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The construction of a readability target and its correlation with resolving power

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THE CONSTRUCTION OF A READABILITY TARGET AND ITS CORRELATION WITH RESOLVING POWER

by

Gary E. Lowe

An Abstract

A thesis submitted in partial fulfillment of the requirements for the degree of Batchelor of Science in the School of Photography in the College of Graphic Arts and Photography of the Rochester Institute of Technology

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ABSTRACT

A readability target was constructed. It consisted of sets of randomized letters which were incremented in size by the twelfth root of two. This new target and the German DIN standard legibility target were photographed simultaneously using a microcopy camera set at various degrees of magnification. Evaluation of the resultant images was done by ten observers who each viewed sixteen sets of target pairs. From this data a correlation of .90 was found between the two targets. Nine out of the ten observers found the new target easier to evaluate. A study of the new target's variability was done and it was concluded that inter-operator mean values were consistent.

INTRODUCTION

A majority of the resolving power test targets in use today rely upon the observer's ability to distinguish a certain type of repeating pattern of dark bars which are separated by white or clear spaces. These targets have a strong mathematical foundation which encourages their use. In several aspects, however, they fall short. Spurious resolution in many instances can destroy their usefullness; observer preknowlege can influence their resulting data and; most of all, they don't relate in any way to the sort of printed matter encountered in daily life.

Conventional readability targets such as those used by opticians consist of complete sentences of different character sixe. In the microfilm industry randomized words of varrying type sizes are used to test their products. In both cases a great deal of error due to preknowlege and memorization is inherent.

What seemed to be needed was some sort of random arrangement of alphabetical characters of a commonly recognized type style in which the size of the letters was varied in a simiiliar manner to that used for common resolving power targets. By using enough of the letters in each group, preknowlege and memorization could be virtually eliminated. One target in

which this has been attempted is the DIN standard legibility target in which, following the ISO reccomendation, seven out of eight character orientations need be identified for the target to be 'legible'. It seemed logical that character identification and information theory could be similiarly used in the case of an alphabetical target; then the two targets could be compared and the variability of the new target investigated.

The objective of this research project was to devise and construct such a readability target which consisted of several groups of randomly arranged alphabetical characters. By using this sort of system it was hoped that preknowlege and memorization could be lessened or eliminated. Secondly, the use of common alphabetical characters was done from the standpoint of practicality (regarding the observer). Characters such as alphabetical ones, it was hoped, would appeal to a viewer more than sets of bars, thus lessening viewer fatigue.

The final objective of the project was the testing of the new target. A correlation, if any existed, between it and the DIN standard legibility target, both viewed under similiar conditions was sought. (The common factor being information content) Lastly, a measure of the target's inherent variability was to be found.

Preliminary Target Construction

In structure the new target consists of rows of randomly selected lower case Times Roman letters which have been arranged in magnifications incremented by the order of the twelfth root of two. This gives a more gradual spacing than that of the DIN standard's which are of the order of the fourth root of two. The width of the DIN character (an octagon with two parallel bars running through the interior) which is defined as "legible" is 2.00 mm. It seemed logical to increment our type sizes around this value and the small case 'o' seemed the most similiar to the DIN target design. It was therefore used as the standard measuring value so the magnifications and reductions went away from this value in both directions by the factor of two times.

The letters were randomized according to the procedures outlined by Grant and Leavenworth.[1] The process is as follows. Each of the twenty-six letters of the alphabet was assigned a value from one to twenty-six. Placing a pencil on the Rand Corperation table of random numbers then selects the column to be used.[2] The numbers in the column between 01 and 26 were used to order the letters randomly and all other numbers encountered were disregarded.

These letters were then typed onto a punched tape with the use of a Friden 8202 Justoperf Recorder. This tape was then fed through a Linofilm Super Quick photographic type

printing machine. The type size and style used was 10G-552 Q1 Times Roman at twelve picas. The paper used in the machine was Kodak Ektamatic Grade S Photomechanical Paper Type 1931 and it was processed in a Kodak Ektamatic Processor. After this processing the paper was run through a cycle of wash-fix-wash to assure stability of the images.* After viewing these images it was decided that to improve reading ease and facilitate easier calculation of information capacity the letters should be arranged into random groups of eight letters each, three groups to a line, and two lines at each subsequent magnification (center justified). Sixteen 'sets' of this type were made and assigned the appropriate number from one to sixteen.

The 'o' sizes were to run from four millimeters down to one millimeter by increments of the twelfth root of two. With this in mind, two primary targets with the sixth root of two as incrementation were made. Then one of these two targets was reduced again by the twelfth root of two to obtain the intermediate increments. The two targets were later joined to form one. The 'sets' of letters at the different reductions on the final artwork were spaced one millimeter apart; twice the spacing between two lines printed normally.

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*This part of the project was made possible in part by Mr. Tompkins of the Printing Department at RIT and the use of the machines in his laboratory.

Figure 1:-'sets' of letters used
-identification numbers
(actual size)

qsuhevtu jkabdblk wrwnvgye
ewcteoao geiyvojt xekpxnqx

arpvcqrb olqqbjaj wrxwfguo
tcjdwpuk oanpjwqe yxarkrks

yygavjln myxgwmxg fomrmgxf
hxjkgika axtydsnn exdsebuh

eyqvnwrw kldbdakj utvehusq
xqnxpkex tjovyieq oaoetiwe

ougfwxrw vjaibqlo brqcvpra
skrkraxy eqwjpnao kupwdjct

qcxwvmla qxmwgxym nnsdytxa
jkadbdlk geiyvojt olqbiajv

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

17 18 19 20 21 22 23 24 25

A four inch hashmark was made to be included in the copying of the artwork at each magnification. It consisted of two edges, one placed at 0.000" and one at 4.000" on a transparency ruler obtained from the Edmund Scientific Company (.005" incrementation). This was used to increase the ease and accuracy of judging when the image of the artwork being copied was at the proper magnification. A Kodak reflection step tablet as well as the appropriate artwork designation number was included when the copying was done.

The artwork, hashmark, step tablet, and designation number were enlarged and reduced with a Polaroid MP-3 Land Camera. This particular camera has incorporated in its viewing back a fresnell lens which proved unsatisfactory for making the fine measurements necessary. So the ground glass back from an Orbiter 4x5 view camera was removed and used in place of it. The lens of the camera was set at F11 for all exposures and the shutter time varied to keep the exposure constant. An eleven by fourteen inch piece of glass from a contact printer was placed on top of the objects being photographed to keep the plane flat. After the exposure and processing of the primary reduced negatives for the individual target magnifications were completed, the groups of letters were opaqued where any pinholes occured by using Grumbacher No. 1445 Speed-O-Paque (for film negatives). A Kodak Coldlight X-ray Illuminator was used to view the negatives during this process.

Next the groups of letters at the various magnifications

were cut out of the unwanted surrounding negative material with a Honeywell-Nikor Saftey Trimmer which was placed on top of the previously mentioned X-ray viewer.. In order to get a one millimeter spacing between the letters of different magnification on the final target the film was cut along a line one half of a millimeter away from the lower and upper extenders of the letters.

The groups of "words" were then taped together. They were arranged with the largest at the top running to the smallest at the bottom.and were left justified. The second target was arranged in the opposite order and right justified to form two trapezoids which butted at their angled edges. A piece of clear acetate, onto which the words were taped, was placed on top of the x-ray viewer. The groups were then lined up with a ninety degree corner which was placed under the acetate and taped down. After the negative strips were taped to the acetate, black charcoal paper was cut so that it had a hole in it the size of the trapezoid formed by the letters. The acetate and paper were taped together and any light leaks taped over.

These two primary master negatives were contact printed on Kodak Ektamatic T photomechanical paper.*

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*This type of paper was reccomended by Mr. T. Shultz of the Graphic Arts Research Center at RIT. He had previously done testing on it and used it in the manufacture of the RIT alpha-numeric resolving power target.

To get as near a point sourse of exposure as possible when doing the contact printing an Omega enlarger was used, stopped down to f22. The safelight used with the paper was a Kodak Wratten Series safelight No. 1 (red). A safelight test was run and the results proved satisfactory. The paper was processed as follows:

Table 1

STEP	dilution	time(min.)
Developer-Kodalith	A:B=1:1	1
Stop-28% acetic acid	1:30	.5
Fixer-Kodak F-6	1:0	3
Wash	---	10
Hypo-Clear	1:4	2
Ferrotype Release Agent	1:200	.5

All solutions were at 68°F. After this the paper was ferrotyped in a Pako print dryer at its slowest speed and 225°F. The paper's exposure was determined by examining the sharpness of the letters and the densitys on a twenty-one step uncalibrated Kodak step wedge (No. 2). The final exposure used was 100 seconds at f22.

After the first few prints were done it was apparent that further opaquing was needed between the individual 'word' negatives. The emulsion surface of the film, facing the acetate was not accessable for opaquing (and couldn't have been because of the separations in it) so the opaquing was tried on the acetate surface. This surface repelled the water base opaque so, instead, thin strips of semi gloss electrical tape were placed on the negative to block any light from coming between the individual negative's edges. This worked quite satisfactorily.

Labeling The Target

The target's different magnifications needed to have some identification relating to them. The ISO standard (No. R-446) has the following method documented:

> 2.3.3 To facilitate reading, the face size is indicated at both ends of a line of characters, upright on one side and inverted on the other. The face size is identified by the corresponding number of the series, eg. face size of the 45/100 millimeter characters is identified by the number 45.
>
> 2.3.4 These face sizes of the members are also in arithmetical progression, selected so as to be proportional to the interline spaces, those for the smallest being larger than the ISO characters themselves and still legible to the naked eye.

The new readability target will have the ability to be read in only one position, eg. with the letters in the upright position so numbers which procede in an arithmetical progression from one to twenty-six were put along the straight side of each target. One target was given odd numbers as labels and the other, even. The numbers started at the smallest magnification. As the 'o' sizes go from 1.000 mm. to 4.000 mm. the actual sizes in inches or millimeters of the o's was not used because they would have had to have been three and four digit numbers and thus would have taken up approximately twice as much space as the largest designation number (26).

For these artwork a Compugraphic cg7200 which has type sizes from 14 to 72 picas was the instrument used. The paper was processed in the same Kodak Ektamatic processor used

earlier with the primary artwork.

In order to mount these numbers on the prints of the target it was first necessary to mount the target on mount board (because of its tendency to curl). The numbers were cut out and pasted flush with the ends of the letter columns with rubber cement.

The paper upon which the numbers had been printed had a yellow tint as compared with the Ektamatic T's white surface, but, later when the prints were copied, no differance was noticeable.

Final Target Construction

The two trapezoidal targets described above were next copied to obtain the final, completed master negatives. The 4.000" hashmark was again included in the scene as well as a Kodak reflection step tablet. The targets (hashmarks) were copied in the following way:

Target	Final (image) hashmark length	% origional size
odd labeled target	3.775"	94.43%
even labeled target	4.000"	100.0%

This reduced the "odd" target by the twelfth root of two and it became the increments between the even target's magnifications. A Klmsch process camera was used.* The graphic arts film used was the same as that used innitially and was

*Courtesy of Mr. Horn, RIT Printing Department.

processed in Kodalith developer until the .50 density level had just begun to visualy darken. In any case, the image quality was judged by the sharpness of the letters.

The two negatives were cut along their angled edges and connected with electrical tape. Black charcoal paper was again used as an opaque 'frame' around the negatives to keep the surrounding area on the subsequent print blank. The joined, single negative was then contact printed onto the Ektamatic T paper using an exposure of 110 seconds at f/22 on the Omega enlarger as before.(condensor in the #3 position) The paper was processed in the same manner as that described on page seven.

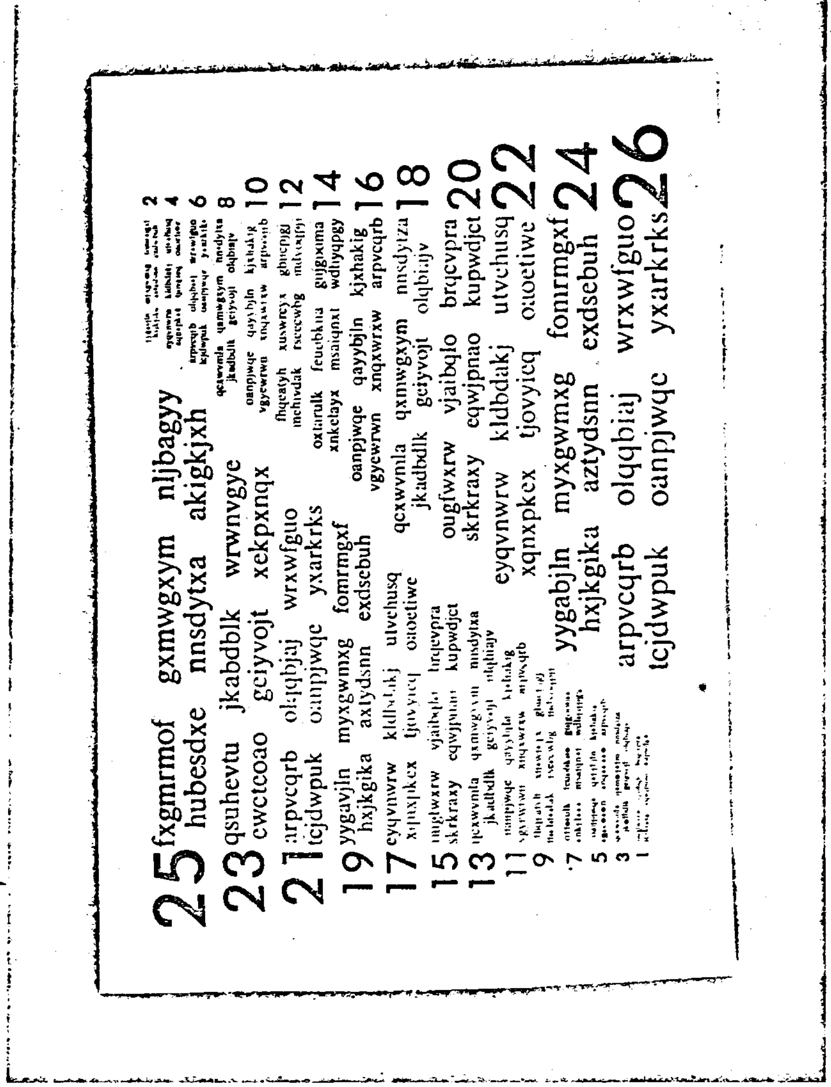
Target Correlation With DIN Standard Target

The objective now was to correlate the information capacities of the new target and that of the DIN standard target. The latter target, obtained from Dean Engleman, was labled as follows: DK778.14.072:602.1:771.537 Deutsche Normen, Härz 1971, DIN 19051 Blatt 2 Beiblatt 1. (Tests for reprographic use, fundamental assembly of typographical characters for legibility tests, test card for use in practice.) The two targets can be seen in the following figures. (turn page)

Method

The method used to compare the two targets was to photograph them simultaneously using a Recordak Microfilm unit (Model MCD-2; ser. no. 2773) which was mounted on a

Figure 2: Enlarged Final Target



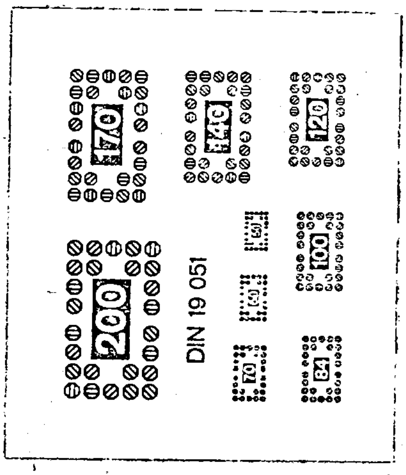


Figure 3: Two targets, Actual size (as compared)

Recordak Microfile machine (Model MRD-2; ser no. 2773; RIT no. 62860). The film used was Recordak fine grain film (16 mm.x 100', prod. no. 1120, 9/71, 7457797R). It was processed using the following steps.

TABLE 2

STEP	DILUTION	TIME (min.)
D-19 Developer (Kodak)	1:0	5
28% Acetic Acid Stop	1:30	.5
F-6 Fixer (Kodak)	1:0	5
Wash- running water	---	10
Photo Flo (Kokak)	---	.1

All solutions were at 68°F. The film was air dryed at 125°F. The processing was done by the lift and drain method of tray processing in which the entire length of the film is hand held at both ends and dipped through the chemistry once every ten seconds and repeated.

By using the microfilm machine it was hoped that the image of the targets could be blurred by different degrees through the use of the various available magnifications. When tried, however, it was found that the two targets were resolved well down to the smallest characters even when using the greatest magnification. To solve this problem several microscope slide glasses were coated with acrylic spray lacquer and placed over the camera's lens. This did the trick but another problem was encountered. The readability target extended quite a bit further in the large character size than did the DIN and the DIN extended equally further in the small character direction. It was decided to reduce the new target

by fifty percent, hoping to make the two correlate in size somewhat better. First, the reduction was attempted using the previously mentioned Polaroid MP-3 copy camera. The lens resolution fell off near the edges of the image, precisely where the smallest target characters are located. The method proved inadequate. Instead, the Klmsch process camera (Mr. Horn's - mentioned previously) was again used along with the same film and processing. The resulting fifty percent negative was contact printed as before on Ektamatic T paper using the same process. This, the final target, was mounted on black mount board to give it support and eliminate curling.

This target and the DIN standard were again photographed simultaneously with the microfilm camera using magnification settings six through twenty-one (in steps of one). The film was processed in a Kodak Prostar film processor, not previously available for use. When examined, the image of the two targets appeared to be degraded concurrently and suitable for use in correlating them.

Next the series of exposures was repeated, this time twice at each magnification level. An extra blank exposure was shot between each target exposure. The film was processed in the Kodak processor as before and the images were cut and labled as to their respective magnifications.

Target Viewing Conditions

Ten observers, selected on the grounds that they had 20-20 vision (corrected or uncorrected), were asked to each examine the sixteen sets of two targets and evaluate them. There were two samples at each magnification, one of which was randomly selected and presented to the observer. Magnification levels were randomized. The film samples were viewed using a Kodak Microfilm viewer. Each observer was allowed to get as close to its screen as he wished using only his naked eye. They were also allowed to operate the focus device on the machine. The targets were centered on the screen before starting each reading. In the case of the DIN standard target the smallest target on which the observer could read seven out of eight of the orientations of the octagon patterns was considered resolved. On the alphabetical target the same applied; the smallest target on which seven out of eight of the letters could be identified correctly was considered resolved. (The group of eight letters which the observer read was picked at random, as with the octagons in the DIN) Each observer took approximately twenty minutes to read all of the targets.

DATA ANALYSIS

The data from the alphabetical target (1-26) were transformed into the respective 'o' sizes in hundredths of a millimeter and correlated with the DIN target values already in those units. The one hundred and sixty DIN target (X) and

alphabetical target (Y) values were fed into a Monroe 1655 calculator (regression analysis - correlation coefficient). The equation obtained was Y=.53X+13.09 with a correlation coefficient of .90 (r). With a sample size of 160 and an alpha risk of .05 the following convidence limits were found:[3]

$$.87 < r < .93$$

The ten observer's mean ($\bar{X}$) and standard deviation (S) values were next calculated. Then the mean ($\bar{\bar{X}}$) and standard deviation ($S_{\bar{X}}$) associated with these means and standard deviations was calculated. These data are tabulated in table three below.

Table 3

Observer	$\bar{X}$	S
1	4.18	3.80
2	6.37	4.64
3	7.62	4.81
4	6.56	4.44
5	4.31	4.16
6	5.80	5.14
7	4.12	3.42
8	7.12	5.45
9	6.06	3.99
10	5.25	4.95

$\bar{\bar{X}}$=5.802; $S_{\bar{X}}$=1.171

$\bar{S}$=4.480; S_S=.6379

Table of Averages and Standard Deviations of Each Observer

A control chart ($\bar{X}$ and s) was constructed from these values using the following limits (Table 4--next page)

Table 4

$$UCL_{\bar{X}} = \bar{\bar{X}} + 3S_{\bar{X}} = 5.802 + 3(1.171) = 9.315$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - 3S_{\bar{X}} = 5.802 - 3(1.171) = 2.289$$

- - -

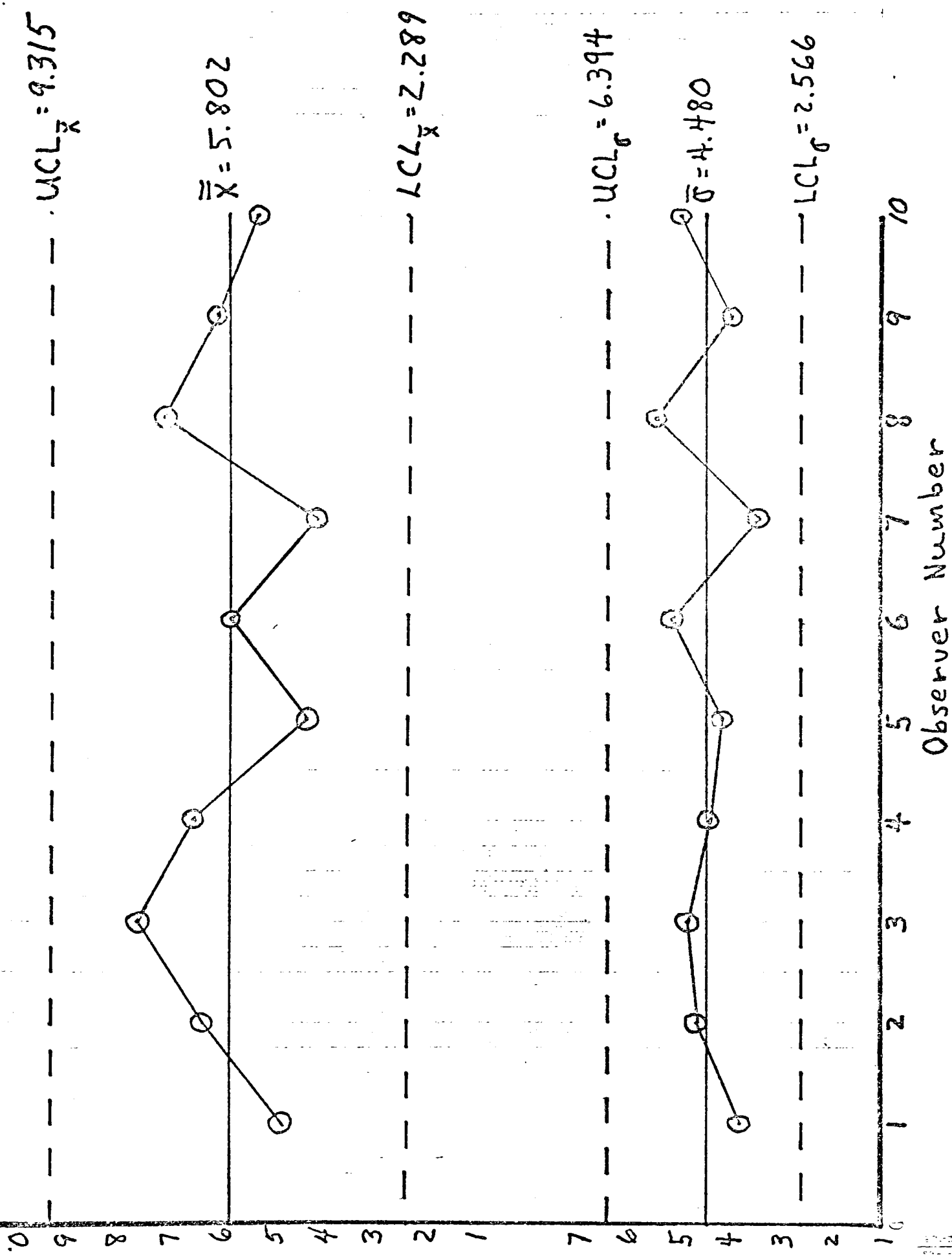
$$UCL_{S} = \bar{S} + 3S_{S} = 4.480 + 3(.6379) = 6.394$$

$$LCL_{S} = \bar{S} - 3S_{S} = 4.480 - 3(.6379) = 2.566$$

Table of Control Chart Limits

The control chart itself is presented on the next page.

Figure 4: Control Chart for Operators



SUBJECTIVE OBSERVATIONS

When asked which target they preferred, nine of the ten observers stated they liked the alphabetical target more than the DIN. The reasons varied. Some are listed here.

1. The necessity of moving ones eyes back and forth in order to find successive magnifications with the alphabetical target helped to decrease memory of preceeding targets.
2. The finer incrementation of the magnifications in the alphabetical target allowed one to judge more accurately than with the DIN.
3. Spurious resolution in the DIN target made it harder to read.
4. The letters were 'easier' to read than the hexagons and less tiring.

CONCLUSIONS

From the data analysis it can be concluded that there is a high degree of correlation between the new alphabetical readability target and the DIN standard legibility target. Indicative of this is the slope of the regression line (.53) which is very nearly a forty five degree angle. The intersection point being at 13.09 isn't significant when one realizes that it depends only upon how far the alphabetical target was origionally reduced. With the conficence limits computed we can safely say ninety-five percent of the time the value for the correlation coefficient will fall in this region:

$$.87<r<.93$$

Looking at the control chart for $\bar{X}$ and s plotted we can conclude that the target is definitely in statistical control; that is, the process is influenced by random, chance causes only. Consistent variability was noted among the ten target observers.

RECOMENDATIONS

The only reccomendation at this point is that the target be similarly compared with other typical resolving power targets and that a target calibration be carried out.

FOOTNOTES

1. Grant, Eugene L. and Richard S. Leavenworth, Statistical Quality Control, fourth edition, (New York, McGraw-Hill Book Co. Inc., 1972), pp. 383-384.

2. Ibid., Table Z, p. 682.

3. David, F.N., "Tables of the Correlation Coefficient," The Biometrika Office, University College, London, 1938.

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3. Grant, Eugene L. and Leavenworth, Richard S., Statistical Quality Control, fourth edition, New York, McGraw-Hill Book Co. Inc., 1972.

4. ISO Recommendation R435-ISO Conventional Typographical Character for Legibility Tests, first edition, (New York, ANSI, 4/65), 5.1-5.2.

5. ISO Recommendation No. R-446, (New York, ANSI, 4/65), 2.3.3-2.3.4.

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8. Rickmers, Albert D. and Todd, Hollis N., Statistics-An Introduction, New York, McGraw-Hill Book Co. Inc., 1967.

9. Wilson, E. Bright Jr., An Introduction to Scientific Research, New York, McGraw-Hill Book Co. Inc., 1952.

APPENDICES

APPENDIX A

Group Letter Listing

Group Number	Letters
1	ougfwxrw vjaibqlo brqcupra
	skrkraxy eqwjpnao kupwdjct
2	yygavjln myxgwmxg fomrmgxf
	hxjkgika axtydsnn exdsebuh
3	qcxwvmla qxmwgxym nnsdytxa
	jkadbdlk geiyvojt olqbiajv
4	eyqvnwrw kldbdakj utvehusq
	xpnxpkex tjovyieq oaoetiwe
5	oanpjwqe qayybjln kjxhakig
	vgyewrwn xnqxwrxw arpvcqrb
6	arpvcqrb olqqbjaj wrxwfgun
	tcjdwpuk oanpjwqe ysarkrks
7	oxtarulk fenobkna gnjgooma
	xnkelayx msaiqnxt wdbyqpqy
8	qcxwvmla qxmwgxym nnsdytxa
	jkadbdkz geiyvojt olqbiajv
9	fhgeatyh xuswrcyx gbucpjgj
	mehtvdak rseecwbg mdvoqpji
10	oanpjwqe qayybjln kjxhakig
	vgyewrwn xnqxwrxw arpvcqrb
11	oanpjwqe qayybjln kjxhakig
	vgyewrwn xnqxwrxw arpvcqrb
12	fhqeatyh xuswrcyx ghucpjgj
	mehtvdak rseecwbj mclvoqpj
13	qcxwvmla qxmwgxym nnsdytxa
	jkadblkd geiyvojt olqbiajv
14	oxtarulk feuobkna gujgooma
	xnkelayx msaiqnxt wdbyqpqy

APPENDIX A (continued)

Group Number	Letters
15	ougfwxrw vjaibqlo brqcupra skrkraxy eqwjpuao kupwdjct
16	oanpjwqe qayybjln kjxhakig vgyewrwn xnqxwrxw arpvcqrb
17	eyqonwrw kldbdakj utvehusq xqnxpkex tjovyieq oaoetiwe
18	qcxwvmla qxmwgxym nnsdytza jkaibdlk geiyvojt olqbiajv
19	yygavjln myxgwmxg fomrmgxf hxjkgika axtydsnn exdsebuh
20	ougfwxrw bjaibqlo brqcvpra skrkraxy eqwjpano kupwdjct
21	arpvcqrb olqqbjaj wrxwfgno tcjdwpuk vanpjwqe yxarkrks
22	eygvnwrw kldbdakj utvehusq xqnxpkex tjovyieq oaoetiwe
23	qsuhevtu jkabdblk wrwnvgye ewcteoao geiyvojt xekpxnqx
24	yygabjln myxgwmxg fomrmgxf hxjkgika axtycdun exdsebuh
25	fxgmrmof gxmwgxym nljbaqyy hubesdxe nnsdytxa akigkjxh
26	arpvcqrb olqqbiaj wrxwfguo tcjdwpuk oanpjwqe yxarkrks

APPENDIX B

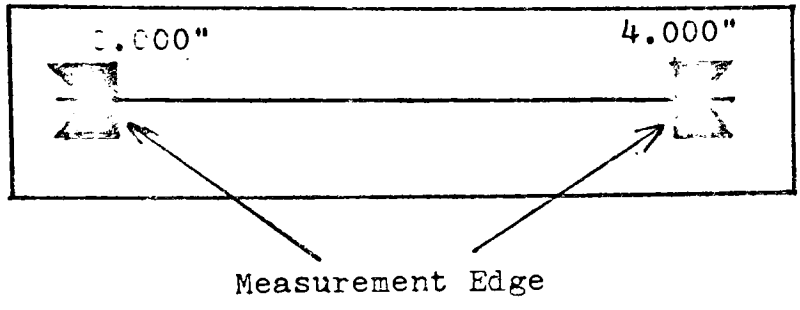
Enlargement - Reduction Construction Specifications

Final 'o' Height mm.	Enlargement-Reduction %	Copy Size of 4" Hashmarks inches	mm.
4.000-	1.185	4.740	12.0396
3.775	1.117	4.468	11.3487
3.560-	1.054	4.216	10.7086
3.360	0.997	3.988	10.1295
3.170-	0.941	3.764	9.5606
3.000	0.888	3.555	9.031
2.830-	0.838	3.352	8.5141
2.670	0.791	3.164	8.0366
2.520-	0.747	2.988	7.5895
2.380	0.705	2.820	7.1628
2.240-	0.664	2.656	6.7462
2.120	0.628	2.512	6.3805
2.000-	0.593	2.372	6.0248
1.890	0.560	2.240	5.6896
1.780-	0.527	2.108	5.3543
1.680	0.498	1.992	5.0597
1.590-	0.471	1.884	4.7854
1.500	0.4	1.7	4.515
1.410-	0.418	1.672	4.2459
1.330	0.394	1.576	4.0030
1.260-	0.373	1.493	3.7922
1.190	0.353	1.412	3.5865
1.120-	0.332	1.328	3.3731
1.060	0.314	1.256	3.1902
1.000-	0.296	1.184	3.0074

This table was used in making the innitial target reductions. The size incrementation is the twelfth root of two. If four inch hash marks are used on the origional artwork the last column in the table indicates their size as measured on the ground glass of the copy camera.

APPENDIX C

Hashmark Construction



Copied from the origional Edmund Scientific Co. ruler with: Dupont Graphic Arts Film, Cronar/Ortho S Litho/ .004 thickness, 11x14", 6045359 3, order code COS4.

The processing used on the film was: (all solutions at 68°F)

Step	Time(min.)
Kodalith A-B Developer	2
Kodak F-6 Fixer	5
Wash	10

Tray processing: 15 second agitation.

APPENDIX C

Miscellaneous

The paper used in the phototypesetting machines was: Kodak Ektamatic grade S, Photomechanical Paper Type 1931, 8"x100', specification 281, exp. 6/71, 83605-80058A.

The paper used for copying the target was: Kodak Ektamatic grade T, Photomechanical paper, exp. 12/72, 19406-72004g.

The pica sizes of the numbers used in labeling the various target groups were:

target groups	point size
1-4	14
5-8	18
9-12	24
13-16	30
17-20	36
21-24	48
25-26	60