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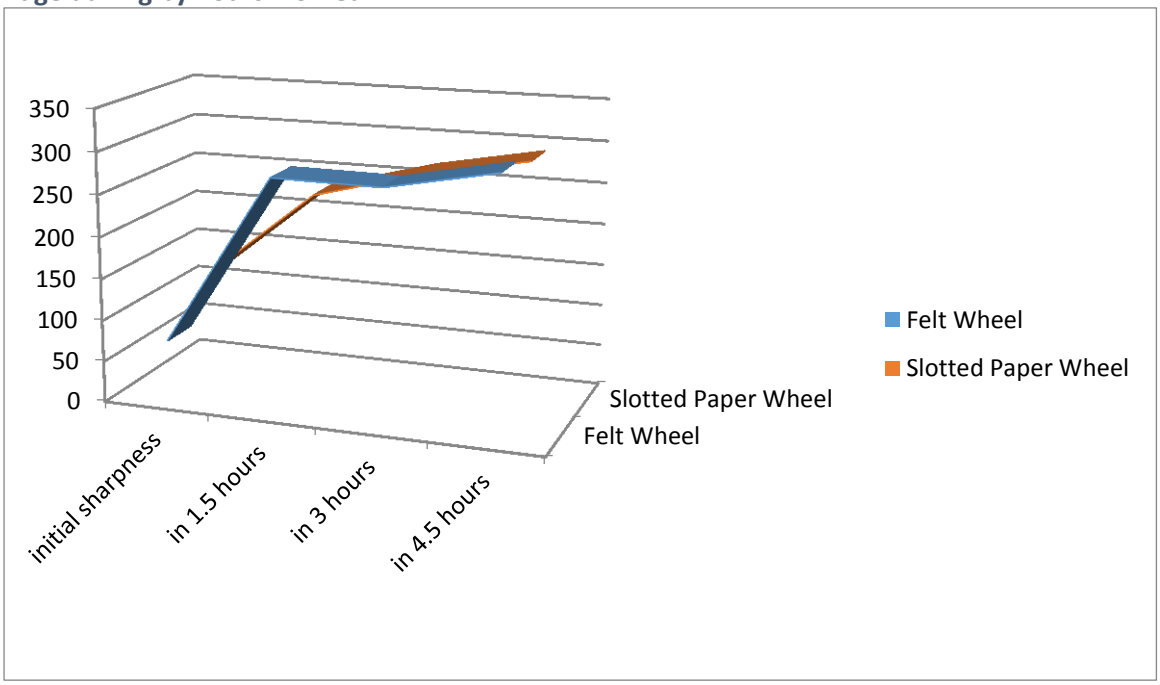
Edge Retention in Knives
Honed on a Solid Felt Wheel versus Slotted Felt & Paper Wheel

During our assessment of in-house sharpening methods at a Sydney meat plant, we compared 2 pairs of identical boning knives, one pair honed and deburred by the plant sharpener on a solid felt wheel at 2850 RPM, and another by us on slotted paper wheels.

Honing wheel	Initial sharpness BESS	In 1.5 hours	In 3 hours	In 4.5 hours
Rock-hard felt wheel	**73**	**278**	**277**	**303**
Slotted paper wheel	**125**	**230**	**265**	**290**

sum of BESS sharpness scores measured at 1.5-hour intervals, divided by the number of measurements taken at that time

Edge dulling by hours worked



the lower the score, the sharper the knife

During the first 2 hours of cutting, knives honed on the slotted paper wheel stay 20% sharper than the same knives honed on the felt wheel.
The felt wheel renders a weaker edge at the very apex that shows more rapid dulling.
The difference evens out as the edge apex in paper wheel knives gets also dull by the 3rd hour.

We think that honing on felt at high RPM overheats and thus over-tempers (some use the term “detempers”) the edge apex, making it prone to rolling and compromising the edge retention.
Felt wheel at high RPM causes the blade to dull at a faster rate through the same usage cycle due to the overheating of the edge during sharpening.

We know many knife sharpeners who use felt wheels at high RPM for honing and deburring, thinking that loading them with a buffing compound saves the edge from burning - unfortunately, it does not save the very edge apex, and while your fingers on the blade don't feel any heat, the 0.1 micron apex gets overheated and loses temper.

Knives are typically tempered at 150-370°C or 300-700F, and many at 150-260°C or 300-500F.
Tempering over 425°C(800F) is usually avoided because it reduces impact resistance.

Once the knife edge is heated to a temperature above the temperature at which this particular steel was tempered, it softens.
Between 200-260° Celsius (400-500°F) edge in mainstream knives starts softening.
By 350-370°C or 650-700F even quality mainstream knives lose their temper and soften.

The softer, detempered structure of the metal causes the edge to fold over (roll) more quickly, resulting in a dull blade.
We suppose that detempering overheating of the apex in the area up to 0.5 micron thick is probable - 0.5 micron or 250 BESS is where the felt and paper-wheel knives start scoring the same.

Felt wheel at 2850 RPM it not the best deburring media. Felt is great for polishing bevels, but not for deburring the edge apex.

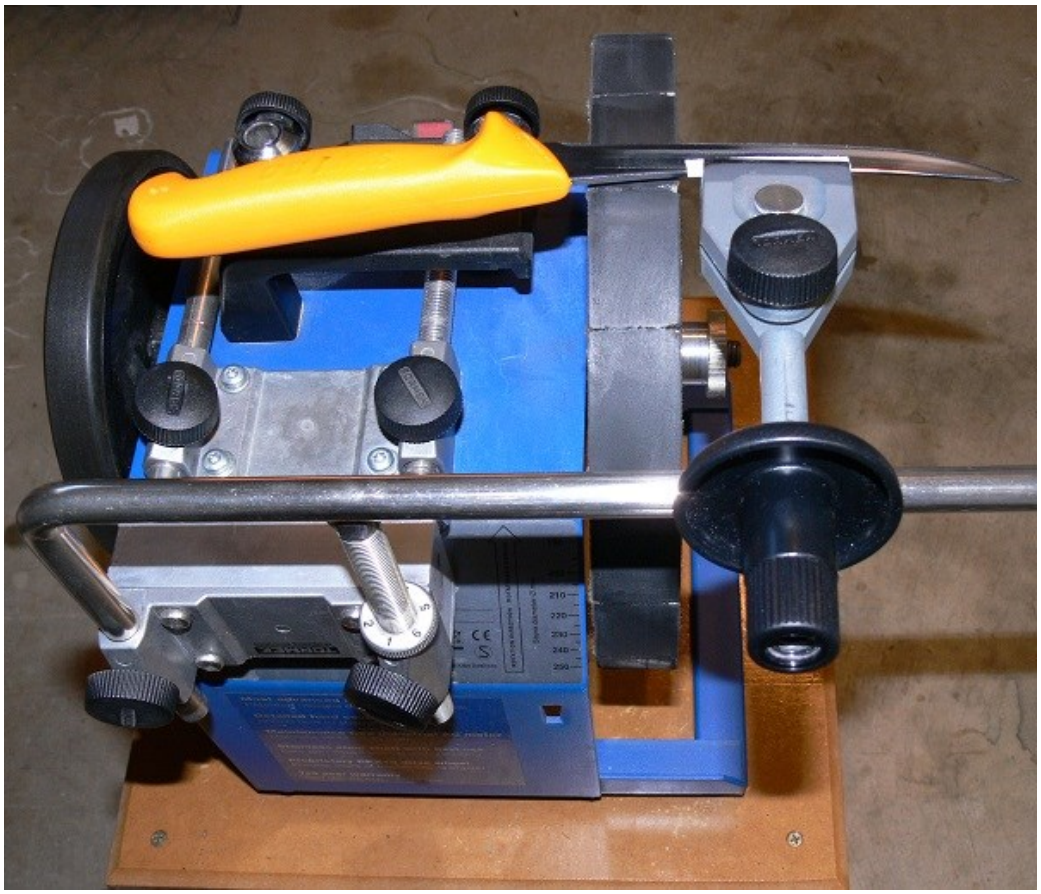
At that high RPM the deburring wheel must be slotted not to cause overheating. Cross slots work as a fan cooling the edge as it is deburred.
Below is pictured a slotted felt wheel we use with half-speed RPM grinders for deburring in our workshop – such wheels cause minimal overheating.

Those observations at the meat plant lead us to a more thorough research of how honing methods may effect the edge retention.

To test further, we engaged a boning butcher at Camden.
We sharpened two identical boning knives for live boning trial - these knives are of the same catalog ID that our butcher uses for life.
Both knives were sharpened at 12 dps the same way, with only one difference:

The **Knife-1** was deburred on a rock-hard slotted felt wheel run on a half-speed grinder at 1425 RPM

While the **Knife-2** was deburred on the same slotted felt wheel run on Tormek at 90 RPM



For the edge angle accuracy, to rule out any discrepancies, we deburred the test knives using a knife jig and our computer software to control the honing angle.
The outcome of this trial was to tell us whether deburring on the felt at high RPM degrades the edge retention.

SET TESTING

We SET-tested the knives we gave to the boning trial.
For the purpose of the SET, we sharpened more knives in the similar manner, deburring them on the same slotted wheel run at 2850 RPM, 1425 RPM and on Tormek 90 RPM (using a reducer bushing to fit the Tormek shaft).

We did 2 series of SET testing: one with a steel impact roller, and another with a copper roller.
The SET testing shows that deburring on a slotted felt wheel at 1425 RPM worsens edge resilience to rolling and its effect is comparable to the slotted paper wheel at 2850 RPM; while the slotted paper wheel at 1425 RPM causes no detectable adverse effect.

SET testing data follow.

SUMMARY

Knives: **Victorinox SWIBO HRC 58**
Edge angle 12 dps
SET Steel roller 150 grams. Sharpness tester BESS PT50A

Sharpening
Edge set on #400 CBN wheel on Tormek, then deburred as specified below.

Deburring Mode	Average sharpness over 100 rolling cycles	% change vs Tormek
Slotted FELT Tormek 90 RPM	360	
Slotted FELT Grinder 1425 RPM	380	5.5%
Slotted PAPER WHEEL Tormek 90 RPM	370	
Slotted PAPER WHEEL Grinder 1425 RPM	372	0.5%
Slotted PAPER WHEEL Grinder 2850 RPM	381	3%

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.
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.

SLOTTED FELT WHEEL

Roller material →	STEEL ROLLER		COPPER ROLLER	
Deburring Mode →	Grinder 1425 RPM	Tormek 90 RPM	Grinder 1425 RPM	Tormek 90 RPM
Initial sharpness (BESS)	125	98	97	101
SHARPNESS (BESS)	x1=226 x2=304 x3=308 x4=282 x5=318 x10=330 x15=355 x20=383 x25=423 x30=406 x35=411 x40=418 x45=442 x50=428 x60=393 x70=451 x80=425 x90=440 x100=467	x1=222 x2=275 x3=258 x4=284 x5=277 x10=298 x15=345 x20=370 x25=392 x30=377 x35=356 x40=382 x45=397 x50=416 x60=397 x70=453 x80=429 x90=446 x100=460	x1=104 x2=87 x3=92 x4=92 x5=104 x10=116 x15=158 x20=131 x25=174 x30=197 x35=150 x40=213 x45=206 x50=250 x60=290 x70=256 x80=251 x90=263 x100=298	x1=90 x2=78 x3=78 x4=81 x5=76 x10=89 x15=99 x20=82 x25=93 x30=96 x35=90 x40=98 x45=91 x50=125 x60=154 x70=172 x80=173 x90=220 x100=218

STEEL ROLLER

KEY INDICATOR → Deburring Mode ↓	Average sharpness over 100 cycles	Average sharpness in the Phase I (elastic deformation)	Sharpness by the end of the Phase II (elasto-plastic transition)
Grinder 1425 RPM	380	288	429
Tormek 90 RPM	360	263	398

COPPER ROLLER

Deburring Mode	Average sharpness over 100 cycles
Grinder 1425 RPM	181
Tormek 90 RPM	116

When in the SET test a copper roller is used instead of the steel, the 1425 RPM edges roll by 56% worse than Tormek-deburred. Using a softer roller in SET testing magnifies the differences in edge holding during the elastic deformation phase, making them readily observable. It takes 100 copper rolls to deform the edge to the same extent that the steel roller does in the first 5 rolls.

SLOTTED PAPER WHEEL

Steel roller

Deburring Mode →	Grinder 2850 RPM	Grinder 1425 RPM	Tormek 90 RPM
Initial sharpness (BESS)	123	125	101
SHARPNESS (BESS)	x1=261 x2=264 x3=279 x4=323 x5=299 x10=365 x15=342 x20=374 x25=377 x30=384 x35=383 x40=413 x45=418 x50=464 x60=449 x70=467 x80=464 x90=438 x100=477	x1=247 x2=270 x3=302 x4=342 x5=317 x10=332 x15=358 x20=348 x25=375 x30=370 x35=417 x40=378 x45=437 x50=421 x60=429 x70=454 x80=400 x90=485 x100=390	x1=207 x2=247 x3=263 x4=288 x5=299 x10=322 x15=334 x20=365 x25=391 x30=386 x35=365 x40=407 x45=416 x50=436 x60=458 x70=458 x80=471 x90=464 x100=449

KEY INDICATOR → Deburring Mode ↓	Average sharpness over 100 cycles	Average sharpness in the Phase I (elastic deformation)	Sharpness by the end of the Phase II (elasto-plastic transition)
Grinder 2850 RPM	381	285	432
Grinder 1425 RPM	372	296	412
Tormek 90 RPM	370	261	420

LIVE BONING TRIAL

The **Knife-1** was deburred on a rock-hard slotted felt wheel run on a half-speed grinder at 1425 RPM; the **Knife-2** was deburred on the same slotted felt wheel run on Tormek at 90 RPM.
Both knives given to the butcher scored the same **55 BESS** - for mainstream knives this is a strong indicator of a clean apex free of any wire edge.

We agreed with our butcher that he would start his beef boning load with our knives and continue with them as long as they last, steeling them the normal way they always steel.
We asked the butcher to compare the knife performance between #1 and #2, and to the similar SWIBO knives he sharpens himself on benchstones - he does not know which knife is what, and can tell them apart only by number of dots on the handle.

The knife #1 end sharpness score was 240 BESS, and the knife #2 was 215 BESS.

Feedback:
The knife #1 did 3 steer carcasses and 2 hind quarters, and the knife #2 did 3 steer carcasses and 2 hind quarters. The knives could cut more, but that was the entire load for that day.
The knives began razor sharp, and kept the edge very well [with steeling], overall they performed "every whit" as good as knives sharpened by himself.
These two knives did differ in performance: the knife #1 better recovered sharpness in response to steeling; while the knife #2 initial razor sharpness lasted longer "for good first 20 minutes of cutting".

The fact that the knife #1 that was honed at high RPM better responded to steeling can be explained by a somewhat softer edge as compared to the knife #2.

RECOMMENDATIONS

FELT
Deburring on solid felt wheel at high RPM is not recommended.
Deburring on slotted felt wheel at 2850 RPM is not recommended.
Deburring on slotted felt wheel at 1425 RPM is conditionally acceptable, provided that the contact of the edge with the wheel is less than 1 second per pass, sides are alternated with each pass, and number of passes is limited to 2 in one go.

PAPER WHEEL
Deburring on solid paper wheel at high RPM is not recommended.
Deburring on slotted paper wheel at 2850 RPM is conditionally acceptable, provided that that the contact of the edge with the wheel is less than 1 second per pass, sides are alternated with each pass, and number of passes is limited to 2 in one go.
Deburring on slotted paper wheel at 1425 RPM is recommended.

Following these recommendations ensures the edge temper is not compromised in the process of deburring.

CONCLUSIONS

It is clear from both our plant trials and the SET-testing numbers that, even though overall worsening of edge retention in high RPM edges may not be huge, the peak worsening happens when the edge is the sharpest - edges compromised by high RPM honing lose the initial sharpness quicker, i.e. transit quicker from the initial elastic deformation to the irreversible plastic deformation.

In simple terms, it matters for very sharp edges.
If your knife application does not require lasting sharpness of < 250 BESS, you can ignore these differences, but now it will be a well-informed consensual ignorance.

The New Zealand university researchers [1], using a different sharpness tester and experimental setup, saw the same pattern in edge holding: the belt sharpened knife dulled about twice as fast as the knife sharpened manually on a bench stone and to a greater degree.
The thorough research on edge overheating by W.B. Rowe[2] supports our findings.

By what we've seen in the scientific studies, and our Australian SET edge rolling experiments, in our trials at the meat plant and with the boning butcher - we can confidently conclude that the difference imparted by sharpening and honing methods matters in the initial performance of very sharp edges under 0.4 micron edge apex width; these differences level out after the first 2 hours of live cutting and/or when the sharpness drops over 0.5 micron edge apex. In other words, where very sharp edge is a requirement, the edge honing must be done slow & cool not compromising its retention.

Scientific studies on grinding [2], interpreted for knives, tell us that the blade is not overheated if pulled across an 8-10” honing wheel at a feed rate of approx. 10cm per 1 second on full speed grinder/buffer, and 5cm on half-speed.

Related literature

[1] Full article can be downloaded from the New Zealand WAIKATO University website:
The Measurement of Knife Sharpness and the Impact of Sharpening Technique on Edge Durability

[2] W B Rowe "Temperature case studies in grinding including an inclined heat source model."
School of Engineering, Liverpool John Moores University UK

[3] https://knifesteelnerds.com/2019/04/08/does-sharpening-with-a-grinder-ruin-your-edge/