharpness.

At this angle the edge and apex are both strong enough to resist deformation.

Knives sharpened at 12 dps stay sharp 3 times longer than knives sharpened at 20 dps, and almost twice as long as 15 dps knives.

On the contrary, lower than 12 dps edges are too weak and easily deform under the load.

As it has been mentioned, SWIBO knives steel best matches Victorinox kitchen knives X50CrMoV15 (HRC 56-58, Carbon contents 0.5%).

For higher ranking kitchen knives (e.g. Global HRC 56-58 Carbon 0.7%) we expect the optimal edge angle to be under 12 dps, while for those with Carbon contents $\leq 0.45\%$ (e.g. Scanpan x45CrMoV15 HRC 56-57 Carbon 0.45%) to be higher. These two lines of knives are being tested as I type this.

We’ve proved that the SET method can be used to determine the most robust edge angle for knives used at meat processing plants.

Sharpening at the best angle for a given knife brand ensures the best edge retention, sharpness and longer life span of the knives, saving plants tens of thousands of dollars a year.

We think of slightly lessening the impact to better match the SET to the meat plant numbers obtained in live studies; we should be able to do this by lessening the angle at which the impact roller meets the edge; additional tests are required to determine the right roller angle.

You may call us day dreamers, but we hope to equal one impact cycle to one hour of cutting at the meat plant conveyer.

SEQUENCE #2

Using the same methods and equipment, we tested edge retention in two more brands of kitchen knives: one of less hardness, less Carbon contents and known to hold the edge worse than the Victorinox SWIBO knives, and the other of higher Carbon contents and known to hold the edge better.

The only difference with the previous tests was that to study relation between the initial sharpness and edge retention we used the initial sharpness of 100 BESS (i.e. next to razor sharp) versus 200 BESS (i.e. utility blade sharpness).

STEP DOWN

SCANPAN Classic Kitchen knife

Stainless steel **X45CrMoV15**, Hardness HRC 56-57, **Carbon 0.45%**



RAW DATA

Data numbers in the charts is the number of the impact roller cycles with the resultant sharpness.

E.g. "x1 = 150, x2 = 300" means after 1 impact cycle the edge sharpness is 150 BESS, after 2 cycles 300 BESS, and so on.

EDGE ANGLE (dps) → INITIAL SHARPNESS ↓	10°	12°	15°	20°
100 BESS	Dented by test media line	x1=268 x2=290 x3=335 x4=385 x5=369 x10=375 x15=416 x20=420 x25=439 x30=498 x35=515 x40=493 x45=547 x50=567 x60=608 x70=623 x80=665 x90=692 x100=719	x1=365 x2=382 x3=396 x4=452 x5=395 x10=469 x15=530 x20=597 x25=624 x30=733 x35=722 x40=738 x45=754 x50=843 x60=764 x70=759 x80=784 x90=830 x100=844	x1=367 x2=406 x3=475 x4=466 x5=487 x10=420 x15=540 x20=694 x25=723 x30=652 x35=694 x40=805 x45=839 x50=808 x60=644 x70=807 x80=857 x90=811 x100=846

200 BESS	Dented by test media line	x1=349	x1=389	x1=398
		x2=360	x2=448	x2=418
		x3=384	x3=483	x3=450
		x4=422	x4=485	x4=501
		x5=505	x5=466	x5=480
		x10=530	x10=530	x10=484
		x15=662	x15=481	x15=552
		x20=511	x20=558	x20=618
		x25=674	x25=649	x25=625
		x30=755	x30=561	x30=639
		x35=688	x35=734	x35=586
		x40=668	x40=568	x40=777
		x45=787	x45=692	x45=729
		x50=787	x50=707	x50=629
		x60=821	x60=721	x60=642
		x70=831	x70=722	x70=755
		x80=716	x80=820	x80=817
		x90=769	x90=882	x90=907
		x100=784	x100=707	x100=850

AVERAGED DATA

We average data the same way we did for the SWIBO knives, mainly to boost trust in the data we've obtained, because the sets of data for each initial sharpness can be treated as a retention test for a given edge angle repeated on different knives to confirm reproducibility of the results.

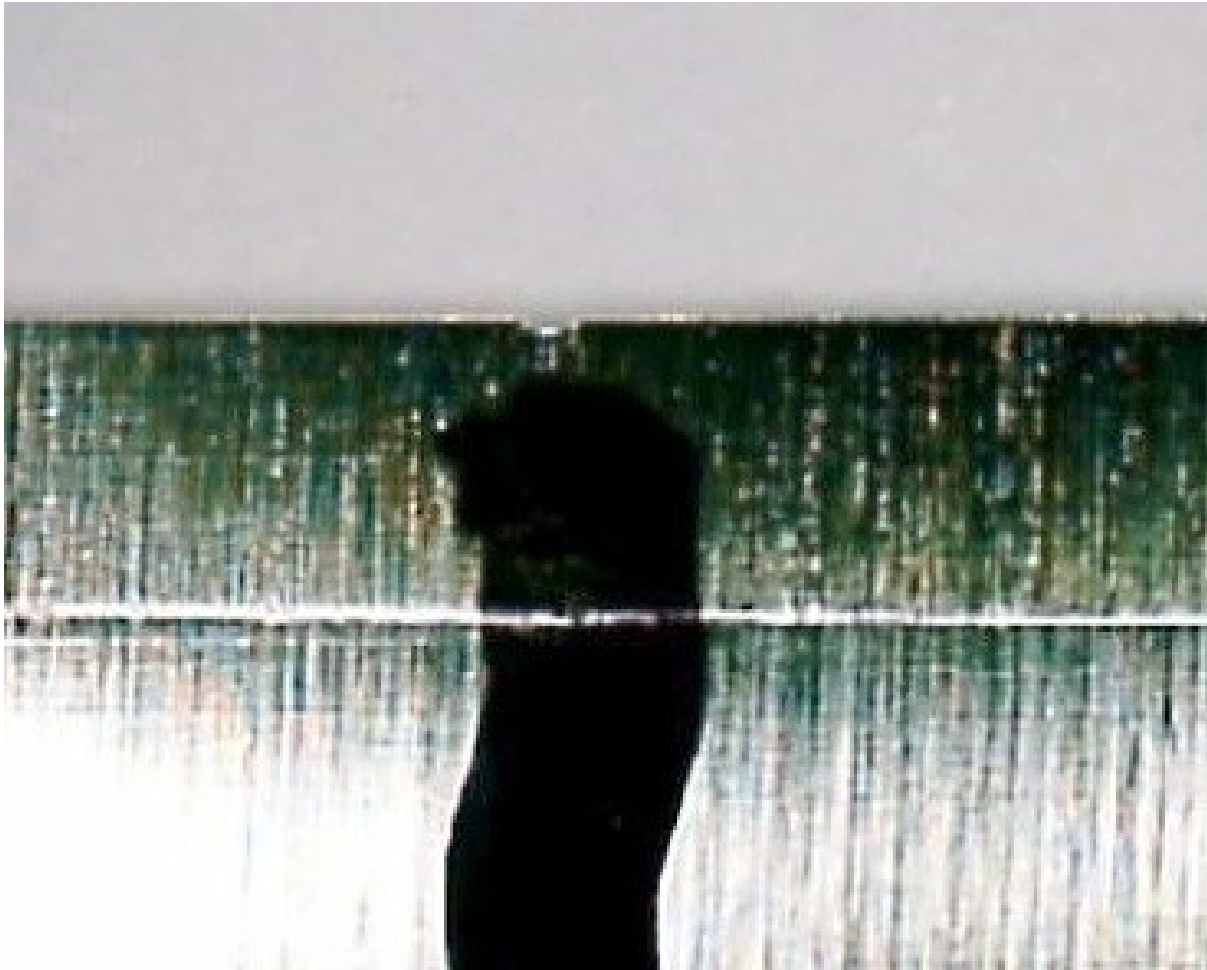
EDGE ANGLE (dps)	12°	15°	20°
AVERAGE SHARPNESS	559	621	637

EDGE ANGLE (dps) →	12°	15°	20°
INITIAL SHARPNESS ↓			
AVERAGE SHARPNESS	x1=309	x1=377	x1=383
	x2=325	x2=415	x2=412
	x3=360	x3=440	x3=462
	x4=404	x4=469	x4=484
	x5=437	x5=430.5	x5=484
	x10=453	x10=500	x10=452
	x15=539	x15=505	x15=546
	x20=466	x20=578	x20=656
	x25=557	x25=637	x25=674
	x30=627	x30=647	x30=646
	x35=602	x35=728	x35=640
	x40=581	x40=653	x40=791
	x45=667	x45=723	x45=784
	x50=677	x50=775	x50=719
	x60=715	x60=743	x60=643
	x70=727	x70=741	x70=781
	x80=691	x80=802	x80=837
	x90=731	x90=856	x90=859
	x100=752	x100=776	x100=848

10 dps (20° degrees included) edge

A shaving sharp 10 dps edge about 150 BESS by the Sharpness Chart, is dented by the test media line, scoring in the dent 700 BESS on the sharpness tester.

As it was in the case of Victorinox SWIBO knives, this indicates the angle at which the edge becomes unstable and easily deformable, rendering further tests both meaningless and impossible.



12 dps (24° degrees included) edge

Microscopy is unremarkable – no visible deformation after sharpness measurements.

The following charts show **edge retention as a function of initial sharpness**.

12 dps (24° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	485
200 BESS	632

The sharper is the edge the better is retention.

15 dps (30° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	631
200 BESS	611

No relation between the initial sharpness and edge retention (difference < 5%).

20 dps (40° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	650
200 BESS	624

No relation between the initial sharpness and edge retention (difference < 5%).

The following chart of **averaged data** shows **edge retention as a function of edge angle**.

EDGE ANGLE (dps)	12°	15°	20°
AVERAGE SHARPNESS	559	621	637

The thinner is the edge the better is retention.

STEP UP

GLOBAL Classic Kitchen Knife

Stainless steel CROMOVA 18, Hardness HRC 56-58, **Carbon 0.7%** (other source 0.55%)



RAW DATA

Data numbers in the charts is the number of the impact roller cycles with the resultant sharpness.

E.g. "x1 = 150, x2 = 300" means after 1 impact cycle the edge sharpness is 150 BESS, after 2 cycles 300 BESS, and so on.

EDGE ANGLE (dps) → INITIAL SHARPNESS ↓	10°	12°	15°	20°
100 BESS	x1=332 x2=332 x3=381 x4=404 x5=393 x10=380 x15=404 x20=426 x25=409 x30=431 x35=411 x40=438 x45=401 x50=439 x60=492 x70=451 x80=499 x90=540 x100=586	x1=357 x2=418 x3=411 x4=388 x5=416 x10=408 x15=436 x20=471 x25=450 x30=461 x35=464 x40=473 x45=518 x50=577 x60=525 x70=533 x80=535 x90=590 x100=597	x1=277 x2=334 x3=384 x4=420 x5=398 x10=429 x15=412 x20=473 x25=455 x30=509 x35=454 x40=554 x45=543 x50=531 x60=497 x70=586 x80=563 x90=587 x100=584	x1=314 x2=366 x3=397 x4=444 x5=482 x10=457 x15=519 x20=546 x25=525 x30=532 x35=531 x40=507 x45=560 x50=582 x60=621 x70=522 x80=620 x90=552 x100=598
200 BESS	x1=340 x2=341 x3=386 x4=372 x5=397 x10=400 x15=412 x20=445 x25=458 x30=474 x35=453 x40=465 x45=431 x50=449 x60=481 x70=566 x80=614 x90=572 x100=561	x1=316 x2=375 x3=395 x4=386 x5=362 x10=396 x15=408 x20=415 x25=463 x30=397 x35=422 x40=439 x45=407 x50=472 x60=502 x70=491 x80=512 x90=538 x100=614	x1=356 x2=451 x3=460 x4=490 x5=491 x10=530 x15=583 x20=544 x25=458 x30=574 x35=614 x40=564 x45=602 x50=524 x60=524 x70=546 x80=613 x90=574 x100=765	x1=418 x2=443 x3=470 x4=419 x5=466 x10=458 x15=580 x20=562 x25=513 x30=550 x35=503 x40=470 x45=464 x50=500 x60=482 x70=508 x80=533 x90=590 x100=569

AVERAGED DATA

EDGE ANGLE (dps)	10°	12°	15°	20°
AVERAGE SHARPNESS	441	456	507	504

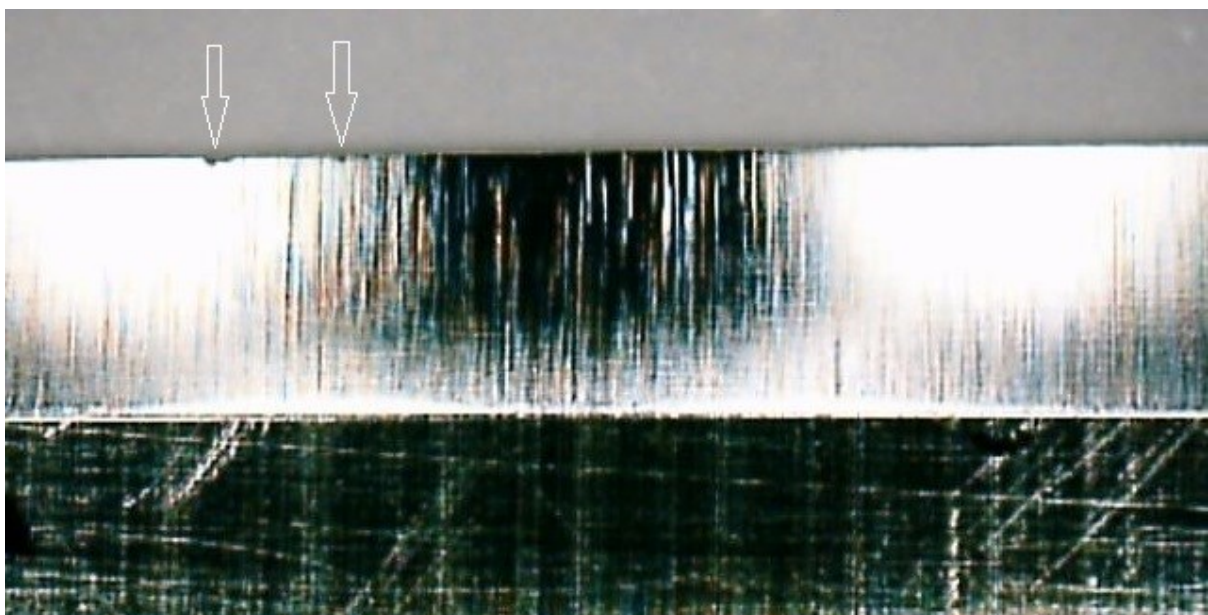
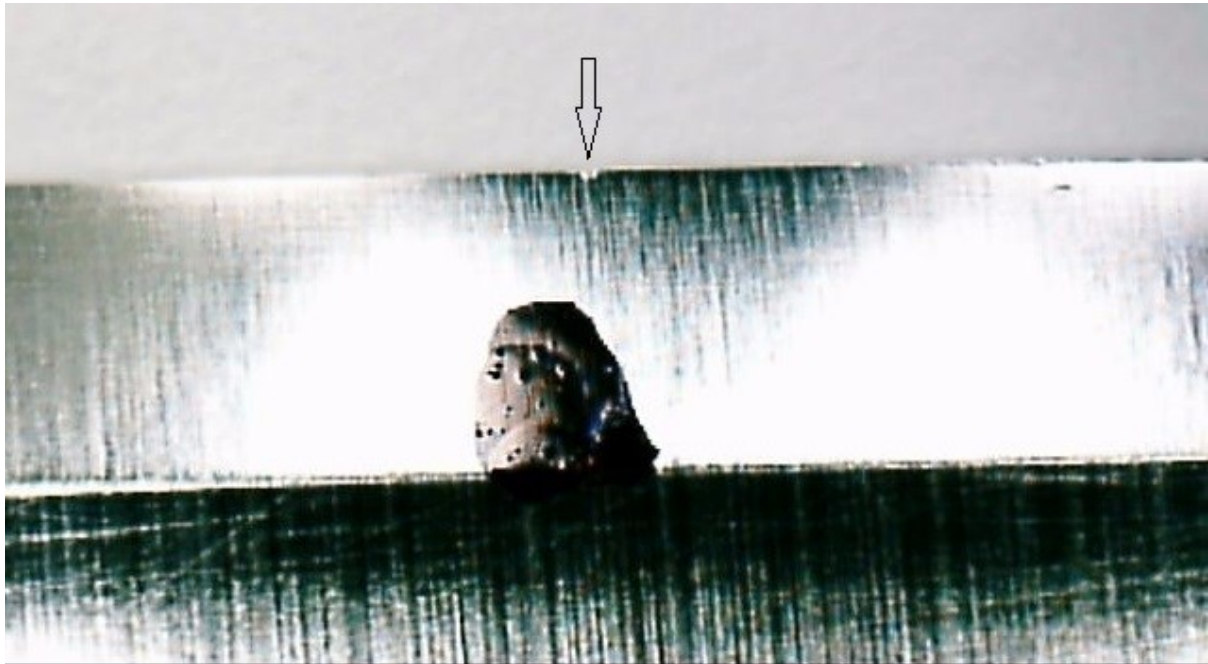
EDGE ANGLE (dps) → INITIAL SHARPNESS ↓	10°	12°	15°	20°
AVERAGE SHARPNESS	x1=336	x1=337	x1=317	x1=366
	x2=337	x2=397	x2=393	x2=405
	x3=384	x3=403	x3=422	x3=434
	x4=388	x4=387	x4=455	x4=432
	x5=395	x5=389	x5=445	x5=474
	x10=390	x10=402	x10=480	x10=458
	x15=408	x15=422	x15=498	x15=550
	x20=436	x20=443	x20=509	x20=554
	x25=434	x25=457	x25=457	x25=519
	x30=453	x30=429	x30=542	x30=541
	x35=432	x35=443	x35=534	x35=517
	x40=452	x40=456	x40=559	x40=489
	x45=416	x45=463	x45=573	x45=512
	x50=444	x50=523	x50=528	x50=541
	x60=487	x60=514	x60=511	x60=552
	x70=509	x70=512	x70=566	x70=515
	x80=557	x80=524	x80=588	x80=577
	x90=556	x90=564	x90=581	x90=561
	x100=574	x100=606	x100=675	x100=584

8 dps (16° degrees included) edge

An 8 dps edge under 100 BESS by the Sharpness Chart, is dented by the test media line, scoring in the dent 300-500 BESS on the sharpness tester.

I am aware that this contradicts common opinion that Global knives can be sharpened to 15 degrees included, yet at this angle the edge is too weak in the apex for testing by our methods.

Below are microscope images of several attempts to measure sharpness on the BESS tester.



10 dps (20° degrees included) edge

Microscopy is unremarkable – no visible deformation after sharpness measurements.

The following charts show **edge retention as a function of initial sharpness**.

10 dps (20° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	429
200 BESS	454

The sharper is the edge the better is retention.

12 dps (24° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	475
200 BESS	437

Reverse relation between the initial sharpness and edge retention.

15 dps (30° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	473
200 BESS	540

The sharper is the edge the better is retention.

20 dps (40° included)

Initial Sharpness	Average Sharpness Score over 100 Cycles
100 BESS	509
200 BESS	500

No relation between the initial sharpness and edge retention (difference < 5%).

The following chart of **averaged data** shows **edge retention as a function of edge angle**.

EDGE ANGLE (dps)	10°	12°	15°	20°
AVERAGE SHARPNESS	441	456	507	504

The thinner is the edge the better is retention.

STEEL COMPARISON

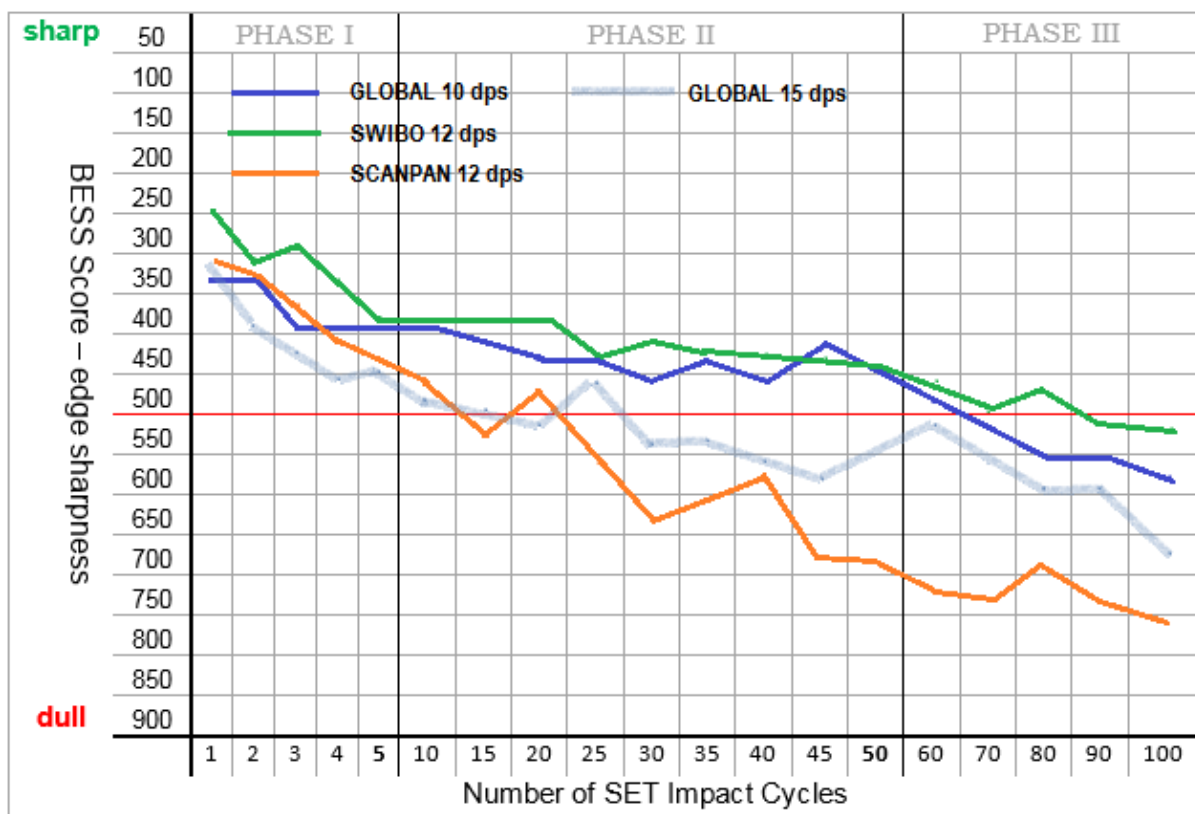
The following charts and graphs **compare** the knives edge retention.

The following two charts show edge retention by steel, and include average sharpness and **number of impact cycles** it took to render the edge blunt i.e. over 500 BESS (a key indicator).

STEEL → AVERAGE SHARPNESS	Weak (SCANPAN)	Mainstream (SWIBO)	Strong (GLOBAL)
10° dps	N/A	N/A	441
12° dps	559	407	456
15° dps	621	452	507
20° dps	637	514	504

STEEL → # of cycles till 500+ BESS	Weak (SCANPAN)	Mainstream (SWIBO)	Strong (GLOBAL)
10° dps	N/A	N/A	70
12° dps	25	90	50
15° dps	15	60	30
20° dps	15	25	15

The following graph shows the **best** edge retention by averaged data for each of the steels tested; additionally shown is one more GLOBAL sharpened at 30 degrees included.



The lower ranking SCANPAN at 12 dps outperforming GLOBAL at 15 dps (though not for long) can be explained by the advantage of the lower edge angle, but what about the winning SWIBO?

The seemingly paradoxical SWIBO knives outperforming the higher ranked Global is discussed in the Conclusions below.

CONCLUSIONS

Softer steel (Step down)

The optimal edge angle for mainstream kitchen knives with HRC 56-57 and Carbon 0.45% is 12 dps (24° included), sharpened to 100 BESS; the 12 dps edges with the initial sharpness of 100 BESS stay sharp twice longer compared to the initial sharpness of 200 BESS.

Edges sharpened at 12 dps stay sharp twice as long as those sharpened at 15 and 20 dps, and the 15 dps edges hold sharpness somewhat better than 20 dps - the edge angle remains a strong determinant in the edge retention of softer steel.

Lower than 12 dps edges are too weak in the apex.

Compared to the SWIBO knives, the SET load causes early plastic deformation in the edge of the softer steel X45CrMoV15.

Absence of relation between the initial sharpness and edge retention that we see in easily deformed edges sharpened at 15 and 20 dps, suggests that the initial sharpness helps to hold edge only in the elastic deformation phase.

Harder steel (Step up)

The optimal edge angle for better kitchen knives like Global is 10 dps, sharpened to 100 BESS; the 10 dps edge stays sharp by 50% longer than the 12 dps edge, and over 2 times longer than the 15 dps edge.

Edge retention as a function of edge angle

Best edge angle for a knife is the lowest angle at which the edge can take a load without deforming. Steels have a certain smallest angle at which the edge becomes unstable, the stronger the steel the smaller is this angle.

Edge retention as a function of initial sharpness

Generally, the sharper edge shows better retention.

Edge retention is improved by the initial sharpness under 100 BESS, however this relation becomes less consistent at and over 100 BESS, especially in lower ranking steels.

Comparison by steel

A knife made of weaker steel, but sharpened to its best at the acutest angle it can hold may outperform a knife of stronger steel sharpened at a more obtuse angle.

As seen by the test data, even a lower ranking SCANPAN knife sharpened to 100 BESS at 12 dps outperforms GLOBAL knife sharpened to 200 BESS at 15 dps.

The above is the common rule ensuing from our SET testing, but not without many exceptions, and

when the exceptions are abundant, this usually tells us there is another hidden rule behind them we are yet to comprehend.

The main **paradox** we see is that SWIBO knives outperform the more wear-resistant Global in our tests.

Obviously, edge rolling is far not the same as wear resistance, and a mainstream steel like SWIBO can tolerate rolling better than a harder steel like GLOBAL; steel compressive strength seems to retain the edge within the elastic deformation range better than hardness.

SET testing method

Number of cycles had been guessed right because sharpness of all knives neared or exceeded 500 BESS (i.e was rendered blunt) by the 100th impact cycle – allowing us to watch the full **life cycle** of the edge within one test.

The testing procedure yields additional information about events happening in the edge as reflected by the test data. The testing regimen we've applied in these series of SET testing has 3 distinctive phases:

- **Phase I** “Elastic deformation” from the 1st to the 5th impact cycle, when sharpness is measured after every cycle – considering that interval between subsequent impact cycles is about 30 sec, this break in impact allows the edge to partially recover from rolling. This phase takes about 2.5 min.
- **Phase II** “Elasto-Plastic transition” from the 6th to 50th impact cycle, where the edge gets 5 impact cycles between sharpness measurements – edge is challenged for resistance to plastic deformation. The elastic deformation transits to plastic here, as seen by the **lessening of variances in sharpness in the second half of this phase**. Phase II is where the initial sharpness contributes the most to the edge longevity through the enhanced elasticity of the thinned edge. Weaker steel simply crashes in this phase. This phase takes 5 min.
- **Phase III** “Plastic deformation” from the 51st to 100th impact cycle, where the edge is continuously rolled 10 times before each next sharpness measurement, testing the edge stability to permanent rolling. This phase takes about 3.5 min.

Key indicators:

- Overall average sharpness over 100 impact cycles;
- Average sharpness in the Phase I (elastic deformation) - calculated as an average of sharpness scores in the first 5 impact cycles;
- Sharpness by the end of the Phase II (elasto-plastic transition) – calculated as an average of 3 sharpness scores: after 40, 45 and 50 impact cycles;
- Number of impact cycles to turn the edge blunt at 500 BESS (resistance to permanent rolling).

Overall, each SET test takes 11 minutes to estimate life cycle of the edge; for comparison, CATRA's "knife sharpness and life tester" takes 15 minutes in the semi-automatic model and 10 minutes in the automatic model.

SET and CATRA testing should not be opposed, as they focus on different attributes of the edge: of the two main constituents of the edge blunting, SET testing focuses on the edge rolling, while CATRA on the abrasive wear; of the three main steel properties playing role in the edge retention: strength, toughness and hardness – strength is more about resilience to rolling, while hardness to wear.

More tests are needed to estimate edge rolling in so called "super-steels", and compare to the mainstream steels; the data we've got so far tell us that the "super-steels" are not necessarily superior in resilience to rolling unless compared to lower end steels.

The SET method has proved to distinguish different types of steels, even when this difference is subtle, just when interpreting SET data keep in mind that in SET compressive strength/elasticity wins over hardness, as it often does in the kitchen.

Related study

Larrin Thomas, Pittsburgh, PA USA "Maximizing Edge Retention – What CATRA Reveals about the Optimum Edge" <https://knifesteelnerds.com/2018/06/18/maximizing-edge-retention>