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A comparison of the gross ophthalmometer cylinder and the gross ophthalmometer cylinder as modified by the rules of Javal, McCulloch and Sutcliffe, with the clinically acceptable cylinder habitually worn by the subject

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Abstract

A comparison of the gross ophthalmometer cylinder and the gross ophthalmometer cylinder as modified by the rules of Javal, McCulloch and Sutcliffe, with the clinically acceptable cylinder habitually worn by the subject

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A COMPARISON OF THE GROSS OPHTHALMOMETER CYLINDER AND THE GROSS OPHTHALMOMETER CYLINDER AS MODIFIED BY THE RULES OF JAVAL, MCCULLOCH AND SUTCLIFFE, WITH THE CLINICALLY ACCEPTABLE CYLINDER HABITUALLY WORN BY THE SUBJECT.

Clinical Year Thesis

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Jack T. Robinson
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INTRODUCTION

PROBLEM:

The purpose of this study was to determine how the gross ophthalmometer cylinder compared to the habitual cylinder which was being worn satisfactorily by a group of subjects. Also to determine how the gross ophthalmometer cylinder when modified in accordance with three standard rules compared to the habitually worn cylinder. The three rules of modification of the gross ophthalmometer cylinder into a net correction cylinder, used in this study were those of Javal, McCulloch, and Sutcliffe. From this information a comparison of the three rules could be made as to their relative validity in predicting a clinically acceptable cylinder from the ophthalmometer findings.

PROCEDURE

The Ophthalmometer findings were taken by the same clinician on the Bausch and Lomb Keratometer. Findings were taken only on patients reported that they were satisfactorily wearing their habitual cylinder. The findings were then grouped according to the power of the habitual cylinders ranging from -.25D to -1.00D in .12D steps and from -1.00D to -3.00D in -.25D steps. The following is an explanation of the method of application of the three above mentioned rules.

1. Javal's Rule:

   a. In cases of with the rule astigmatism (minus cylinder axis nearest 180°) the gross ophthalmometer cylinder is multiplied by 1.25 and .50D X 90 is then subtracted from the product. If the product is less than .50D the axis becomes 90°.

   b. In case of against the rule astigmatism (minus cylinder axis nearest to 90°) the gross ophthalmometer cylinder is multiplied by 1.25 and .50D is then added to this product.

   c. For the purpose of analysis in the case of oblique astigmatism (axis 45° or 135°) the gross ophthalmometer cylinder becomes the net cylinder. We are interpreting this rule as ignoring oblique astigmatism so that the gross cylinder becomes the net.

2. McCulloch's Rule

a. In cases of with the rule astigmatism (minus cylinder axis nearest 180°) the gross ophthalmometer cylinder is multiplied by one and one eighth and .75D is subtracted from the product. If the product is less than .75D the net cylinder axis is 90°.

b. In case of astigmatism against the rule (minus axis nearest 90°) the gross ophthalmometer cylinder is multiplied by one and one eighth and .75D is added to the product.

c. For the purpose of analysis in the case of oblique astigmatism (axis 45° or 135°) the gross ophthalmometer cylinder becomes the net cylinder. W_e are interpreting this rule as ignoring oblique astigmatism so that the gross cylinder becomes the net.

3. 3. Sutcliffe's Rule

a. In case of with the rule astigmatism (minus cylinder axis nearest 180°) the gross ophthalmometer cylinder is multiplied by 1.5 and from this 1.00D is subtracted. If the product is less than 1.00D, the axis becomes 90°.

b. In cases of against the rule astigmatism (minus cylinder axis nearest 90°) the gross cylinder is multiplied by 1.33 and the product becomes the net cylinder.

c. In cases of oblique astigmatism (minus cylinder axis at 45° and 135°,) the rule has no provision for these cases so they were not considered in this paper with respect to Sutcliffe's Rule.

In all cases, when the net cylinder axis was reversed to 90° by application of the rules, the cylinder was transposed to plus cylinder form for purposes of analysis. In all other cases minus cylinder form was used.

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
10	F	-.25 X 100	43.62 @ 170 44.25 @ 80	-.62 X 170	-.28 X 170	-.05 X 90	-.17 X 90
10	F	-.25 X 155	43.75 @ 170 44.00 @ 80	-.25 X 170	-.19 X 90	-.47 X 90	-.62 X 90
77	M	-.25 X 140	43.62 @ 5 44.62 @ 95	-1.00 X 5	-.75 X 5	-.37 X 5	-.50 X 5
51	M	-.25 X 165	42.87 @ 175 44.00 @ 85	-1.12 X 175	-.90 X 175	-.50 X 175	-.68 X 175
23	M	-.25 X 157	41.75 @ 155 42.25 @ 180	-.50 X 155	-.12 X 155	-.19 X 90	-.25 X 90
28	M.	-.25 X 90	43.37 @ 90 43.25 @ 180	-.12 X 90	-.35 X 90	-.62 X 90	-.82 X 90
13	M	-.25 X 105	44.75 @ 40 44.62 @ 130	-.12 X 130	-.Ø5 X 130	-.88 X 130	-.16 X 130
13	M	-.25 X 45	44.50 @ 155 44.37 @ 65	-.12 X 65	-.88 X 65	-.88 X 65	-.16 X 65
19	M	-.25 X 90	41.50 @ 6 41.75 @ 96	-.25 X 6	-.19 X 90	-.47 X 90	-.62 X 90
19	M	-.25 X 65	41.62 @ 171 42.25 @ 81	-.62 X 171	-.28 X 171	-.05 X 90	-.07 X 90
58	M	-.25 X 120	44.62 @ 157 45.25 @ 67	-.62 X 157	-.28 X 157	-.05 X 90	-.07 X 90
58	M	-.25 X 80	44.25 @ 164 44.87 @ 74	-.62 X 164	-.28 X 157	-.05 X 90	-.07 X 90

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
23	M	-.25 X 75	43.00 @ 166 43.50 @ 76	-.50 X 166	-.12 X 166	-.19 X 90	-.25 X 90
23	M	-.25 X 140	43.50 @ 162 44.50 @ 72	-1.00 X 162	-.75 X 162	-.37 X 162	-.50 X 162
18	F	-.25 X 85	43.25 @ 136 43.37 @ 46	-.12 X 136	-.35 X 90	-.62 X 90	-.82 X 90
58	M	-.25 X 180	43.50 @ 165 45.00 @ 75	-1.50 X 165	-1.38 X 165	-.94 X 165	-1.25 X 165
54	M	-.25 X 115	41.62 @ 163 41.87 @ 73	-.25 X 163	-.19 X 90	-.47 X 90	-.62 X 90
54	M	-.25 X 75	41.62 @ 175 42.62 @ 85	-1.00 X 175	-.75 X 175	-.37 X 175	-.50 X 175
447	F	-.25 X 105	41.75 @ 180 42.62 @ 90	-.87 X 180	-.59 X 180	-.22 X 180	-.30 X 180
42	M	-.25 X 105	41.37 @ 85 41.12 @ 175	-.25 X 175	-.19 X 90	-.47 X 90	-.62 X 90
26	F	-.25 X 135	44.25 @ 155	-.25 X 155	-.19 X 90	-.47 X 90	-.37 X 90
20	F	-.37 X 175	44.25 @ 175 44.62 @ 85	-.37 X 175	-.04 X 90	-.33 X 90	-.45 X 90
55	F	-.37 X 165	43.37 @ 150 44.25 @ 60	-.87 X 150	-.59 X 150	-.23 X 150	-.30 X 150

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
55	F	-.37 X 80	43.50 @ 10 44.50 @ 100	-1.00 X 10	-.75 X 10	-.38 X 10	-.50 X 10
45	F	-.37 X 65	43.87 @ 171 44.50 @ 81	-.62 X 171	-.28 X 171	-.05 X 90	-.07 X 90
21	F	-.37 X 95	41.75 @ 180 43.25 @ 90	-1.50 X 180	-1.38 X 180	-.94 X 180	-1.55 X 180
34	F	-.37 X 107	43.12 @ 180 44.12 @ 90	-.75 X 180	-.75 X 180	-.38 X 180	-.50 X 180
31	F	-.37 X 50	45.00 @ 90 44.50 @ 180	-.50 X 180	-.12 X 180	-.19 X 90	-.25 X 90
42	M	-.37 X 15	43.75 @ 180 44.50 @ 90	-.75 X 180	-.44 X 180	-.09 X 180	-.13 X 180
26	M	-.50 X 75	42.12 @ 42 42.00 @ 132	-.12 X 132	-.65 X 132	-.89 X 132	-.16 X 132
21	M	-.50 X 60	44.50 @ 10 44.87 @ 100	-.37 X 10	-.04 X 90	-.34 X 90	-.50 X 90
15	F	-.50 X 7	45.12 @ 172 46.12 @ 82	-1.00 X 172	-.75 X 172	-.37 X 172	-.50 X 172
27	M	-.50 X 112	43.37 @ 32 42.75 @ 122	-.62 X 122	-1.28 X 122	-1.45 X 122	-.83 X 122
18	F	-.50 X 180	41.62 @ 170 42.75 @ 80	-1.12 X 170	-.90 X 170	-.50 X 170	-.68 X 170

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
48	F	-.50 X 172	43.50 @ 172 44.37 @ 82	-.87 X 172	-.50 X 172	-.23 X 172	-.31 X 172
27	M	-.50 X 180	44.25 @ 170 45.12 @ 80	-.87 X 170	-.59 X 170	-.23 X 170	-.31 X 170
18	F	-.50 X 75	43.25 @ 180 43.75 @ 90	-.50 X 180	-.12 X 180	-.19 X 90	-.25 X 90
32	F	-.50 X 165	44.50 @ 150 45.62 @ 60	-1.12 X 150	-.90 X 150	-.50 X 150	-.68 X 150
58	M	-.50 X 176	43.25 @ 180 44.62 @ 90	-1.37 X 180	-1.21 X 180	-.79 X 180	-1.06 X 180
28	F	-.50 X 15	44.75 @ 180 46.62 @ 90	-1.87 X 180	-1.84 X 180	-1.34 X 180	-1.81 X 180
20	F	-.50 X 165	46.25 @ 180 45.25 @ 90	-1.00 X 90	-1.75 X 90	-1.87 X 90	-1.33 X 90
19	M	-.50 X 73	42.62 @ 40 42.00 @ 130	-.62 X 130	-1.28 X 130	-1.45 X 130	-.83 X 130
72	F	-.50 X 165	46.00 @ 180 46.50 @ 90	-.50 X 180	-.12 X 180	-.19 X 90	-.25 X 90
39	F	-.50 X 110	43.00 @ 180 44.00 @ 90	-1.00 X 180	-.75 X 180	-.39 X 180	-.50 X 180
9	M	-.50 X 170	42.25 @ 170 43.00 @ 80	-.75 X 170	-.44 X 170	-.09 X 170	-.13 X 170

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph Reading	Gross Oph. Cyl.	Net Cyl. Naval	Net Cyl. McCulloch	Net Cyl. Sutcliffe
20	F	-.62 X 175	44.37 @ 175 44.87 @ 85	-.50 X 175	-.12 X 175	-.19 X 90	-.25 X 90
23	M	-.62 X 170	42.00 @ 177 43.12 @ 87	-1.12 X 177	-.90 X 177	-.51 X 177	-.16 X 177
21	F	-.62 X 85	41.75 @ 180 42.50 @ 90	-.75 X 180	-.44 X 180	-.09 X 180	-.13 X 180
18	F	-.62 X 115	45.00 @ 180 44.00 @ 90	-1.00 X 90	-1.75 X 90	-1.88 X 90	-1.33 X 90
19	F	-.62 X 180	49.00 @ 175 49.50 @ 85	-.50 X 175	-.13 X 175	-.19 X 90	-.25 X 90
42	M	-.62 X 5	44.00 @ 180 44.50 @ 90	-.50 X 180	-.13 X 180	-.19 X 90	-.25 X 90
34	F	-.62 X 175	44.50 @ 90 44.25 @ 180	-.25 X 180	-.13 X 180	-.19 X 90	-.25 X 90
34	F	-.62 X 175	44.50 @ 90 44.25 @ 180	-.25 X 180	-.12 X 90	-.47 X 90	-.62 X 90
48	F	-.75 X 20	44.62 @ 4 45.12 @ 94	-.50 X 4	-.12 X 4	-.20 X 90	-.25 X 90
81	F	-.75 X 180	43.25 @ 164 44.62 @ 74	-1.37 X 164	-1.21 X 164	-.79 X 164	-1.05 X 164
38	F	-.75 X 80	45.87 @ 142 44.75 @ 52	-1.12 X 52	-1.90 X 52	-1.98 X 52	-1.48 X 52

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
21	M	-.75 X 135	43.12 @ 160 44.00 @ 70	-.87 X 160	-.50 X 160	-.22 X 160	-.30 X 160
21.	M	-.75 X 10	43.25 @ 175 44.00 @ 85	-.75 X 175	-.44 X 175	-.11 X 175	-.12 X 175
52	F	-.75 X 3	42.37 @ 170 44.37 @ 80	-2.00 X 170	-2.00 X 170	-1.45 X 170	-2.00 X 170
77	M	-.75 X 95	44.00 @ 5 43.62 @ 95	-.37 X 95	-.96 X 95	-1.16 X 95	-.49 X 95
21	M	-.75 X 78	44.75 @ 170 45.25 @ 80	-.50 X 170	-.12 X 170	-.19 X 90	-.25 X 90
68	F	-.75 X 45	44.12 @ 180 44.50 @ 90	-.37 X 180	-.34 X 90	-.04 X 90	-.45 X 90
21	F	-.75 X 180	42.62 @ 180 44.00 @ 90	-1.37 X 180	-1.21 X 180	-.79 X 180	-1.05 X 180
21	F	-.75 X 5	42.37 @ 170 44.25 X 80	-1.87 X 120	-1.84 X 170	-1.35 X 170	-1.80 X 170
45	F	-.75 X 15	44.25 @ 3 46.75 @ 93	-2.50 X 3	-2.82 X 3	-2.06 X 3	-2.75 X 3
31	M	-.75 X 10	43.37 @ 10 43.62 @ 100	-.37 X 10	-.19 X 90	-.47 X 90	-.62 X 90
17	M	-.75 X 120	45.50 @ 140 45.75 @ 50	-.25 X 140	-.19 X 90	-.47 X 90	-.62 X 90

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
17	M	-.75 X 30	44.87 @ 9 46.25 @ 99	-1.37 X 9	-1.22 X 9	-.79 X 9	-1.00 X 9
20	F	-.87 X 165	45.00 @ 156 46.87 @ 66	-1.87 X 156	-1.85 X 156	-1.34 X 156	-1.81 X 156
20	F	-.87 X 10	44.75 @ 180 46.50 @ 90	-1.75 X 180	-1.69 X 180	-1.22 X 180	-1.62 X 180
65	F	-.87 X 180	42.50 @ 5 44.12 @ 95	-1.62 X 5	-1.85 X 5	-1.34 X 5	-1.81 X 5
13	F	-.87 X 80	45.87 @ 180 45.37 @ 90	-.50 X 90	-1.12 X 90	-1.31 X 90	-.67 X 90
48	M	-.87 X 5	39.12 @ 175 40.87 @ 86	-1.75 X 175	-1.68 X 175	-1.21 X 175	-1.62 X 175
68	F	-.87 X 135	42.00 @ 180 43.75 @ 90	-1.75 X 180	-1.21 X 180	-1.68 X 180	-1.62 X 180
58	F	-1.00 X 10	43.75 @ 178 45.12 @ 88	-1.37 X 178	-1.21 X 178	-.87 X 178	-1.05 X 178
45	F	-1.00 X 113	47.12 @ 120 48.12 @ 30	-1.00 X 120	-1.75 X 120	-1.87 X 120	-1.33 X 120
35	M	-1.00 X 165	43.50 @ 180 45.00 @ 90	-1.50 X 180	-1.38 X 180	-.93 X 180	-1.25 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
15	M	-1.00 X 83	42.75 @ 180 42.50 @ 90	-.25 X 90	-.81 X 90	-1.03 X 90	-.33 X 90
15	F	-1.00 X 180	44.75 @ 2 46.00 @ 92	-1.25 X 2	-1.06 X 2	-.66 X 2	-.88 X 2
27	M	-1.00 X 180	43.75 @ 180 45.12 @ 90	-1.37 X 180	-1.21 X 180	-.79 X 180	-1.05 X 180
21	M	-1.00 X 76	45.00 @ 30 45.37 @ 120	-.38 X 30	-.04 X 90	-.79 X 180	-1.05 X 180
32	M	-1.00 X 90	45.25 @ 85 45.75 @ 175	-.50 X 85	-1.12 X 85	-1.31 X 85	-.66 X 85
32	M	-1.00 X 90	45.75 @ 90 46.00 @ 180	-.25 X 90	-.81 X 90	-1.03 X 90	-.33 X 90
80	F	-1.00 X 105	43.87 @ 165 44.50 @ 75	-.62 X 165	-.28 X 165	-.19 X 90	-.07 X 90
34	M	-1.00 X 110	46.50 @ 10 46.37 @ 100	-.12 X 100	-.65 X 100	-.89 X 100	-.15 X 100
18	F	-1.00 X 72	41.87 @ 73 42.12 @ 163	-.25 X 73	-.81 X 73	-1.03 X 73	-.33 X 73
35	M	-1.25 X 25	43.75 @ 175 45.25 @ 85	-1.50 X 175	-1.37 X 175	-.94 X 175	-1.25 X 175
58	F	-1.25 X 175	43.50 @ 167 45.62 @ 99	-2.12 X 167	-2.15 X 167	-1.63 X 167	-2.18 X 167

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
19	M	-1.25 X 125	41.00 @ 4 42.50 @ 94	-1.50 X 4	-1.37 X 4	-.94 X 4	-1.25 X 4
38	F	-1.25 X 105	46.00 @ 28 45.25 @ 118	-.75 X 118	-1.44 X 118	-1.59 X 118	-1.00 X 118
36	M	-1.25 X 85	47.25 @ 52 46.00 @ 142	-1.25 X 142	-1.06 X 142	-.65 X 142	-.87 X 142
20	F	-1.25 X 175	46.87 @ 90 45.25 @ 180	-1.62 X 180	-1.52 X 180	-1.07 X 180	-1.43 X 180
13	F	-1.25 X 95	45.75 @ 180 45.25 @ 90	-.50 X 90	-1.12 X 90	-1.31 X 90	-.67 X 90
26	M	-1.50 X 90	43.12 @ 30 43.00 @ 120	-.12 X 120	-.65 X 120	-.89 X 120	-.16 X 120
29	F	-1.50 X 180	42.62 @ 170 44.75 @ 80	-2.12 X170	-2.12 X 170	-1.64 X 170	-2.18 X 170
32	F	-1.50 X 165	42.50 @ 175 42.87 @ 85	-.37 X 175	-.04 X 90	-.34 X 175	-.45 X 90
48	M	-1.50 X 170	39.25 @ 168 41.50 @ 78	-2.25 X 168	-2.31 X 168	-1.80 X 168	-2.37 X 168
56	F	-1.50 X 30	43.37 @ 31 40.50 @ 121	-2.87 X 121	-4.08 X 121	-3.97 X 121	-3.83 X 121

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
51	F	-1.50 X 175	43.25 @ 180 44.50 @ 90	-1.25 X 180	-1.06 X 180	-.65 X 180	-.87 X 180
51	M	-1.50 X 170	43.75 @ 180 44.50 @ 90	-.75 X 180	-.43 X 180	-.09 X 180	-.12 X 180
27	M	-1.50 X 170	42.25 @ 170 44.00 @ 80	-1.75 X 170	-1.68 X 170	-1.21 X 170	-1.62 X 170
81	F	-1.75 X 152	44.37 @ 165 44.75 @ 75	-.37 X 165	-.04 X 90	-.33 X 90	-.44 X 90
65	F	-1.75 X 174	42.75 @ 180 43.75 @ 90	-1.00 X 180	-.75 X 180	-.38 X 180	-.50 X 180
29	F	-1.75 X 175	42.75 @ 175 44.87 @ 85	-2.12 X 175	-2.12 X 175	-1.64 X 175	-2.18 X 175
48	M	-1.75 X 90	44.87 @ 6 43.50 @ 96	-1.37 X 96	-2.21 X 96	-2.25 X 96	-1.82 X 96
48	M	-1.75 X 90	44.00 @ 25 42.62 @ 115	-1.37 X 115	-2.21 X 115	-2.25 X 115	-1.82 X 115
81	F	-1.75 X 152	44.37 @ 165 44.75 @ 75	-.37 X 165	-.04 X 90	-.33 X 165	-.44 X 90
52	F	-1.75 X 178	42.75 @ 180 43.62 @ 90	-.87 X 180	-.59 X 180	-.23 X 180	-.31 X 180
18	F	-1.75 X 180	41.37 @ 180 42.87 @ 90	-1.50 X 180	-1.33 X 180	-.94 X 180	-1.25 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
23	F	-2.00 X 180	45.50 @ 90 43.37 @ 180	-2.12 X 180	-2.15 X 180	-1.64 X 180	-2.18 X 180
29	F	-2.00 X 180	44.87 @ 180 46.00 @ 90	-1.12 X 180	-.90 X 180	-.50 X 180	-.68 X 180
14	M	-2.00 X 106	43.87 @ 120 45.25 @ 30	-1.37 X 120	-2.21 X 120	-2.29 X 120	-1.83 X 120
67	F	-2.00 X 180	42.00 @ 180 45.00 @ 90	-3.00 X 180	-3.25 X 180	-1.31 X 90	-.65 X 90
47	F	-2.00 X 85	46.75 @ 90 47.25 @ 180	-.50 X 90	-1.12 X 90	-1.31 X 90	-.65 X 90
53	M	-2.00 X 178	43.62 @ 180 46.00 @ 90	-2.37 X 180	-2.46 X 180	-1.91 X 180	-2.55 X 180
34	M	-2.25 X 7	44.25 @ 5 46.75 @ 105	-2.50 X 5	-2.62 X 5	-2.06 X 5	-2.75 X 5
55	M	-2.25 X 3	41.50 @ 180 43.75 @ 90	-2.25 X 180	-2.30 X 180	-1.78 X 180	-2.37 X 180
48	F	-2.25 X 85	42.50 @ 90 44.00 @ 180	-1.50 X 90	-2.37 X 90	-2.43 X 90	-2.00 X 90
48	F	-2.25 X 92	43.50 @ 178 42.25 @ 88	-1.25 X 88	-2.06 X 88	-2.16 X 88	-1.67 X 88
32	F	-2.25 X 180	43.50 @ 178 45.25 @ 88	-1.75 X 178	-1.69 X 178	-1.22 X 178	-1.63 X 178
56	M	-2.25 X 10	41.50 @ 180 43.50 @ 90	-2.00 X 180	-2.00 X 180	-1.50 X 180	-2.00 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
34	M	-2.50 X 165	44.25 @ 170 46.75 @ 80	-2.50 X 170	-2.62 X 170	-2.06 X 170	-2.75 X 170
83	F	-2.50 X 90	42.75 @ 90 44.25 @ 180	-1.50 X 90	-2.38 X 90	-2.44 X 90	-2.00 X 90
49	F	-2.50 X 180	43.50 @ 3 47.00 @ 93	-3.50 X 3	-3.88 X 3	-3.19 X 3	-4.25 X 3
54	F	-2.50 X 5	44.50 @ 90 42.50 @ 180	-2.00 X 180	-2.00 X 180	-1.50 X 180	-2.00 X 180
25	M	-2.50 X 15	40.75 @ 9 44.25 @ 99	-3.50 X 9	-3.88 X 9	-3.19 X 9	-4.25 X 9
25	M	-2.50 X 175	41.00 @ 169 44.37 @ 79	-3.37 X 169	-3.71 X 169	-3.04 X 169	-4.06 X 169
5	M	-2.75 X 180	44.75 @ 180 48.50 @ 90	-3.75 X 180	-4.18 X 180	-3.45 X 180	-4.62 X 180
49	F	-2.75 X 180	43.50 @ 180 47.00 @ 90	-3.50 X 180	-3.87 X 180	-3.25 X 180	-4.25 X 180
55	M	-2.75 X 180	41.50 @ 180 43.75 @ 90	-2.25 X 180	-2.31 X 180	-1.75 X 90	-2.37 X 180
36	M	-2.75 X 75	41.50 @ 60 44.00 @ 150	-2.50 X 60	-3.62 X 60	-3.56 X 60	-3.32 X 60
53	F	-2.75 X 165	42.00 @ 90 44.25 @ 180	-2.25 X 90	-3.31 X 90	-3.33 X 90	-2.99 X 90
25	M	-2.75 X 10	42.50 @ 180 45.00 @ 90	-2.50 X 180	-2.62 X 180	-2.06 X 180	-3.00 X 180

TABULATION OF DATA

Age	Sex	Hab. Cyl.	Oph. Reading	Gross Oph. Cyl.	Net Cyl. Javal	Net Cyl. McCulloch	Net Cyl. Sutcliffe
13	M	-3.00 X 180	40.75 @ 180 43.75 @ 90	-3.00 X 180	-3.25 X 180	-2.62 X 180	-3.50 X 180
9	M	-3.00 X 20	44.37 @ 111 41.75 @ 21	-3.12 X 21	-3.40 X 21	-2.75 X 21	-3.68 X 20
10	M	-3.00 X 60	43.50 @ 37 46.00 @ 127	-2.50 X 37	-3.62 X 37	-3.62 X 37	-3.25 X 37
34	F	-3.00 X 115	45.50 @ 90 48.25 @ 180	-2.75 X 90	-3.87 X 90	-3.75 X 90	-3.65 X 90
59	F	-3.00 X 135	45.00 @ 145 47.00 @ 55	-2.00 X 145	-3.00 X 145	-3.00 X 145	-2.66 X 145
37	F	-3.00 X 170	43.87 @ 160 46.87 @ 20	-3.00 X 160	-3.25 X 160	-2.62 X 160	-3.50 X 160

THE STATISTICAL ANALYSIS OF THE COMPILED DATA

Each catagory of habitually worn cylinders is analyzed as a unit with respect to each of the three rules. The central value used in this study was the MEAN, calculated in the conventional manner by using the formula $\left(\frac{\Sigma X}{N}\right)$. The STANDARD DEVIATION was likewise calculated in the conventional manner by using the formula $\left(\sqrt{\frac{\Sigma x^2}{N}}\right)$, x being X - M. If the mean cylinder is found to lie within one probable error (.6745 X standard deviation) of the habitually worn cylinder it is considered significant on a group data basis. The use of the probable error allows the significant limits to encompass 50% of the cases scattered symetrically about the mean net cylinder. This statistical data was recorded on graphs for each catagory of habitual worn cylinder.*

* See graph pages 19-33

EXPLANATION OF GRAPHS:

Two methods were used in plotting the graphs contained in this study. For each habitually worn cylinder catagory, one graph was plotted with the net cylinder as calculated by the rules on the X-axis rounded to the nearest .12D and the frequency of the net cylinders on the Y-axis. Each graph contains a line for each of the rules and the gross, showing the four distributions in a manner which facilitates comparison. [1]

The second method of graphing the data consists of four graphs, one for each rule and the gross, plotting the entire range of habitually worn cylinders on the X-axis against the mean net cylinder on the Y-axis. The significant range of plus or minus one probable error is shaded in on each side of the mean. From these graphs one can visualize the degree of deviation from the habitually worn cylinders as it varies throughout the range. [2]

1. See graph pages 19-33
2. See graph pages 34-37

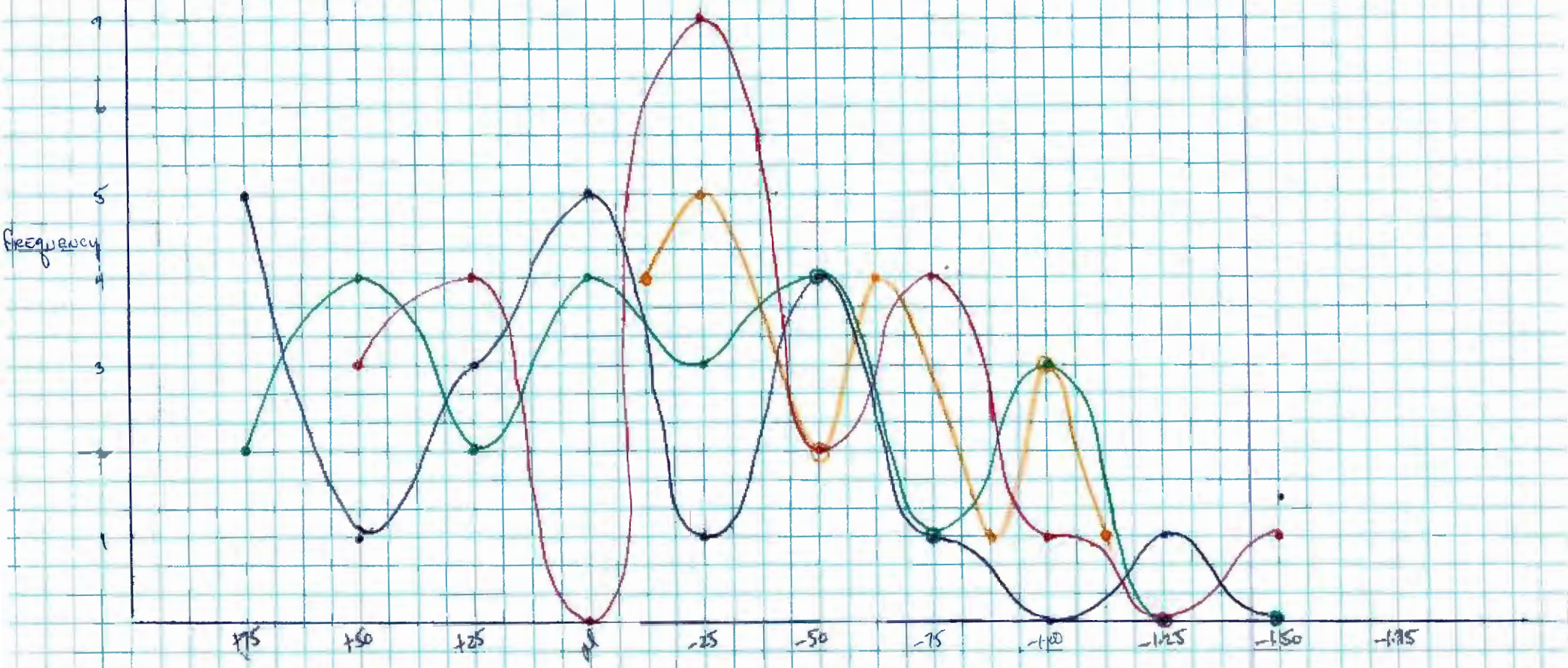
-.25 Habitual

-.25 Habitual Cylinder

Showing Frequency of Nets and Gross Powers

RULE	N	Mean	Sigma	P. E.
Javal	21	.30	.45	.3035
McCulloch	21	.02	.49	.33
Sutcliffe	21	+ .06	.54	.36
Gross Oph	21	.56	.38	.26

RED = Javal
GREEN = McCulloch
BLUE = Sutcliffe
ORANGE = Gross oph.



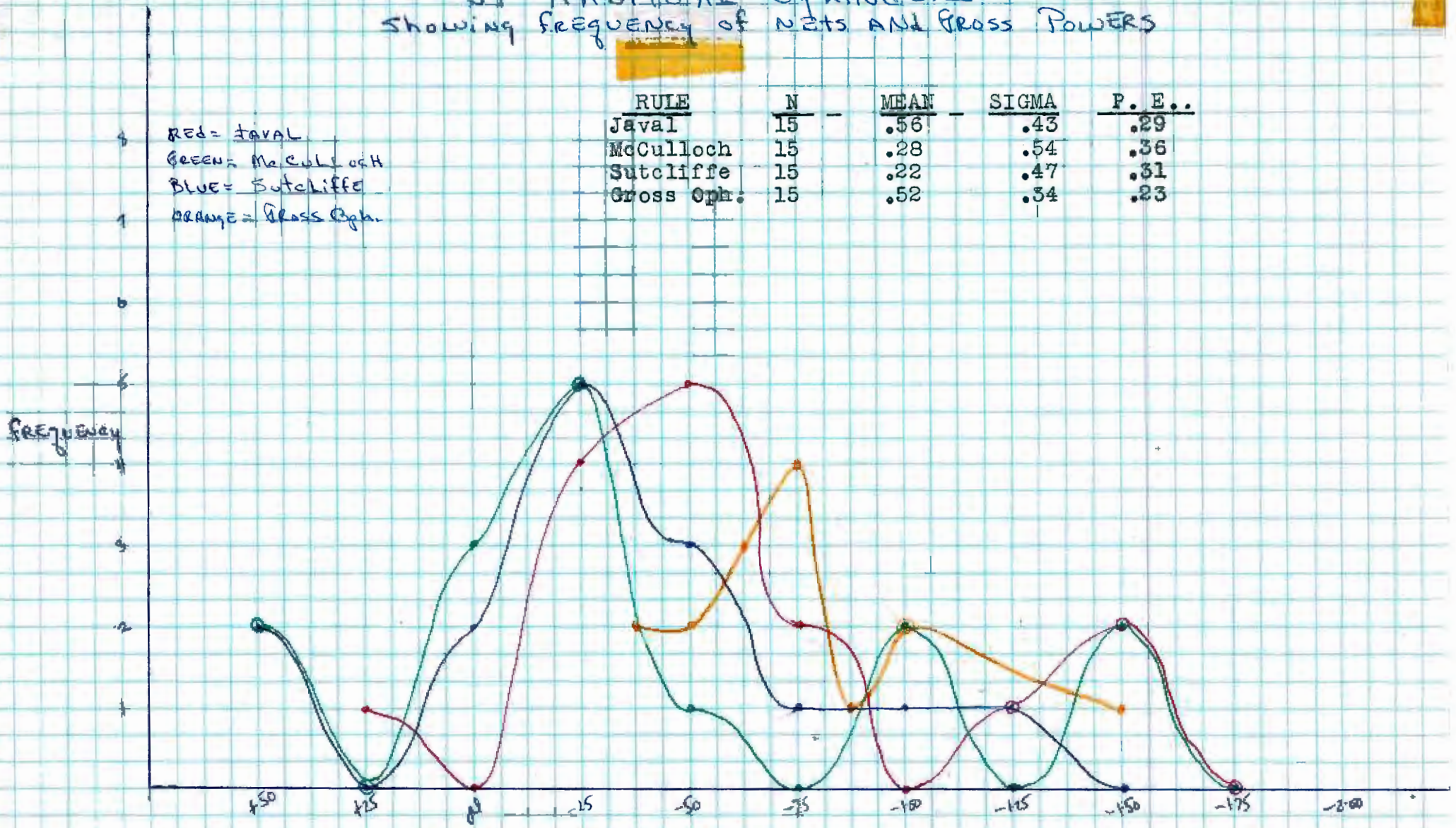
~.37

-.37 HABITUAL CYLINDER

Showing frequency of NETS AND GROSS POWERS

RULE	N	MEAN	SIGMA	P. E..
Javal	15	.56	.43	.29
McCulloch	15	.28	.54	.36
Sutcliffe	15	.22	.47	.31
Gross Oph.	15	.52	.34	.23

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS OPH.



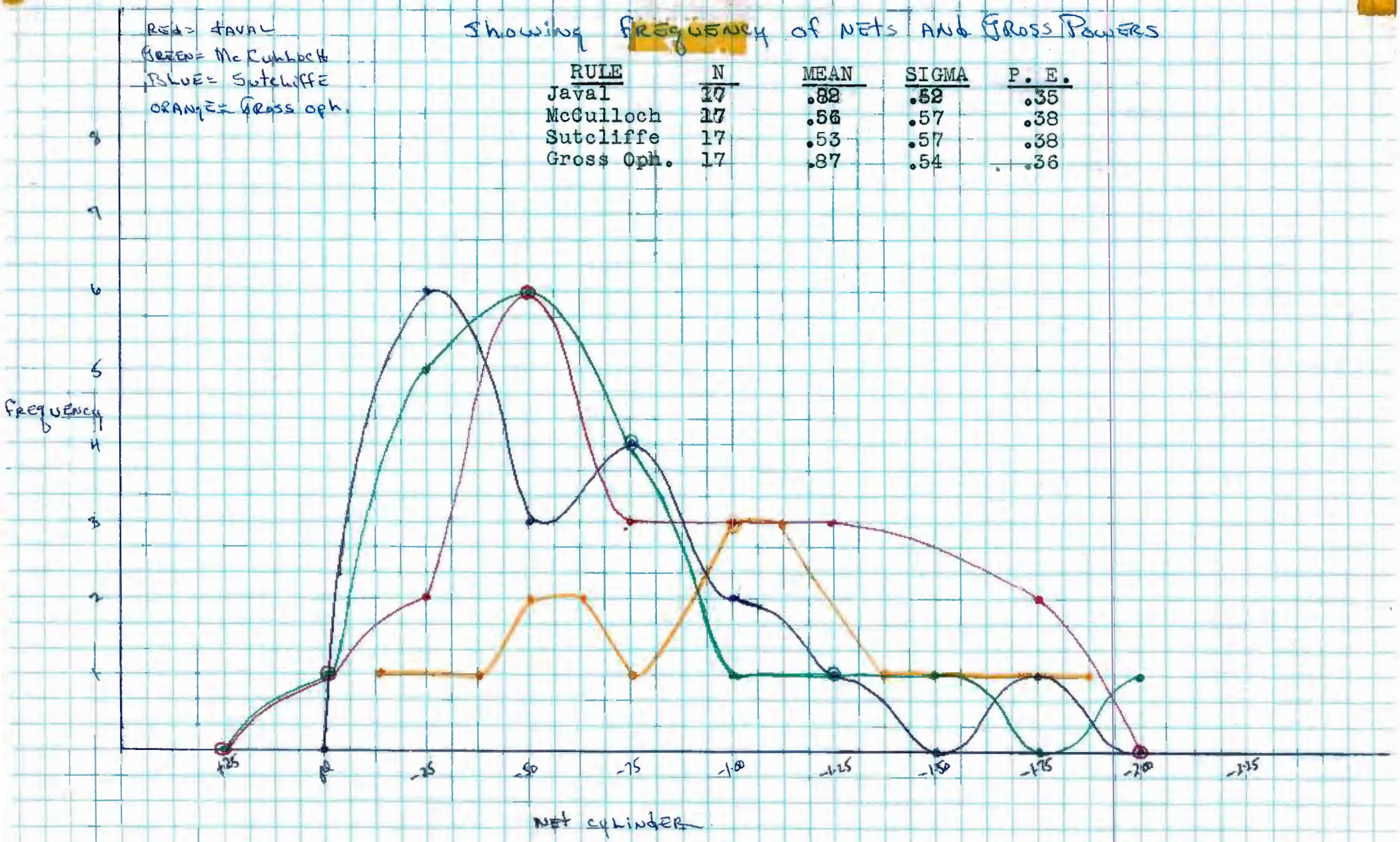
-.50 Habitual

-.50 Habitual Cylinder

Showing frequency of Nets and Gross Powers

RED = Javal
GREEN = McCulloch
BLUE = Sutcliffe
ORANGE = Gross oph.

RULE	N	MEAN	SIGMA	P. E.
Javal	17	.82	.52	.35
McCulloch	17	.56	.57	.38
Sutcliffe	17	.53	.57	.38
Gross Oph.	17	.87	.54	.36



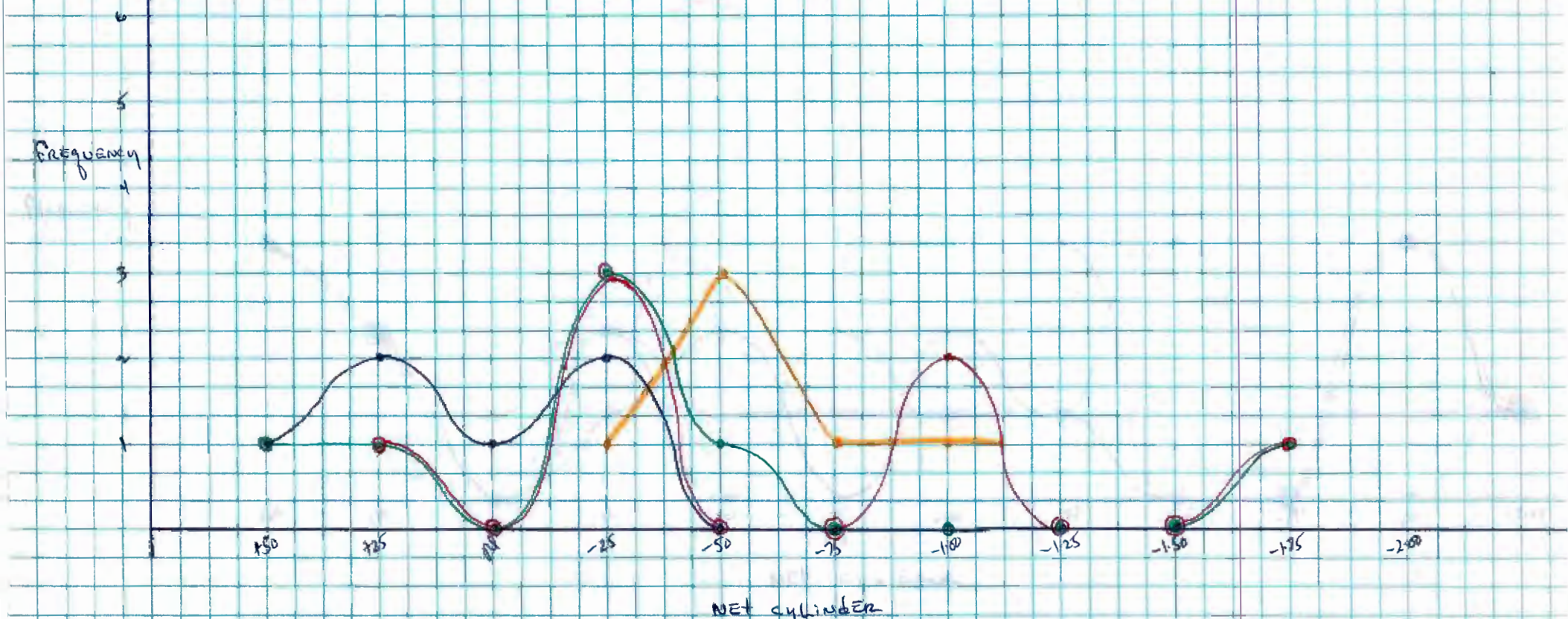
-.62 HABITUAL

-.62 HABITUAL CYLINDER

Showing frequency of NETS AND GROSS POWERS

Red = Javal
Green = McCulloch
Blue = Sutcliffe
Orange = Gross Oph.

RULE	N	MEAN	SIGMA	P. E.
Javal	7	.48	.60	.40
McCulloch	7	.21	.74	.50
Sutcliffe	7	.04	.69	.46
Gross Oph	7	.66	.28	.19



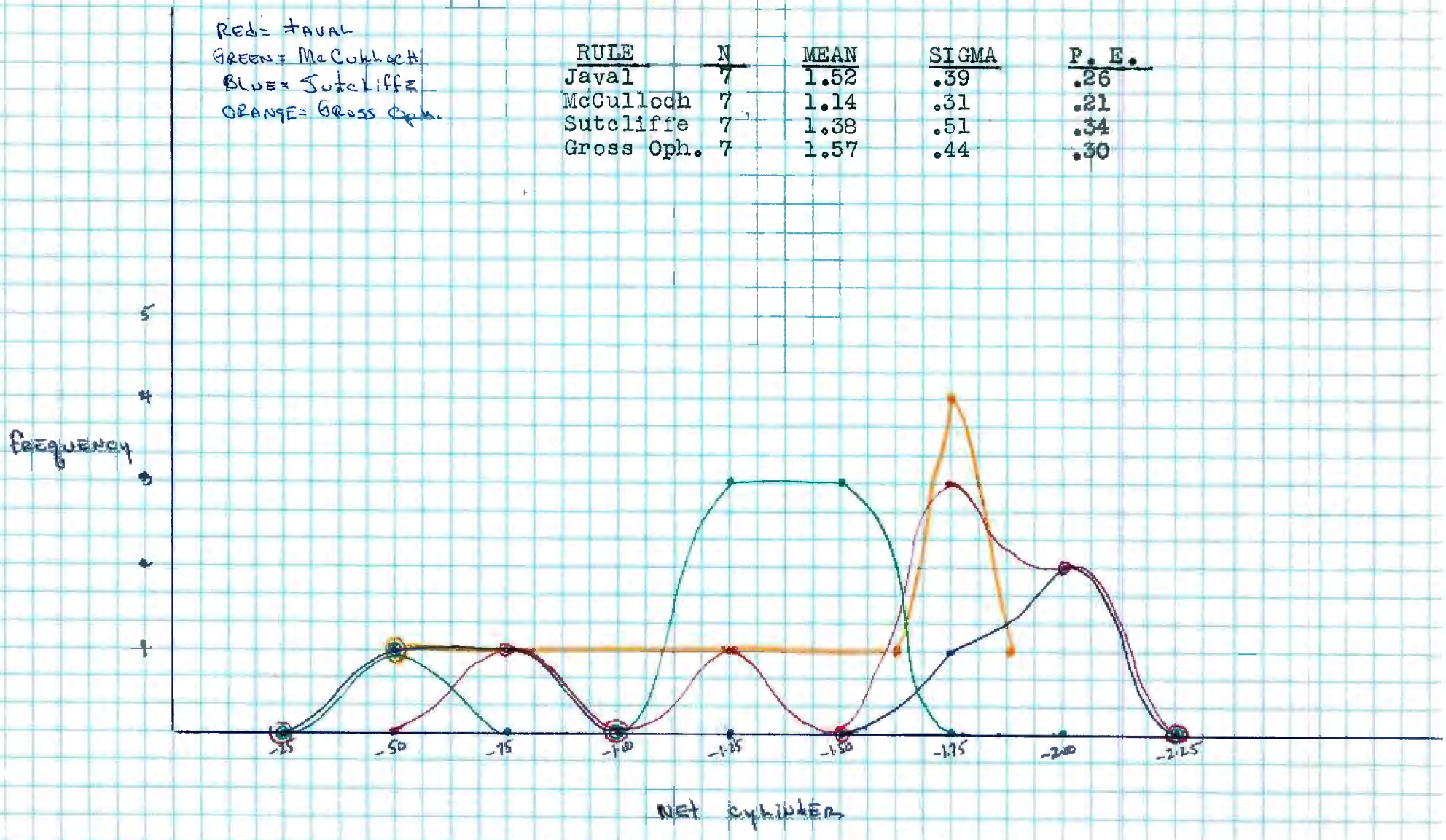
-.87 Habitual

-.87 HABITUAL CYLINDER

showing FREQUENCY of NETS and GROSS POWERS

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS OPH.

RULE	N	MEAN	SIGMA	P. E.
Javal	7	1.52	.39	.26
McCulloch	7	1.14	.31	.21
Sutcliffe	7	1.38	.51	.34
Gross Oph.	7	1.57	.44	.30



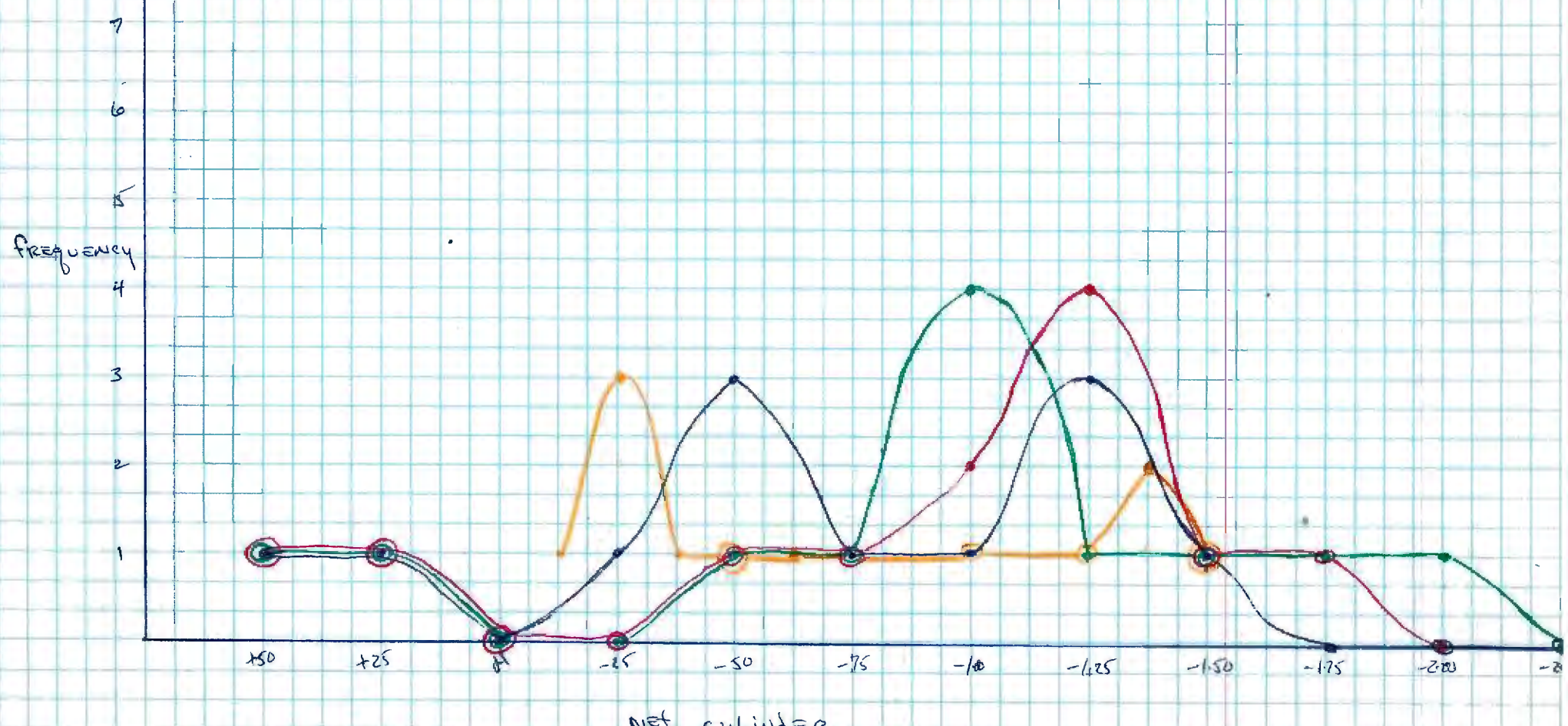
-1.00 Habitual

-1.00 HABITUAL CYLINDER

showing frequency of Nets and Gross Powers

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS OPH.

RULE	N	MEAN	SIGMA	P. E.
Javal	12	.92	.52	.35
McCulloch	12	.86	.50	.34
Suttliffe	12	.60	.55	.37
Gross Oph.	12	.74	.50	.34



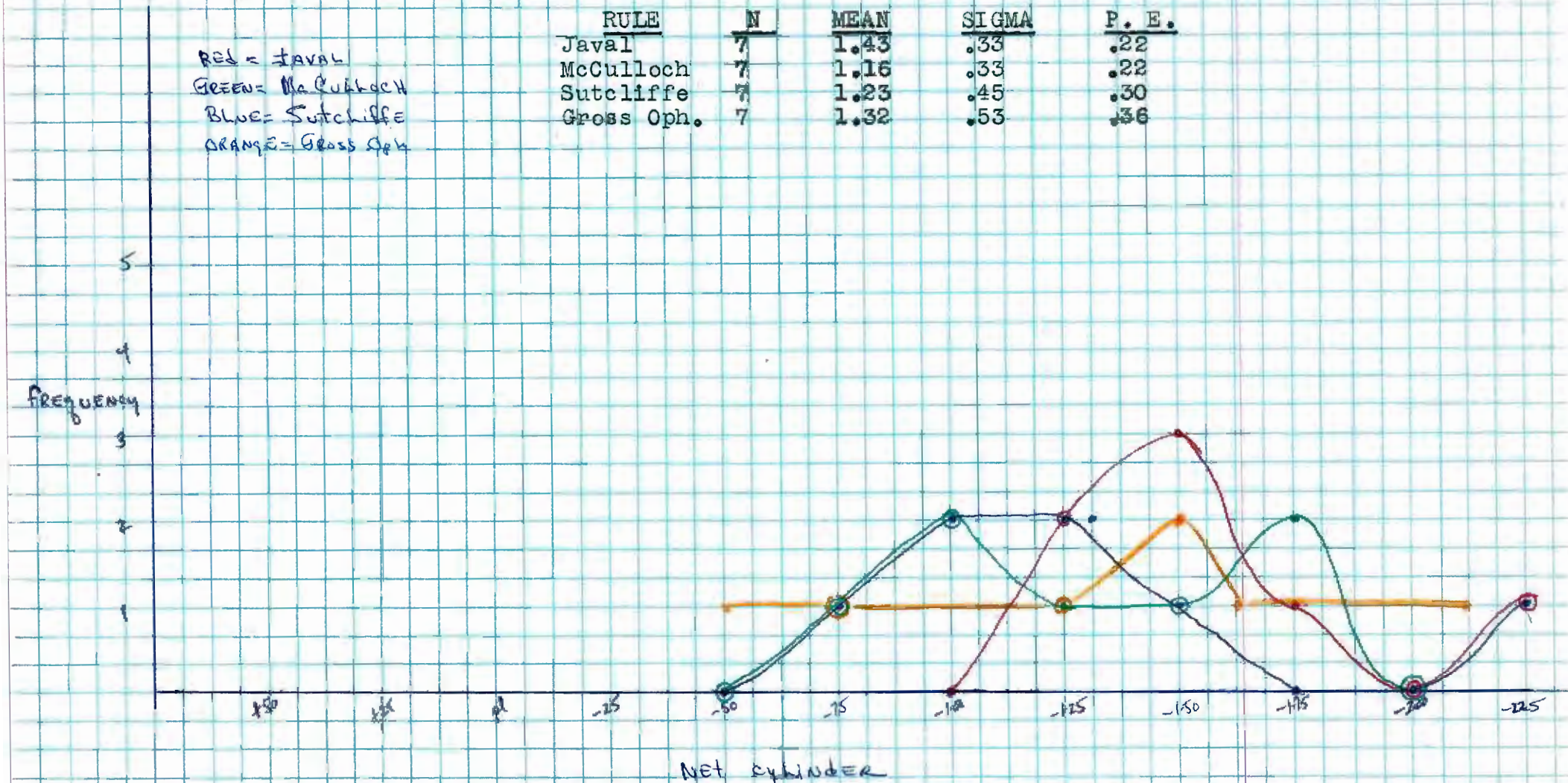
-1.25 Habitual

+1.25 Habitual Cylinder

Showing Frequency of Nets and Gross Powers

RULE	N	MEAN	SIGMA	P. E.
Javal	7	1.43	.33	.22
McCulloch	7	1.16	.33	.22
Sutcliffe	7	1.23	.45	.30
Gross Oph.	7	1.32	.53	.36

RED = Javal
GREEN = McCulloch
BLUE = Sutcliffe
ORANGE = Gross Oph



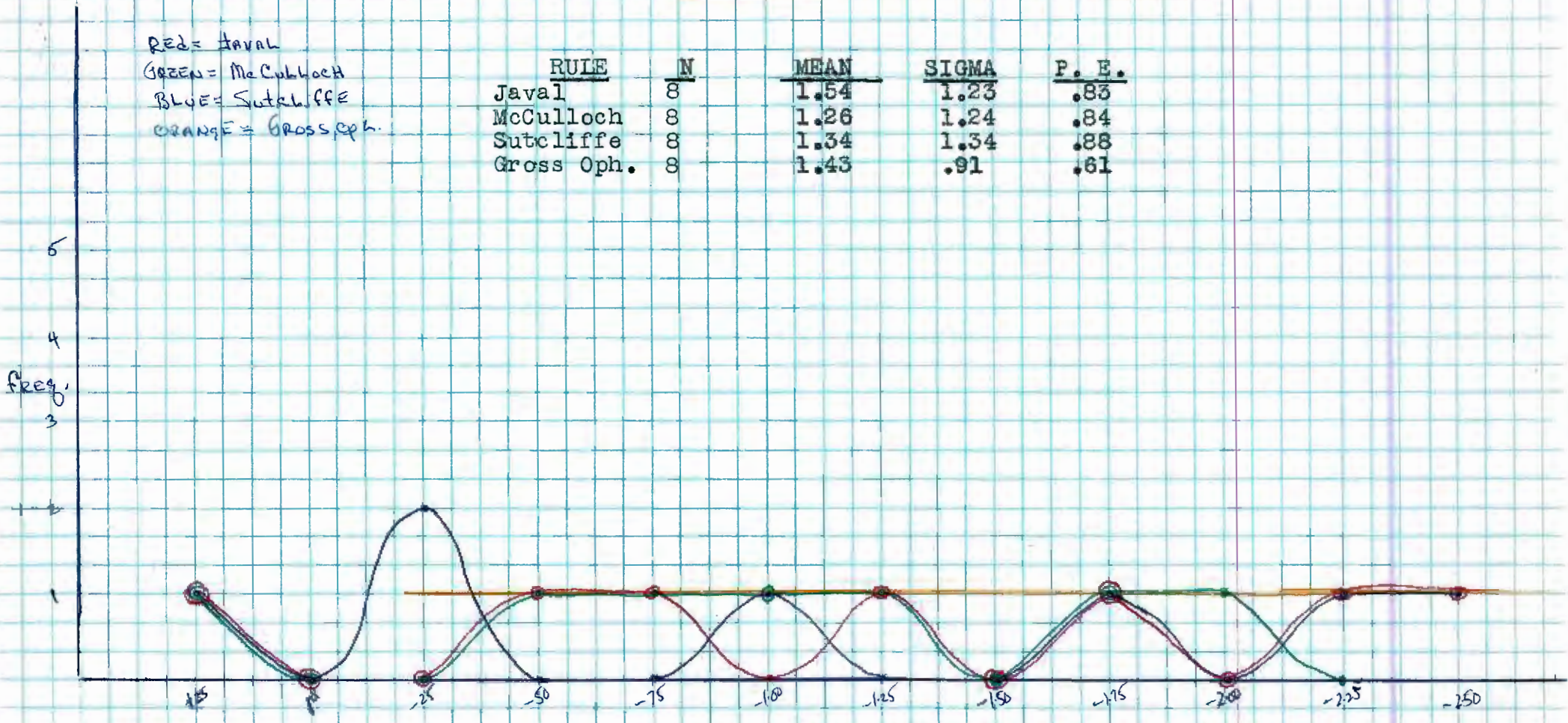
-1.5φ Habitual

-1.5a Habitual Cylinder

showing frequency of Nets and Gross Powers

RED = Haval
GREEN = McCulloch
BLUE = Sutcliffe
ORANGE = Gross Oph.

RULE	N	MEAN	SIGMA	P. E.
Javal	8	1.54	1.23	.83
McCulloch	8	1.26	1.24	.84
Sutcliffe	8	1.34	1.34	.88
Gross Oph.	8	1.43	.91	.61



Net Cylinder

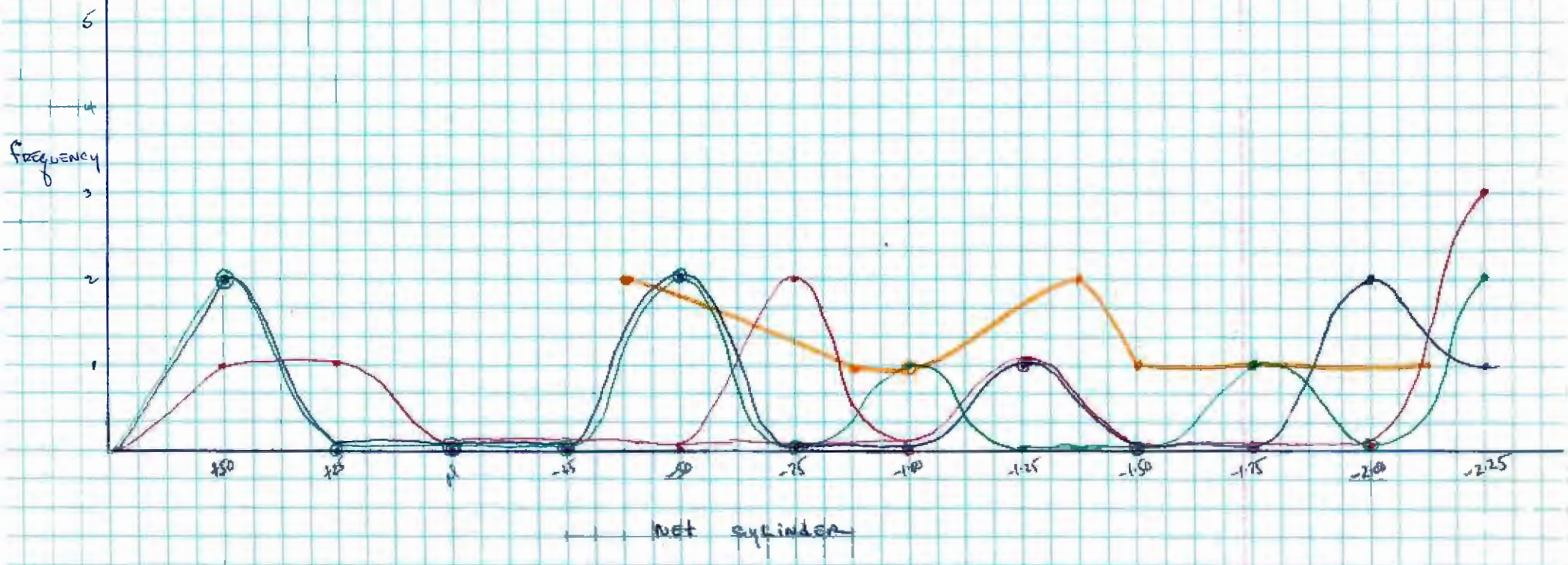
-1.75 Habitual

-1.75 Habitual Cylinder

showing frequency of Nets and Gross Powers

RULE	N	MEAN	SIGMA	P. E.
Javal	8	1.14	.96	.61
McCulloch	8	.88	.98	.66
Sutcliffe	8	.88	1.10	.74
Gross Oph.	8	1.12	.56	.38

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS OPH.



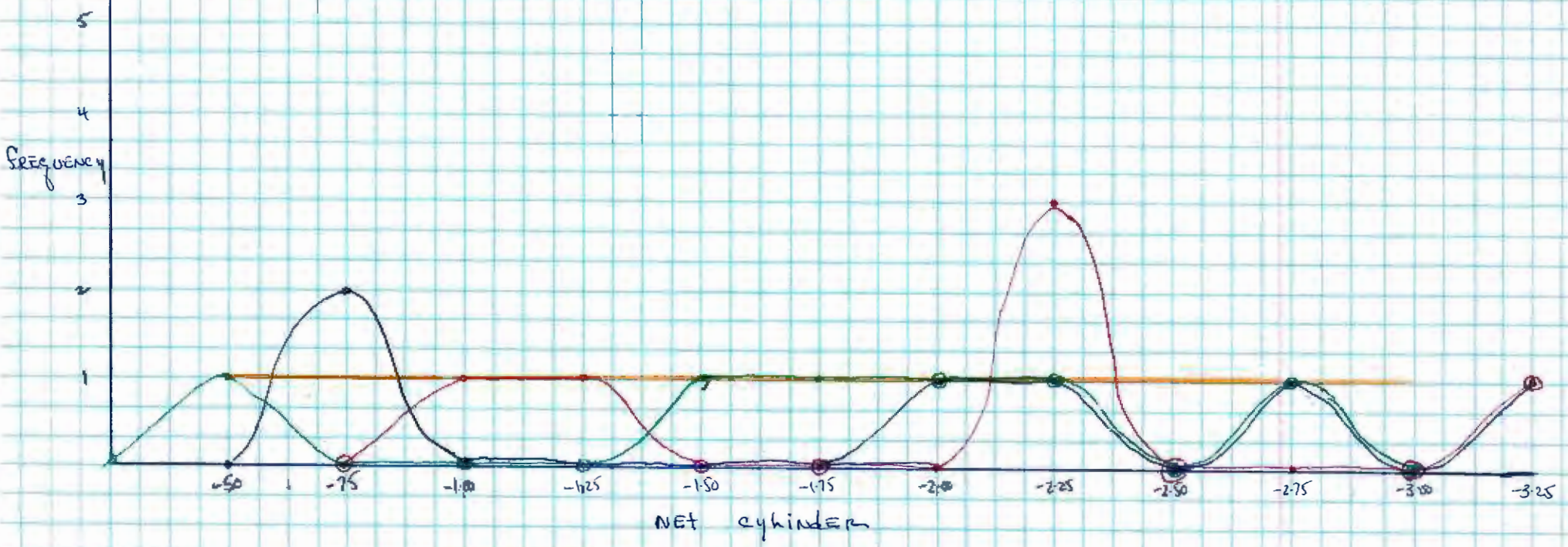
-2.00 Habitual

-2.00 HABITUAL CYLINDER

showing frequency of NETS AND Gross Powers

RULE	N	MEAN	SIGMA	P. E.
Javal	6	2.09	.84	.56
McCulloch	6	1.71	.79	.53
Sutcliffe	6	1.89	1.00	.67
Gross Oph.	6	1.75	.84	.57

RED = JAVAL
GREEN = McCulloch
BLUE = Sutcliffe
ORANGE = Gross Oph.



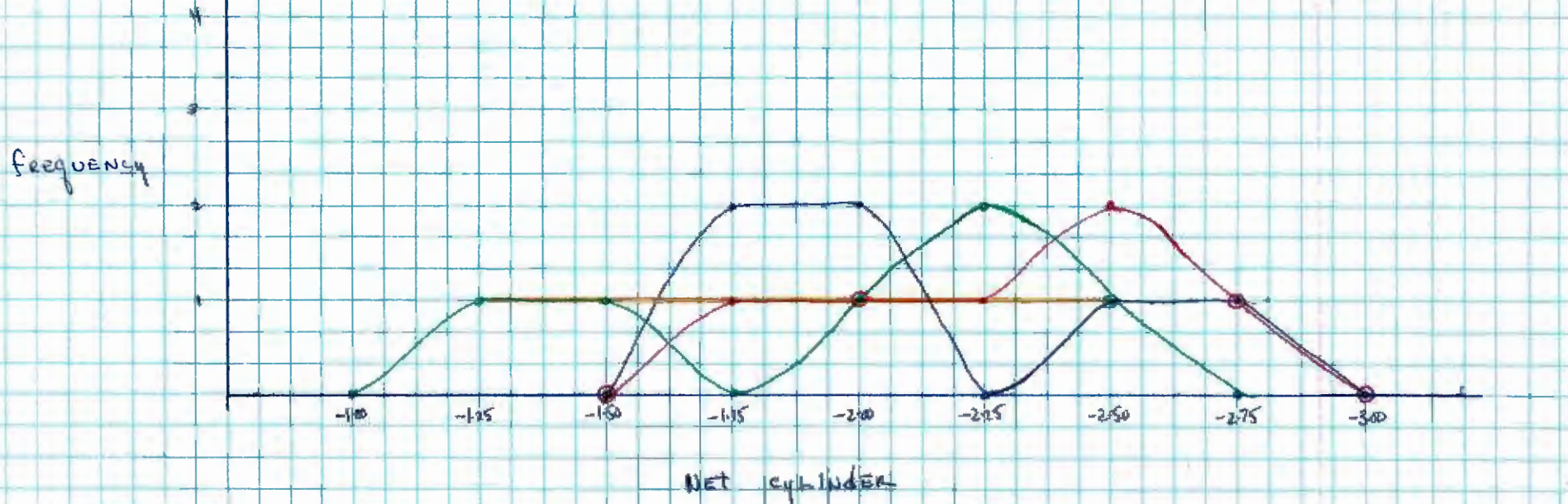
-2.25 Habitual

-2.25 HABITUAL CYLINDER

showing FREQUENCY of NETS AND GROSS POWERS

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS OPH.

RULE	N	MEAN	SIGMA	P. E.
Javal	6	2.17	.30	.20
McCulloch	6	1.86	.41	.27
Sutcliffe	6	2.07	.39	.26
Gross Oph.	6	1.88	.42	.28



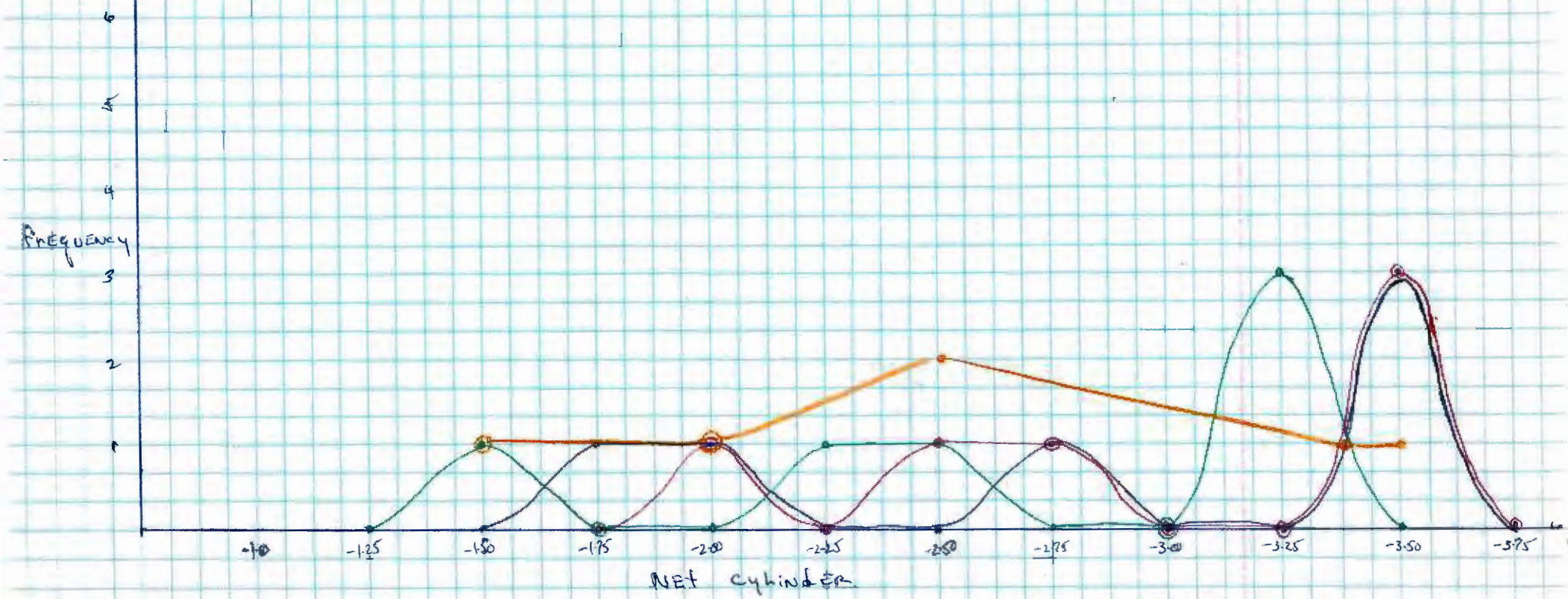
-2.50 HABITUAL

-2.50 HABITUAL CYLINDER

showing frequency of Nets AND Gross Power

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS SPH.

RULE	N	MEAN	SIGMA	P. E.
Javal	6	3.08	.77	.52
McCulloch	6	2.57	.63	.42
Sutcliffe	6	3.22	1.00	.67
Gross Oph.	6	2.56	.73	.49



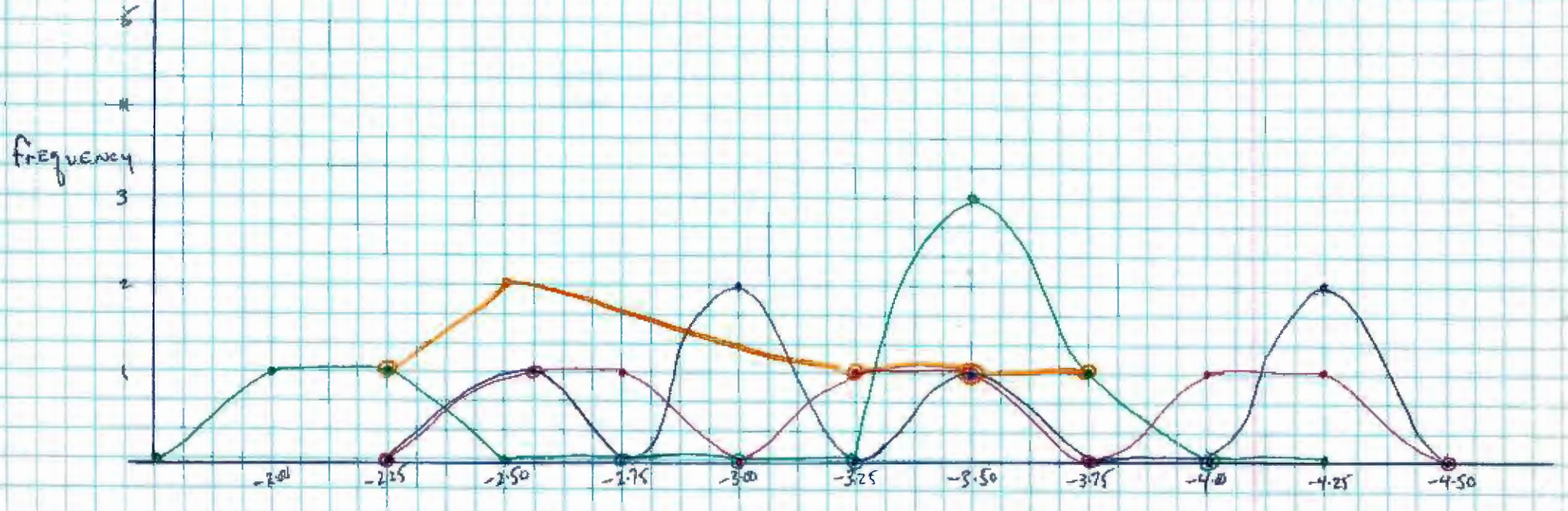
-2.75 HABITUAL

-2.75 HABITUAL CYLINDER

Showing frequency of Nets and Gross Powers

RED = Javal
GREEN = McCulloch
BLUE = Sutcliffe
ORANGE = Gross Oph.

RULE	N	MEAN	SIGMA	P. E.
Javal	6	3.31	.81	.55
McCulloch	6	2.90	.74	.49
Sutcliffe	6	3.55	.74	.49
Gross Oph.	6	2.79	.60	.40



NET Cylinder

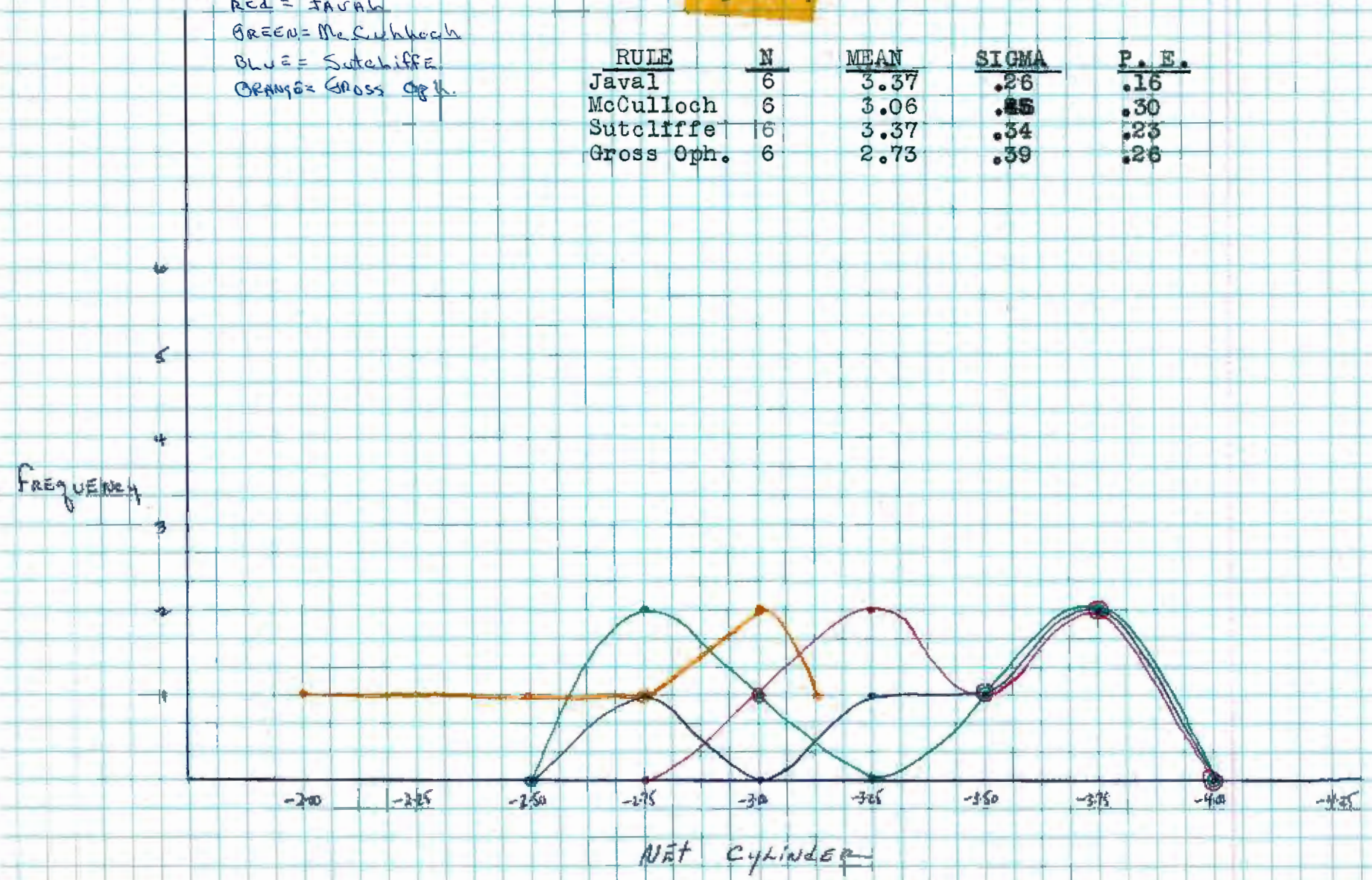
-3.00 Habitual

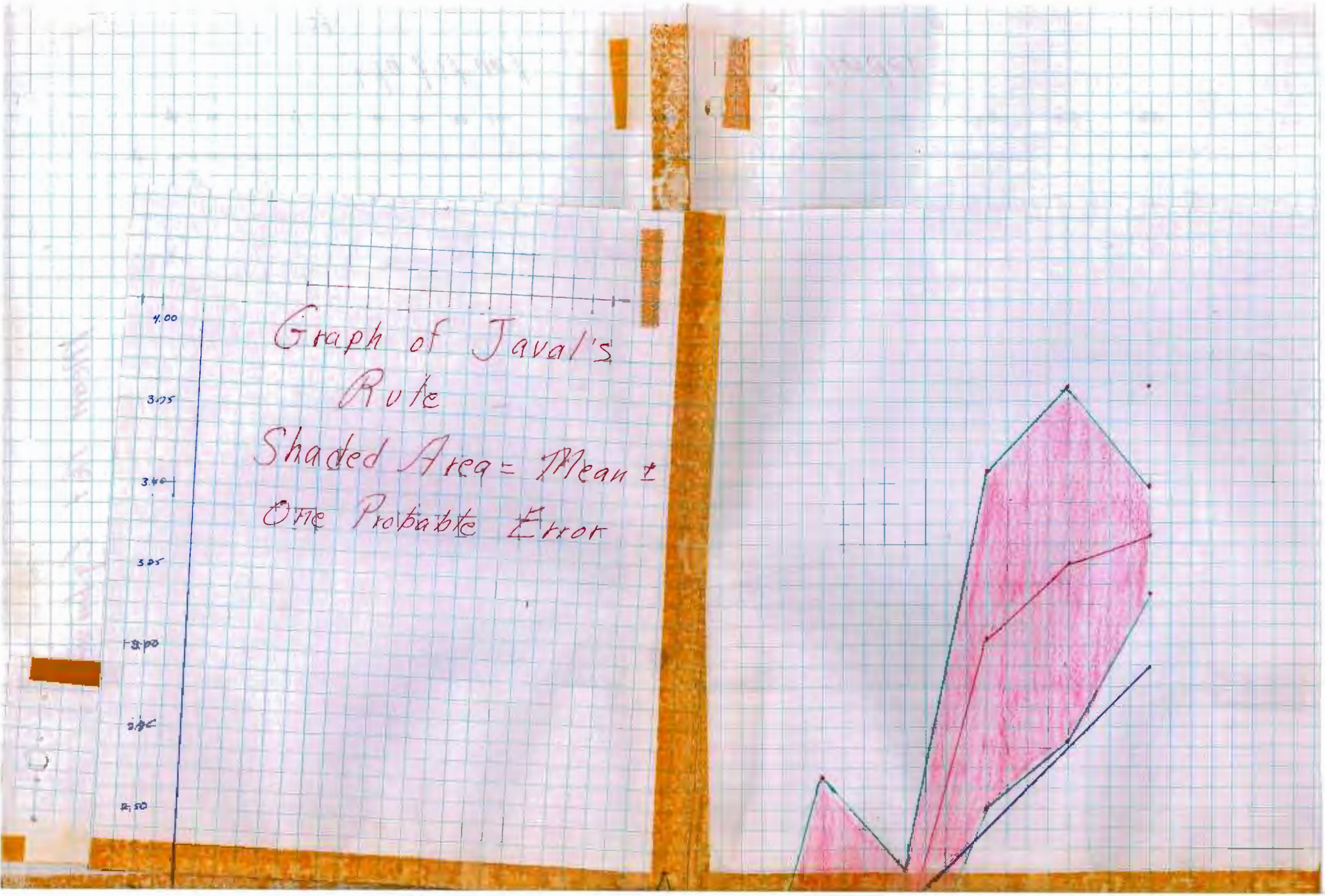
-3.00. HABITUAL CYLINDER

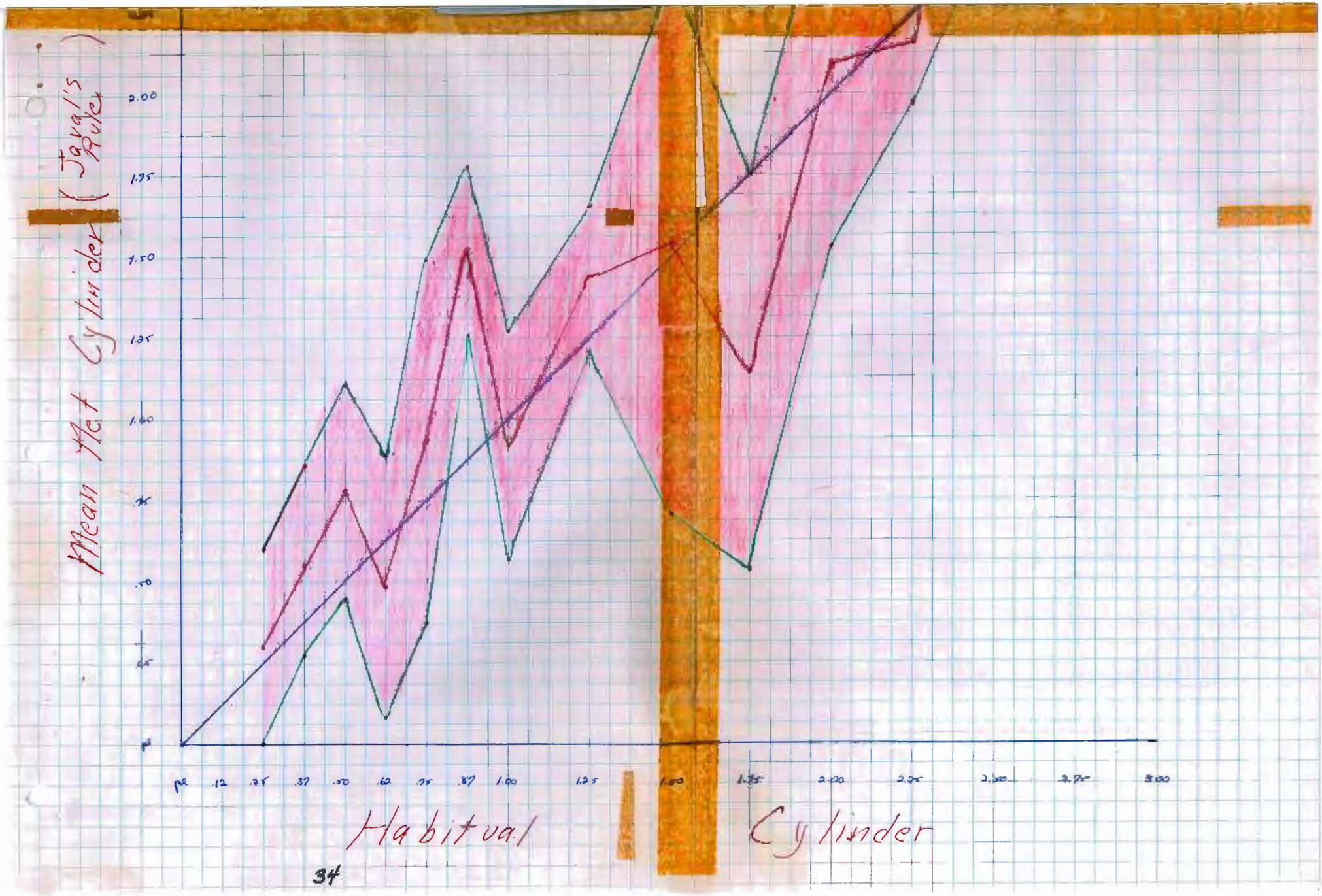
Showing frequency of Nets and Gross Powers

RED = JAVAL
GREEN = McCULLOCH
BLUE = SUTCLIFFE
ORANGE = GROSS OPH.

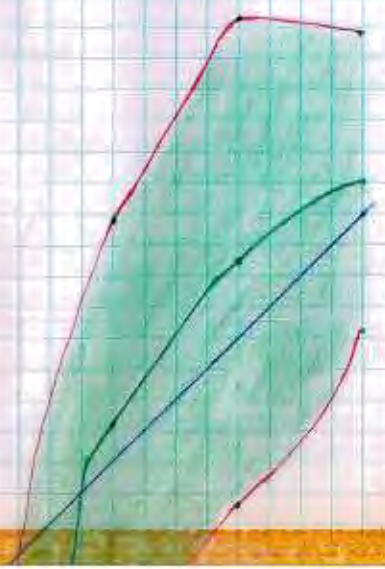
RULE	N	MEAN	SIGMA	P. E.
Javal	6	3.37	.26	.16
McCulloch	6	3.06	.45	.30
Sutcliffe	6	3.37	.34	.23
Gross Oph.	6	2.73	.39	.26

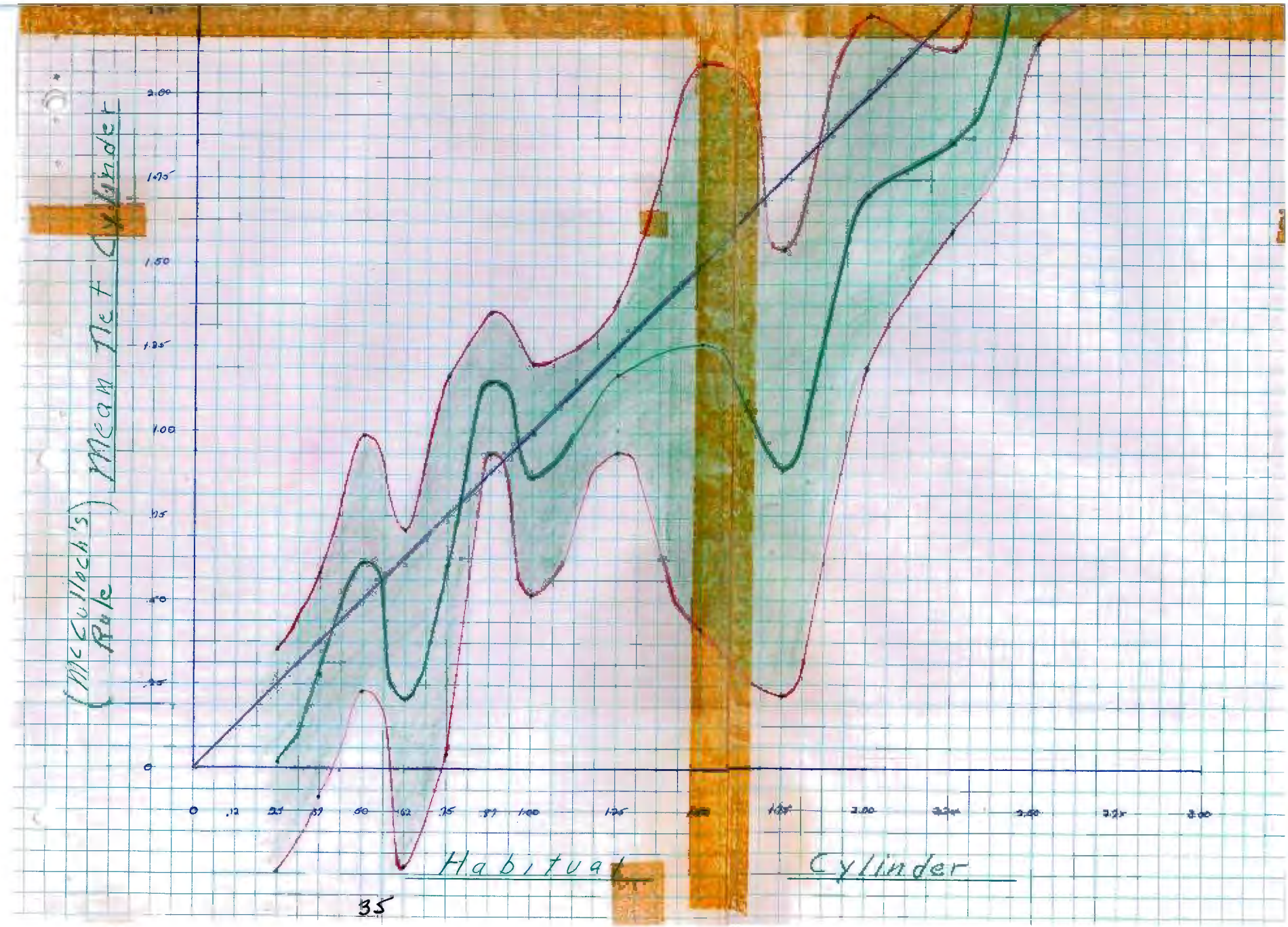



4.00
3.75
3.50
3.25
3.00
2.75
2.50
Graph of Javal's
Rule
Shaded Area = Mean ±
One Probable Error


Mean Mat Cylinder (Jaya's Rule)
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
.12
.25
.37
.50
.62
.75
.87
1.00
1.25
2.00
2.50
3.00
Habitual
Cylinder

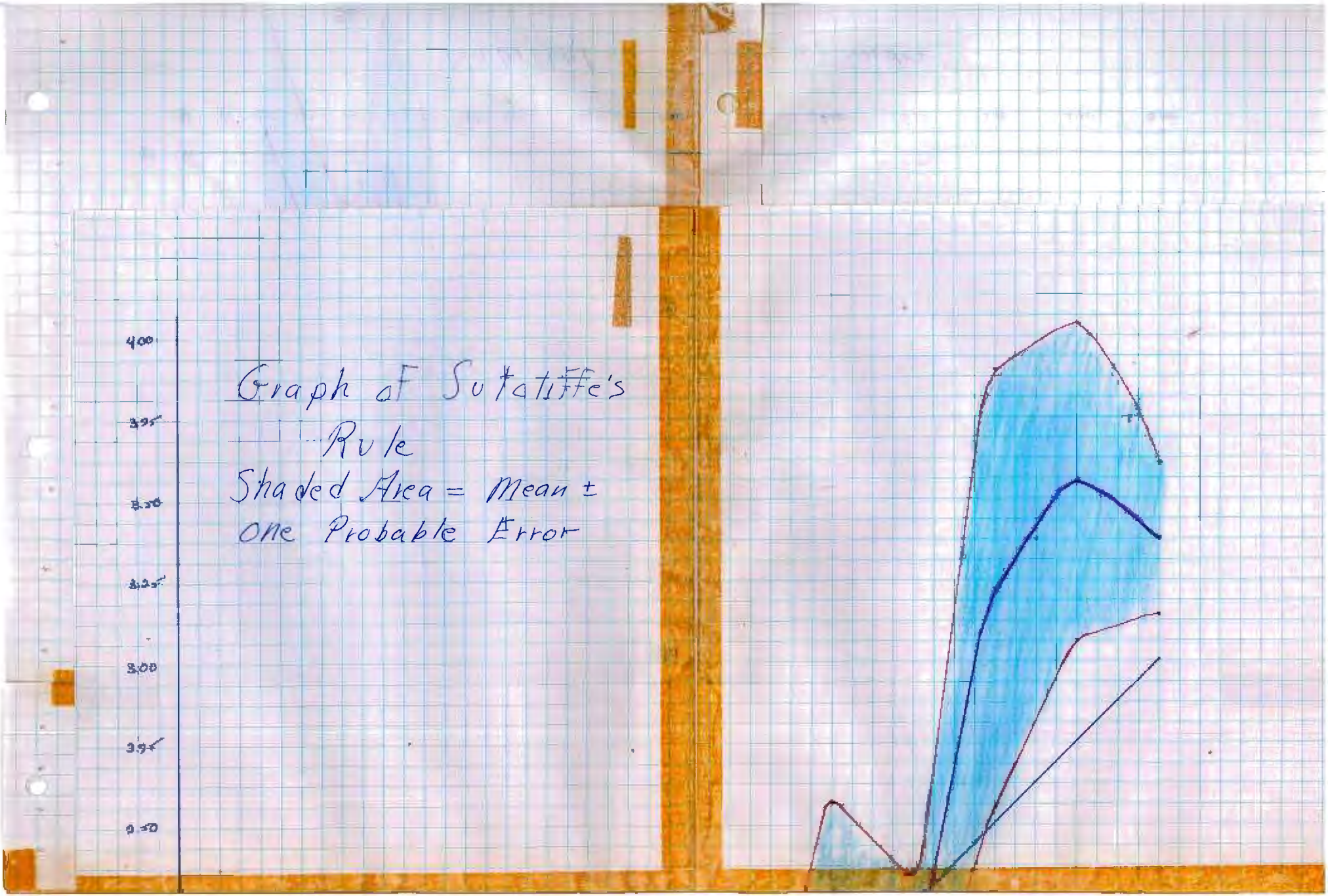
Graph of
McCulloch's Rule
Shaded Area = Mean ±
one Probable Error

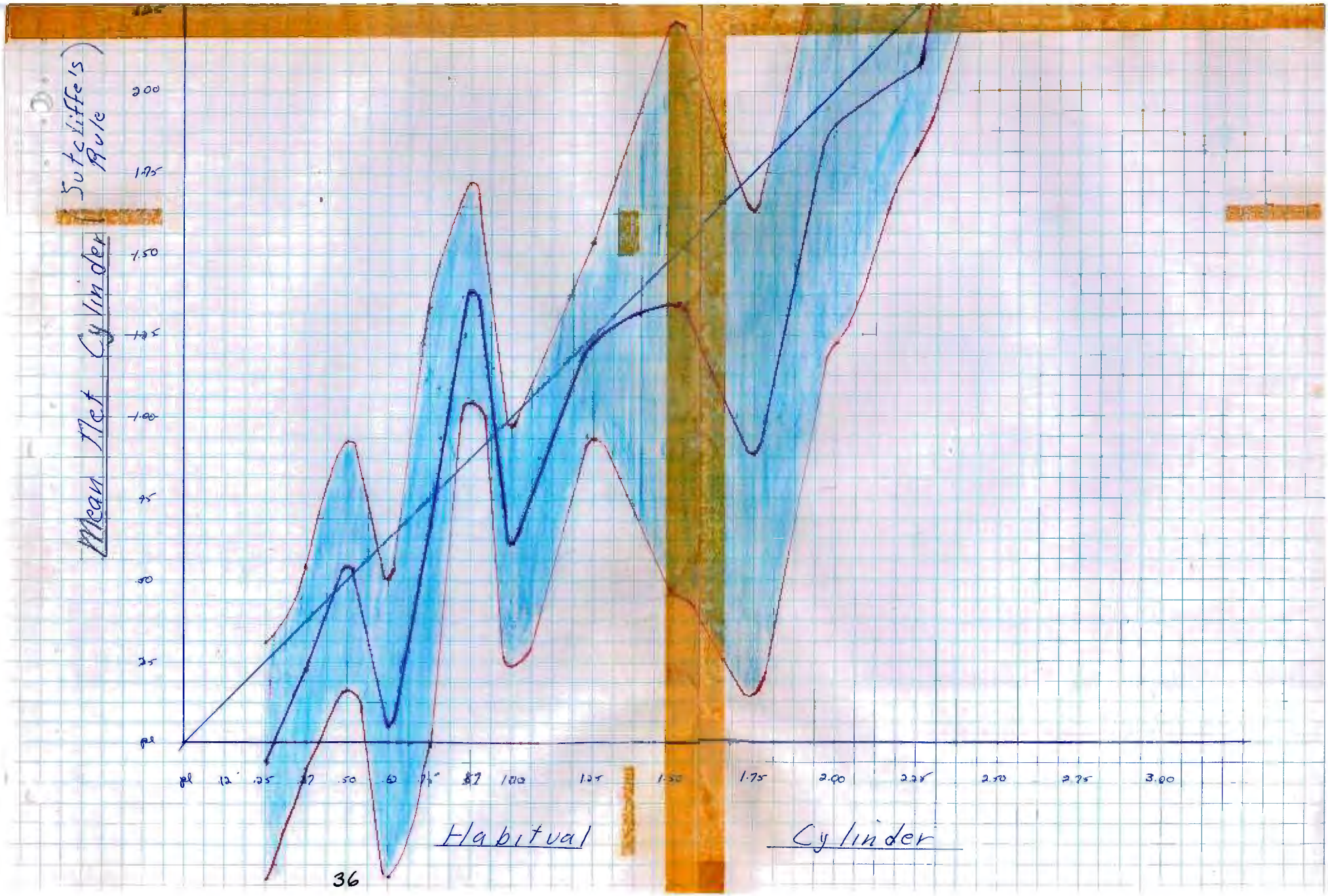



(McCulloch's) Mean Net Cylinder Rule
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
0
0
.12
.25
.37
.50
.62
.75
.87
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
Habitual
Cylinder

Graph of Sutcliffe's Rule

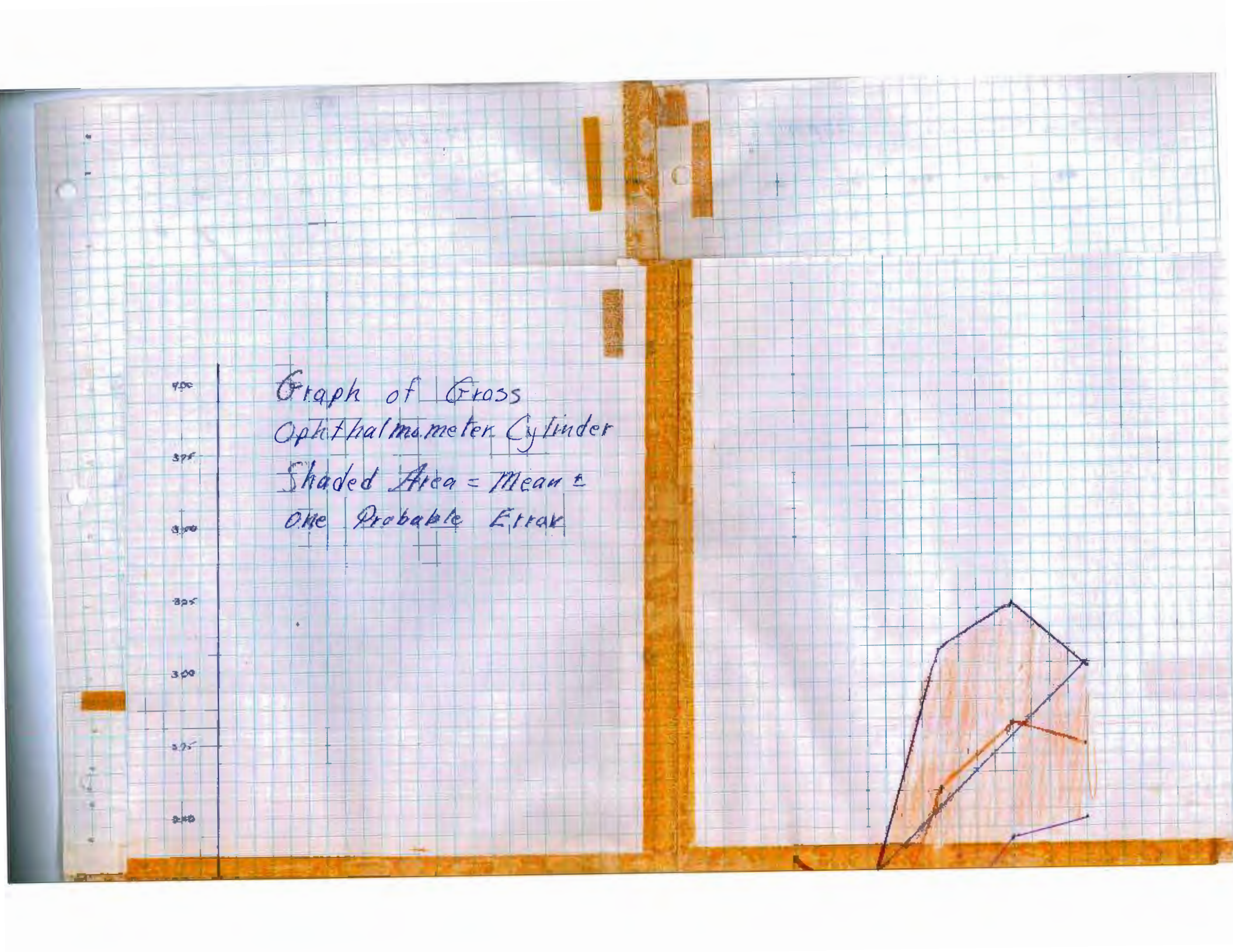
Shaded Area = Mean ± one Probable Error

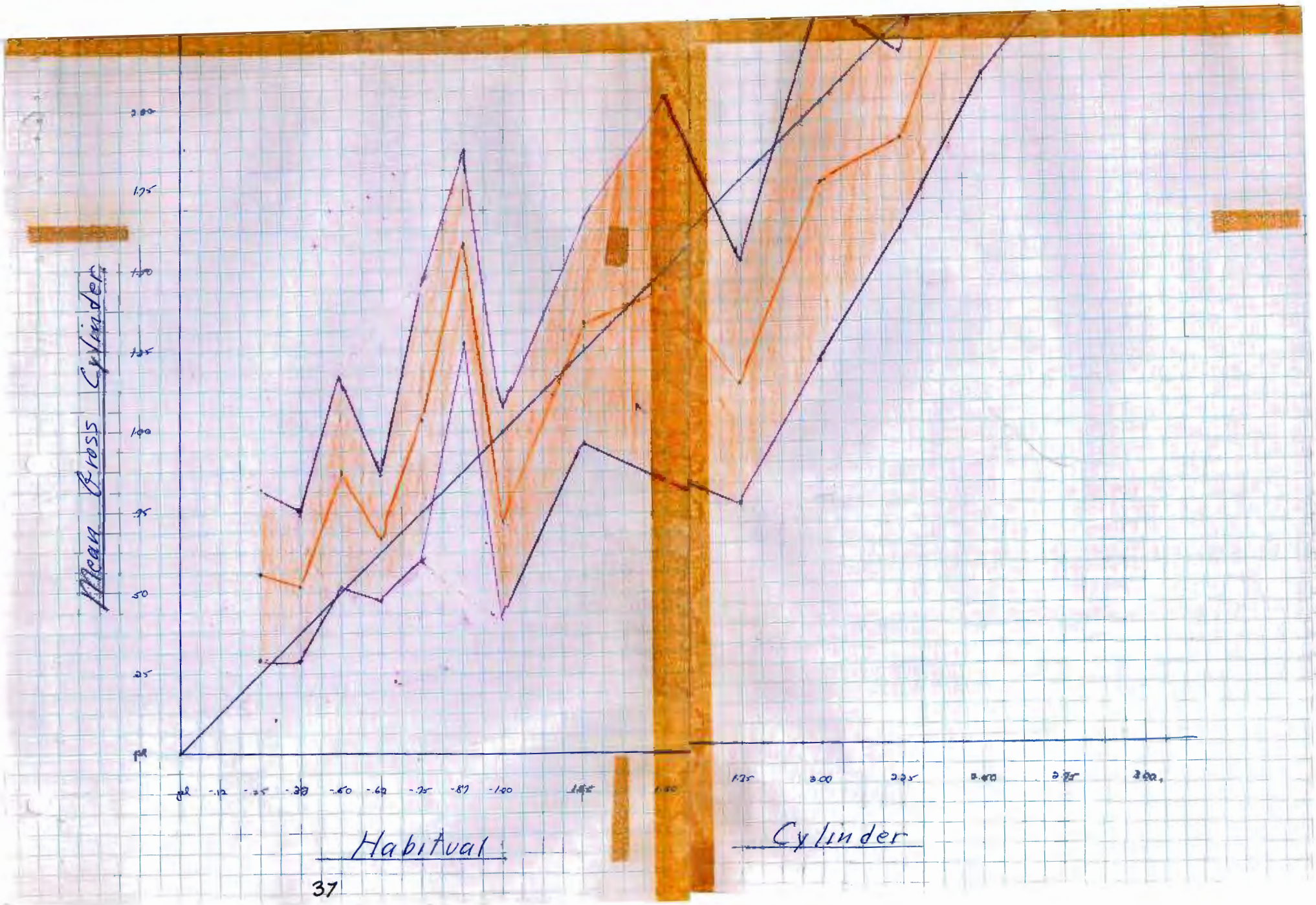



Mean Ref Cylinder
Sutcliffe's Rule
200
175
150
125
100
75
50
25
pd
pd .12 .25 .37 .50 .62 .75 .87 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Habitual
Cylinder

Graph of Cross Ophthalmometer Cylinder

Shaded Area = Mean ± One Probable Error




Mean Erosis Cylinder
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
.00
.12
.25
.38
.50
.62
.75
.87
1.00
1.25
1.50
1.75
2.00
2.25
Habitual
Cylinder

CONCLUSION

From the graphical analysis of the accummulated data, the following conclusions may be drawn:

1. In regard to the observations made upon processing the gross ophthalmometer cylinders by means of the rule of Javal, in each of the 15 habitual cylinder catagories, the mean net cylinder was found to lie within plus or minus one probable error of measurement from the habitually worn cylinder except in four instances; -.87, -2.50, -2.75, -3.00. The only apparent significance of these deviations is that three of the four variances were consecutive values at the upper end of the progression. This may tend to indicate that a gross error in Javal's rule evolves when the cylinder lies within significant limits of the habitual cylinder, in most cases, computation of a prescriptable cylinder by means of Javal's rule on an individual basis appears to be futile due to the wide extent of the distribution in each category.

2. Subjected to the same analysis as was Javal's Rule, McCulloch's Rule shows a more random dispersion of deviations. The categories which failed to result in significance were -.87, -1.75, and -2.25D. The lack of proximity of these deviations fails to locate any area in which McCulloch's Rule would not be applicable. In contrast to Javal, McCulloch does show significance with cylinders of -2.50D and above. Another observation was that the mean net cylinder was consistantly below the habitual cylinder in the values from -1.00D to -2.50D. Here again, the range of the distributions of the individual nets about the means would indicate that McCulloch's Rule cannot be used on an individual basis for the prescribing of a wearable cylinder.

3. Sutcliffe's Rule results in failure to show significance in seven categories; These categories are scattered at random in the low and medium powers but shows a definate trend above the habitual cylinder in powers from -2.50D and up. In the lower power cylinders, the mean net cylinder by Sutcliffe varys quite erratically.

Due again to the excessive variation of the individual case from the mean, the conclusion to be drawn is that Sutcliffe's Rule with few exceptions cannot be used to determine a prescriptable cylinder.

4. In view of the conclusions drawn from the application of the above three rules, the gross ophthalmometer cylinder powers were subjected to a similiar analysis to determine if the lack of correlation between the net cylinder and the habitually worn cylinder was due to the rule modification or to the variance of the gross cylinder. * The graph of the gross cylinder indicates that one rule for all cylinder powers is not sufficient. By following the mean gross cylinder from the lowest through the highest powers, it is seen that below -1.25D, the mean is consistantly high, from -1.25D through -2.25D, the mean falls below the habitual cylinder, and for values above the mean gross cylinder closely approximates the habitually worn cylinder.
5. In conclusion, the authors are essentially of the opinion expressed some years ago by Laurance and Wood which states:

> "Advocates of the keratometer have attempted to draw up empirical tables of corrections to be applied to the corneal readings to give the cylindrical correction for distance. In the authors opinion such attempts are futile. Obviously, these tables imply that the lenticular astigmatism is subject

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* See graph page 37

to some sort of law, for which there appears to be no justification at all." *

Although the formulation of one rule for gross cylinder modification does not seem feasible, from our investigation it appears that the internal astigmatism varies geometrically with the corneal astigmatism rather than arithmetically as the use of only one rule would suggest. On a group data basis, three rules would enable the clinician to more closely approximate a satisfactorily worn cylinder.

On an individual basis it appears that prescribing cylinder from the ophthalmometer reading can not be accurately accomplished with any rule or group of rules in sufficient instances to afford clinical success.

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* Laurance, Lionel, and Wood, Oscar H., "Visual Optics and Sight Testing", P. 351

Authors opinion of necessary subsequent studies in this field

1. An investigation of the axis determination with regard to rules contained in this study.

2. An investigation to determine if a correlation exists between the success of the rules with respect to age and sex.

3. Comparison similiar to that done in this study but separating the data into two groups, against and with the rule astigmatism.

4. Determination of a rule which provides for alteration of the process according to the power of the cylinder under investigation. This is indicated by the fact that the rules considered in this study show regions of reasonable accuracy.

END