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MEASURING THE SHARPNESS OF KNIVES USED IN WOODWORKING MACHINERY

By:Ph.A.Roulier.

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CONTENT.

INTRODUCTION.

This report is the continuation of a research started by Richard J. Kohrt in the Fall 1946-47, in an effort to find some facts about the sharpness of knifes used in wood working machines, such as planers, shapers...etc, and if possible to develop a method of actually measuring this sharpness.

Very few facts are available on this important matter; R. Kohrt however who based his researches on the theory used to verify the sharpness of the microtone, found by examining the edges of the blades from the side, that the distance between the protrusions was varying inversely with the sharpness of the knife: as the knife became sharper, this distance decreased.

He encountered however many difficulties on account of the number of irregularities appearing along the edge, which made very difficult to judge which of these protrusions were to be considered as high points.

In this experiment, a different approach was used.

The first question that comes to the mind of the observer is: just what makes a knife to be sharp? or in other words, what are the characteristics of a sharp knife?

In order to answer it, a new razor blade (of the Eversharp type) was examined under a microscope assuming that such a cutting edge is somewhat near the perfection.

Seen from the side,it showed a very smooth edge,appearing as a perfectly straight line.

Then the blade was turned perpendicularly and the edge examined from the top. A scale fitted in the eyepiece of the microscop showed that the width of this edge was very consistently one and 1/4 division,which after calibration was found to be: 9.9 μ. in.

This confirmed therefore the two facts that a sharp knife should have as nearly as possible a straight edge when seen from the side, and be as thin a s possible when seen from the top.

The first characteristic undoubtedly is responsible for a smooth finished surface,and the second for the ease of penetration of the blade into the wood with a good cutting action.

The researches were therefore conducted along those two lines with emphasis on the first one.

FIRST PART: MEASURING THE THICKNESS OF THE EDGE.

Five shapers knives were selected: they were 3" long, 1" wide, with a 10 degrees cutting angle (See Fig.1).

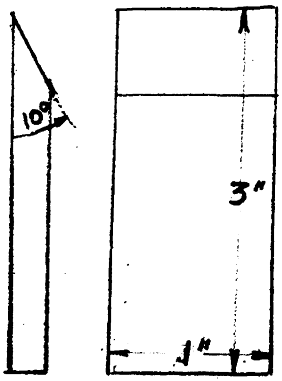


FIG.1

They were studied as they were found, without any alteration; therefore some were quite blunt, some on the contrary appeared at the start fairly sharp.

In addition, two new razor blades, of the Eversharp type were used for comparison.

1/ Method.

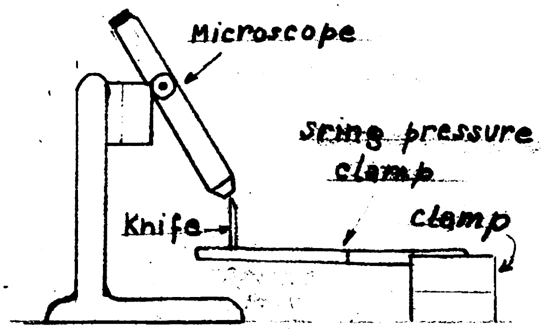


FIG.2

The measuring instrument was a microscope, in the eyepiece of which had been fitted a graduated scale: the magnification power of the objective lens was 12.5 and of the eyepiece also 12.5.

The scale had to be calibrated for this particular combination and it was accomplished by placing a micrometer slide on the stage of the microscope and determining the number of microns corresponding to each unit of the scale in the eyepiece. The ratio was found to be 7.9 microns for one division.

After this had been done, the stage of the microscope had to be removed because it was in the way of the knife held vertically by a spring pressure clamp (See Fig.2).

It was essential to have the edge well lighted and two lamps were set, one on top and in the back of the knife, the other below and in front; an additional mirror was judged necessary: it could be moved around by hand and when the picture was properly focused, it was placed on one side of the knife, then on the other, so that both sides of the edge were successively stongly illuminated and accurate readings could be obtained.

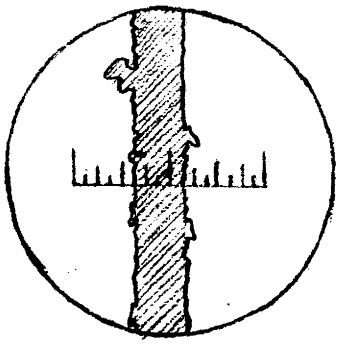


Fig.3

The knife was then moved little by little under the microscope, so that its whole width could be examined, but usually its thickness was fairly consistent and one reading sufficed.

Occasionally, some large projections were encountered and their length was noted, but they were not taken into account in the determination of the thickness of the edge (See Fig.3)

After this first step, the knives were sharpened on the grinding wheel and re-examined in the same way, before honing.

Finally, they were honed carefully on the honing stone until they appeared and felt sharp under the finger. They were examined for the third time and the results recorded as in the previous cases.

2/ Results.

	Thickness (in microns).		
	Before Sharpening	Before Honing	After Honing
Razor blade	9.9	-	-
Knife No.1	23.7	102.7	19.8
Knife No.2	63.1*	126.3	15.8
Knife No.3	39.5**	63.3	17.8
Knife No.4	43.5**	182	15.8
Knife No.5	118.5	55.2	19.8

3/Discussion of results.

These results seem to confirm the hypothesis that the sharper a knife gets, the thinner its edge gets too.

The razor blade (9.9 microns) is way ahead of the others, which could be foreseen, but the five knives after sharpening are well grouped around 16 microns, with a satisfactory consistency. In spite of all efforts it was impossible by resharpening to bring any of them below 15.8 microns (two divisions of the scale) which

* Has projections up to 80 microns.

** Has a front bevel.

is apparently the optimum limit.

It should be pointed out that most of the results obtained before sharpening corresponded quite well to expectations: for instance, knife No.1 felt quite sharp even before sharpening when tested with the finger, and this is confirmed by comparing its thickness before (23.7 microns) and after (19.8 microns) sharpening. On the contrary, knives No.2 (63.1 microns) and No.5(118.5 microns) felt very blunt under the finger, while knives No.3 (39.5 microns) and No.4 (43.5 microns) appeared to stand somewhere between those two extremes.

There seems therefore to exist a definite relationship between sharpness and thickness of the edge, although this characteristic alone is obviously not the determining factor of a well sharpened knife.

SECOND PART: ANALYSING THE SMOOTHNESS OF THE EDGE.

1/ Method used in making the chart.

This second part of the problem was solved by the use of a "Brush" Surface Analyser. This extremely accurate apparatus is primarily designed to analyse apparently smooth surfaces and record their irregularities, like bearing surfaces, gear faces, etc. It was thought however that it could be applied in this case.

The machine consists essentially of three parts: the motor driven pick-up arm, the calibrating amplifier and the direct inking oscillograph.

The surface under consideration is traced with a fine diamond stylus (.0005 in. radius), the vertical and horizontal motion of which is then magnified and recorded on a moving paper chart.

a/ The motor driven pick-up arm.

The exploring head consists of a 110 volts, 60 cycles A.C. motor and gear train enclosed in a housing and mounted on a stand that can be adjusted horizontally and vertically. Extending from the bottom of the housing is a shaft to which is attached the pick-up arm: the movement of the shaft guides the pick-up arm in a reciprocating motion of 1/16" long in either direction.

The pick-up arm is held in place by conical bearings in the yoke-type hanger and can be readily raised off. Best results are obtained when this arm is approximately horizontal.

A piezo-electric crystal element is housed in the outer end of the pick-up arm; to this is connected thru a lever system the diamond stylus which rises over and falls into the surface irregularities as it moves back and forth over the specimen under test. Located directly behind the stylus is an adjustable positioning shoe. This shoe rests upon a relatively large surface, bearing the entire free weight of the arm and establishing a zero reference from which the stylus measures the surface variations.(See fig.4).

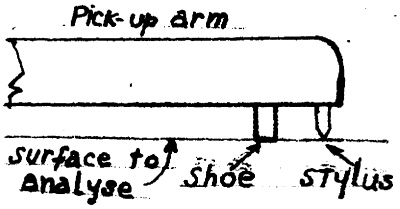


Fig.4

b/ The calibrating amplifier.

The calibrating amplifier greatly magnifies the electrical impulses produced by the bending of the crystal, the polarity of which depends on the direction of the stylus movement, and delivers them to the oscillograph pen motor. It has a stable linear circuit that faithfully amplifies and reproduces the stylus movement from 1 to 500 cycles per second.

A six steps sensitivity control, or attenuator, on the input is adjustable for different degrees of roughness in the analysed surface; in the case considered, it was found best suitable to place it on: .1.

A gain control regulates the degree of amplification and makes it possible to calibrate the instrument.

c/ The direct inking oscillograph.

The direct inking oscillograph makes a graphic record of the profile of surface irregularities, the inking

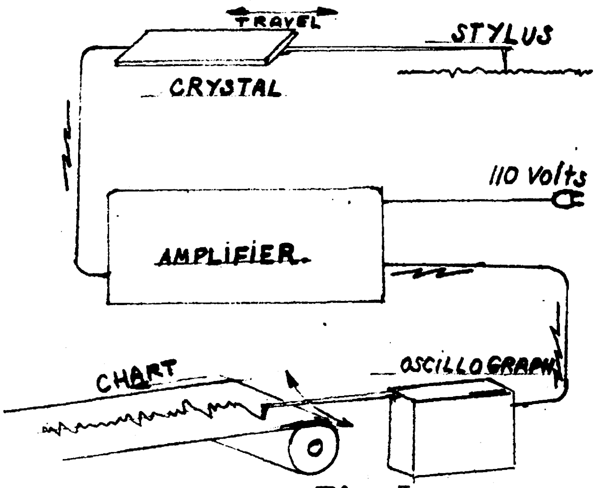


Fig.5

pen swinging back and forth in rapid irregular strokes over the moving chart paper.

The chart is drawn by a constant speed motor, and selective gear trains give a choice of three speeds: 5mm/sec., 25 mm/sec. and 125 mm/sec, corresponding to approximately 1/5",1" and 5"/sec. (See Fig.5).

To isolate the drive head and test specimen from extraneous vibrations, they are mounted on a cast iron surface plate which is supported by 4 heavy duty rubber insulated feet.

The main practical difficulty encountered in applying this method to our case, was to keep the end of the stylus from falling from the edge of the knife under test. It was finally overcome very satisfactorily by placing

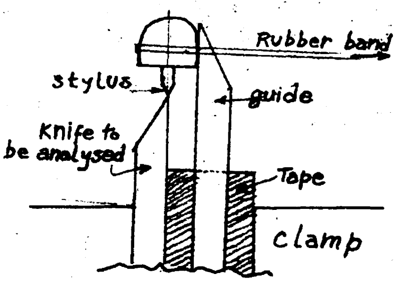


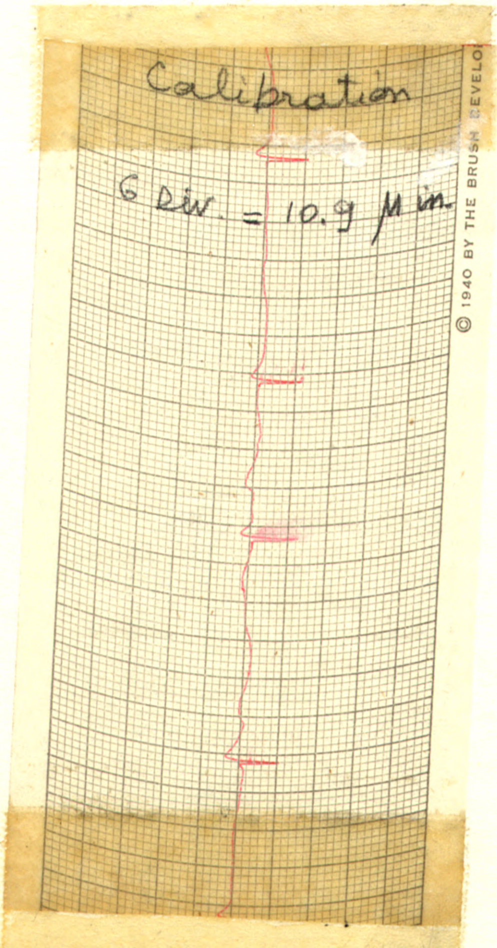
Fig.6

another knife as a guide at the proper distance along the first one, so that the arm holding the stylus would ride against it; the distance between the two knives was regulated by varying the number of windings of a piece of tape around the guide-knife.(See Fig.6) A rubber band prevented the stylus from falling on the other side.

An other difficulty was that the movement of the stylus being only 1/16", it was impossible to cover the whole width of the knives, but in general five analysis were made along each edge at different places, by moving slightly the knife and its holding device. In each position, several curves were obtained with the slow speed of the chart, and one at least with the medium speed.

The five knives and one razor blade were thus analysed ,first as they were found, i.e. usually blunt, and a second time after sharpening, so as to give a good basis for comparison. (See charts at end of report).

Calibration.



The analyser was calibrated by having the stylus ride on a perfecly smooth glass surface, containing however a small groove of known depth (10.9 micro in.); we can see on the chart at left that it corresponds to about 6 divisions on the graph paper used.

2/ Interpretation of the charts.

It was then endeavoured to relate the charts thus obtained to a numerical figure that would be proportional to the sharpness characteristics of the knife.

Remembering that the ideal edge would be represented on the chart by a straight line, two methods seemed appropriate:

- measuring the sum of the areas contained between the curve and the horizontal axis of reference (above and below).
- measuring the lenght of the curve corresponding to a complete cycle of the stylus.

In both cases, it was thought the result would vary inversely with the sharpness, since we assumed that a sharp knife would give a smoother curve, more nearly following the axis, than a blunt knife. This assumption was verified.

By glancing at the charts, it was evident that analysing the chart obtained with the slow speed of the registering machine was just impossible, on account of the excessive number of irregularities packed up along such a small distance; the experimental error would have been unacceptable. Nevertheless, the slow speed charts kept a certain interest because they gave at a glance a better idea of the results to be expected; that is why they were made in spite of their drawback.

The medium speed chart on the contrary was spread on a much longer distance (50 squares of the chart against 10) and it lent itself much more readily to the desired measurements.

a/ Measuring the areas.

The instrument used to measure these areas was the Planimeter.

It is composed of two arms united by a hinge. The end of one of the arms bears a sharp point, that is stuck in the table, outside of the area to be measured and is used as a fixed point.

The other arm is equipped at the end nearest to the hinge with a roller and a graduated wheel with vernier; at the other end with an other point which is guided by hand along the curve.

As this point is moved, the roller revolves by friction on the table, and the number of revolutions is recorded by the calibrated wheel and vernier. The apparatus does not have to be set on zero, but a first reading is taken before starting and substracted from the reading obtained at the end. The result is then multiplied by 10 and the number obtained is the area in square inches of the surface measured.

It is essential that the outline of the area to be measured should be followed clockwise: in our case consequently, as part of it is below the axis, and part of it above, it was necessary to start at the left, and

and follow the curve toward the right, staying continuously above or on the axis when meeting it; when reaching the far end of the curve on the right, the return was done from right to

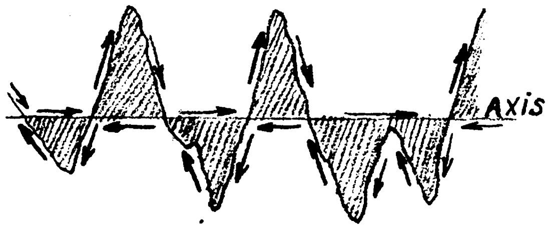


Fig. 7

left, staying continuously below or on the axis, when meeting it (See Fig.7).

That way as indicated by the arrows, each individual area is encircled clockwise and they all add up in the final result.

b/ Measuring the length of the curves.

This part of the operation was carried out with a simple curvemeter, such as those used in geography to measure distances on a map. This device is essentially composed of a corrugated wheel guided by hand along the curve; the number of revolutions is recorded on a dial that can be easily calibrated.

It is obvious that, the shortest distance between two points being a straight line, the smoother the curve, the shorter it will be, the more irregular, the longer it will be.

From the total number of divisions obtained, 24.4 were substracted because it is the number corresponding to the distance in straight line between the two points considered, and what we are most interested in is the amount by which the lenght of the curve exceeds this quantity.

The result was then ~~divided~~ multiplied by .4 to have it in inches (1 division of the dial corresponds to .4 in.)

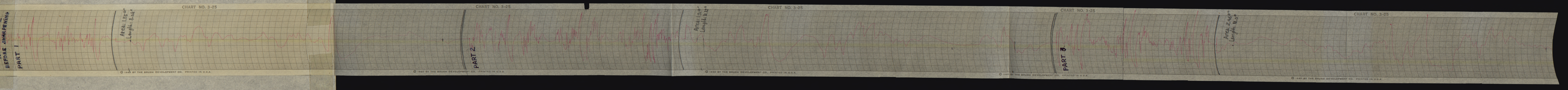
This is only a different method to analyse the curves and should yield approximately the same classification as the preceding one.


RAZOR BLADE.
PART 1.
SLOW SPEED
cycle
HIGH SPEED
Area: .86"
Length: .66"
(over 24.4")
CHART NO. 3-25
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.
PART 2
Area: 1.33"
Length: .96"


KNIFE No 1
AFTER SHARPENING
PART 1.
Area: 1.60□"
Length: 13.00
CHART NO. 3-25
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.
PART 2
PART 3
PART 4
PART 5


KNIFE No 1.
BEFORE SHARPENING
PART 1.
Area: .180□"
Length: 14.24"
CHART NO. 3-25
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.
PART 2
PART 3
PART 4


KNIFE No 2
AFTER SHARPENING
PART 1
CHART NO. 3-25
Area: .780"
Length: 2.68"
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.
PART 2
PART 3
PART 4
PART 5


BEFORE SHARPENING
PART 1
CHART NO. 3-25
Area: 1.85"
Length: 8.04"
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.
PART 2
PART 3

18


KNIFE No 3
AFTER SHARPENING
PART 1.
CHART NO. 3-25
Area: 1.71 □"
Length: 4.24"
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KNIFE No 3
BEFORE SHARPENING
PART 1.
CHART NO. 3-25
Area: 2.51 □"
Length: 7.88"
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.


KNIFE N° 4
AFTER SHARPENING.
PART 1.
CHART NO. 3-25
Area: .410"
Length 1.44"
PRINTED IN U.S.A.
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.


KNIFE No 4
BEFORE SHARPENING.
PART 1.

KNIFE N°4
AFTER SHARPENING.
PART I.
CHART NO. 3-25
Area: .410"
Length: 1.44"
© 1940 BY THE BRUSH DEVELOPMENT CO. PRINTED IN U.S.A.

KNIFE No 4
BEFORE SHARPENING.
PART I.
© 1940 BY THE BRUSH DEVELOPMENT

3/ <u>Results of chart analysis</u>.

RAZOR BLADE.

	Area (sq.in.)		Length (in.)	
Part 1	5.855		25.8	
	-5.769		-24.4	
	.086x10	.86	1.4x.4	.66
Part 2	6.310		26.8	
	-6.177		-24.4	
	.133x10	1.33	2.4x.4	.96
Part 3	5.674		25.0	
	-5.585		-24.4	
	.089x10	.89	.6x.4	.24
Part 4	4.837		26.6	
	-4.692		-24.4	
	.145x10	1.45	2.2x.4	.88
Part 5	3.939		24.5	
	-3.870		-24.4	
	.069x10	.69	.1x.4	.04
Part 6	3.302		24.8	
	-3.225		-24.4	
	.077x10	.77	.4x.4	.16
Average:	.98 sq.in.		.49 in.	

KNIFE No. 1

1/ Area. (sq.in.)	Before sharpening	After sharpening.
Part 1	8.217 -8.037 = .180x10 1.80	3.992 -3.832 = .160 x10 1.60
Part 2	8.646 ~~*8*~~415 = .231x10 2.31	1.958 -1.886 = .072x10 .72
Part 3	7.810 -7.588 = .222x10 2.22	9.450 -9.353 = .097x10 .97
Part 4	8.028 -7.707 = .321x10 3.21	8.134 -8.046 = .088x10 .88
Part 5	-	6.370 -6.310 = .060x10 .60
Average:	2.39 sq.in.	.95 sq.in.

2/ Length (in.)	Before sharpening	After sharpening.
Part 1	60 -24.4 = 35.6x.4 14.24	56.9 -24.4 = 32.5x.4 13.0
Part 2	73 -24.4 = 48.6x.4 19.44	32.8 -24.4 = 8.4x.4 3.36
Part 3	66 -24.4 = 41.6x.4 16.64	34.9 -24.4 = 10.5x.4 4.20
Part 4	65 -24.4 = 40.6x.4 16.24	43.7 -24.4 = 19.3x.4 7.72
Part 5	-	46 -24.4 = 21.6x.4 8.64
Average:	16.64 in/	7.38 in.

KNIFE No. 2

1/ <u>Area</u> (sq.in.)	Before sharpening	After sharpening.
Part 1	1.581 -1.396 .185x10 1.85	8.090 -8.012 .078x10 .78
Part 2	9.907 -9.716 .191x10 1.91	7.787 -7.676 .111x10 1.11
Part 3	7.638 -7.392 .246x10 2.46	7.852 -7.759 .093x10 .93
Part 4	-	7.421 -7.311 .110x10 1.10
Part 5	-	6.943 -6.857 .086x10 .86
Average:	.207 sq.in.	.95 sq.in.

2/ <u>Length</u>.(in.)	Before sharpening	After sharpening.
Part 1	44.5 -24.4 20.1x.4 8.04	31.1 -24.4 6.7x.4 2.68
Part 2	52.2 -24.4 27.8x.4 11.12	49 -24.4 24.6x.4 9.84
Part 3	51.9 -24.4 27.5x.4 11.00	39 -24.4 14.6x.4 6.84
Part 4	-	50.3 -24.4 25.9x.4 11.36
Part 5	-	36 -24.4 11.6x.4 4.64
Average:	10.05 in.	7.07 in.

KNIFE No. 3

1/ Area. (sq.in.)	Before sharpening	After sharpening.
Part 1	2.846 -2.595 .251x10 2.51	3.915 -3.744 .171x10 1.71
Part 2	1.927 -1.661 .266x10 2.66	5.098 -4.978 .120x10 1.20
Part 3	4.710 -4.457 .253x10 2.53	3.918 -3.846 .072x10 .72
Part 4	4.069 -3.847 .222x10 2.22	2.608 -2.525 .083x10 .83
Part 5	-	2.523 -2.462 .061x10 .61
Average:	2.48 sq.in.	1.01 sq.in.

2/ Length. (in.)		
Part 1	44.1 -24.4 19.7x.4 7.88	35 -24.4 10.6x.4 4.24
Part 2	44.5 -24.4 20.1x.4 8.04	38.2 -24.4 13.8x.4 5.52
Part 3	53.9 -24.4 29.5x.4 11.80	29 -24.4 4.6x.4 1.84
Part 4	41.8 -24.4 17.4x.4 6.96	34.8 -24.4 10.4x.4 4.16
Part 5	-	28.9 -24.4 4.5x.4 1.80
Average:	8.67 in.	3.51 in.

KNIFE No. 4

1/ Area. (sq.in.)	Before sharpening	After sharpening
Part 1	-	2.596 -2.555 .041x10 .41
Part 2	2.157 -1.891 .266x10 2.66	2.331 -2.351 .080x10 .80
Part 3	3.603 -3.423 .180x10 1.80	1.818 -1.773 .045x10 .45
Part 4	2.072 -1.872 .200x10 2.00	-
Part 5	-	1.464 -1.387 .077x10 .77
Average:	2.15 sq.in.	.60 sq.in.

2/ Length. (in.)

Part 1	56 -24.4 31.6x.4 12.64	28 -24.4 3.6x.4 1.44
Part 2	94.6 -24.4 70.2x.4 28.08	36.5 -24.4 12.1x.4 4.84
Part 3	53.5 -24.4 29.1x.4 11.64	29.5 -24.4 5.1x.4 2.04
Part 4	-	32.1 -24.4 8.7x.4 3.48
Average:	17.45 in.	2.95 in.

KNIFE No. 5

1/ Area (sq.in.)	Before sharpening	After sharpening.
Part 1	2.240 -1.781 .459x10 4.59	2.647 -2.573 .074x10 .74
Part 2	2.435 -2.191 .244x10 2.44	2.902 -2.789 .113x10 1.13
Part 3	2.847 -2.498 .349x10 3.49	2.776 -2.656 .120x10 1.20
Part 4	2.763 -2.483 .280x10 2.80	3.201 -3.116 .085x10 .85
Part 5	-	3.261 -3.191 .070x10 .70
Average:	3.33 sq.in.	.92 sq.in.

2/Length (in.)		
Part 1	57.6 -24.4 33.2x.4 13.28	33 -24.4 8.6x.4 3.44
Part 2	46 -24.4 21.6x.4 8.64	33.7 -24.4 9.3x.4 3.72
Part 3	46.2 -24.4 21.8x.4 8.72	39.6 -24.4 15.2x.4 6.08
Part 4	48 -24.4 23.6x.4 9.44	37.8 -24.4 13.4x.4 5.36
Part 5	-	35 -24.4 10.6x.4 4.24
Average:	10.01 in.	4.56 in.

SUMMARY OF RESULTS.
(Classified.)

1/**Microscope**: Thickness of edge in microinches.

	Before	&	after sharpening
Razor blade	9.9		-
1- Knife no.1	23.7	1-Knife no.4	15.8
2- Knife no.3	39.5	2-Knife no.2	15.8
3- Knife no.4	43.5	3-Knife no.3	17.8
4- Knife no.2	63.1	4-Knife no.5	19.8
5- Knife no.5	118.5	5-Knife no.1	19.8

2/**Planimeter**: Area of curves above & below the axis, in square inches (average values).

	Before	&	after sharpening
Razor blade	.98	1- Knife no.4	.60
1- Knife no.2	2.07	2- Knife no.5	.92
2- Knife no.4	2.15	3- Knife no.2	.95
3- Knife no. 1	2.39	4- Knife no.1	.95
4- Knife no.3	2.48	Razor blade	.98
5- Knife no.5	3.33	5- Knife no.3	1.01

3/**Curvemeter**: Length of curves in inches, above 24.4 in.

	Before	&	after sharpening
Razor blade	.16		-
1- Knife no.3	8.67	1- Knife no.4	2.95
2- Knife no.5	10.01	2- Knife no.3	3.51
3- Knife no.2	10.05	3- Knife no.5	4.56
4- Knife no.1	16.64	4- Knife no.2	7.07
5- Knife no.4	17.45	5- Knife no.1	7.38

4/Thickness (from microscope) x length (from curvemeter)

	Before	&	after sharpening
Razor blade	1.58		-
1-Knife no.3	342	1- Knife no.4	47
2-Knife no.1	384	2- Knife no.3	62.5
3-Knife no.2	630	3- Knife no.5	90.1
4-Knife no.4	759	4- Knife no.2	111.5
5-Knife no.5	1185	5- Knife no.1	146

DISCUSSION OF RESULTS.

It is interesting to note, from the average values of the charts analysis that, at least when measuring with the curvemeter, the best results were obtained with knives No.4 and No.3 which were the only two of the lot who had a front bevel. It would seem to indicate therefore that a front bevel helps in obtaining a smooth edge.

In general the values obtained after sharpening were at least 1/3 of the ones obtained before sharpening, and in some cases the discrepancy was still more accentuated: the reader is referred to chart No. 4 as a typical example of a very dull knife on the left and a very sharp one on the right. The smoothest curve obtained was as could be foreseen the profile of the razor blade (p.15).

When considering one of the most irregular curves, it should be born in mind that the 1/16 in. movement of the stylus is represented by 1 in. on the chart; its horizontal movement is therefore amplified 16 times.

The calibration of the machine, on the other hand indicated that an irregularity of 10.9 micro in. corresponded to 6 divisions of the chart; thus 20 divisions (.75 in.) correspond to a vertical movement of the stylus of .000036 in., which means that this vertical movement is amplified about 2,000 times.

The great difference in horizontal and vertical amplification results in this apparently wild profile.

We can see on page 27, where the results are summarised (using only the average values) that the classifications obtained with the planimeter and the curvemeter are not identical for the five knives analysed before sharpening, although, except for knife No. 3 which is displaced, it is the same after sharpening. This together with the fact that the razor blade is coming only fourth in the classification obtained with the planimeter, seems to indicate the inferiority of this first method to the second one.

One could imagine in fact a knife that would be quite smooth but still would not follow too closely the axis of reference (see Fig. 8), thus registering a relatively large area on the planimeter, while the curvemeter, by clearly showing how close it is of the length of a straight line between the two points considered, would indicate its smoothness much more adequately.

Fig. 8

This is apparently the reason why the razor blade appears in a surprisingly bad position with the planimeter, but comes way ahead of all others as expected with the curvemeter and the latter method is therefore held as more satisfactory.

It should also be pointed out that the classifications obtained both before and after sharpening with the microscope on one hand, and the curvemeter on the other, are again not quite identical. But this is not surprising because it is obvious that a knife with a very thick edge might be made perfectly smooth by honing it vertically again the stone, and still be quite blunt; while a knife with a very thin edge might have been ground with an excessively coarse abrasive which would result in a very irregular profile.

The point to be brought out is that it is a combination of those two independent characteristics (smoothness and thinness of the edge) that makes a knife to be satisfactorily sharpened.

It is common when measuring the machinability of metals or wood, to measure with a Prony brake the force to be exerted by the knife in order to cut out a chip; but this idea may work both ways and for a given metal or wood, the force to be exerted will be proportional to the sharpness of the tool: this force is expressed in pounds per square inch, and the smaller the area on which it has to be exerted, the smaller the total amount of pounds to be applied; i.e. the sharper the tool.

This area on which the force is applied is precisely the area of the edge and it is reduced to a minimum when the thickness of the edge is minimum and when its profile approaches the straight line; in fact the ideal and unattainable goal would be an edge represented by a simple straight line of area equal to 0.

This constatation leads to the combination of the results obtained with the microscope and the curvemeter, by multiplying the thickness of the edge by its length.

No attempt was made here to convert both these values to the same unit and get the actual value of the area, because the results would have been too small and all what we are interested in is a comparison between the different knives considered.

Thus the actual thickness of the knife in microinches was multiplied by the amount in inches by which the length of the curve exceeded 24.4 inches. The resulting classification (bottom of p.27) is not different in this case from the one obtained with the curvemeter alone, but this is a sheer coincidence due to the fact that after sharpening the thicknesses were not widely different: the razor blade is still way ahead, followed in order by knife No.4, No.3, No.5, No.2, and No.1, and the values after sharpening are on the whole about 1/10 of the values before sharpening.

These final values should definetely be proportional to the sharpness of the knives studied and it seems therefore that this method provides a way of measuring it.

Obviously, it cannot be expected to be applicable in the industry on account of its complexity, as well as the care and time involved, and it remains strictly a

Laboratory method.

It could however open the way to some researches: studying for instance the relative qualities of different abrasives, comparing methods of grinding in view of obtaining the best results, analysing tools made of different steel qualities and finding out which is easier to machine into a sharp knife and which remains sharp longer...etc.

The need for such researches is felt strongly and they might prove valuable.

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