AD640076

UNCLASSIFIED

[redacted]

AN APPRAISAL REPORT UNDER CONTRACT WITH
SPECIAL DEVICES CENTER, OFFICE OF NAVAL RESEARCH

REPORT NO. 166-1-80

APPRAISAL OF DEVELOPMENT MODELS OF SIXTY-INCH VERTICAL PLOTTING BOARDS

SYSTEMS RESEARCH
THE JOHNS HOPKINS UNIVERSITY

20 JANUARY 1949

Psychological Laboratory

THE JOHNS HOPKINS UNIVERSITY

Institute for Cooperative Research

20 January 1949

1315 St. Paul Street Baltimore 2, Maryland

To: Chief, Bureau of Ships
Navy Department
Washington 25, D. C.

Attention: Code 665h

Subject: Appraisal of Development Models of Sixty-inch Vertical Plotting Boards

References: (a) BuShips ltr S24-7 (23) (665) dtd 11 Mar 1948 to Director SDC, ONR.

(b) Systems Research ltr, Garner to Mead at SDC, ONR, dtd 1 June 1948.

(c) Director, SDC, ONR. ltr SDC:29:HAV dtd 9 June 1948 to BuShips.

(d) BuShips ltr NObs-46658(665h-1773) dtd 30 June 1948 to Reisner Mfg Co.

(e) BuShips ltr S24-7(23) (665) dtd 5 Oct 1948 to Director, SDC, ONR.

(f) Director, SDC, ONR ltr SDC:914:VS dtd 20 Oct 1948 to Director, Systems Research.

1. Reference (a) from BuShips requested designs for the grid overlays of two sixty-inch vertical plotting boards. Drs. T. W. Reese and J. Volkmen from Mt. Holyoke College and W. R. Garner and J. W. Gebhard from The Johns Hopkins University collaborated in designing two grid overlays, which were transmitted to Special Devices Center via reference (b) and thence to BuShips via reference (c). Reference (d) points out certain revisions in

[redacted]

designs which were made as a result of a conference between representatives of Systems Research, BuShips, and Reisner Mfg. Co. Of the two designs proposed, one (Design A) was intended to produce maximum speed of plotting and comprehension by viewers. The other (Design B) was intended to produce maximum accuracy of plotting and reading of target positions. After prototypes of these two designs were produced by the Reisner Mfg. Co., the boards were sent to Systems Research Laboratory for appraisal, which was requested by references (e) and (f).

2. This appraisal report states the results of tests made on these two vertical plotting boards, with appraisal of other features of the board than maximum speed and accuracy of plotting and reading of target positions. This report also includes (in Appendix A) one design for the grid overlay of the vertical plotting board which incorporates the best features of the old design and the two proposed designs.

3. Estimation of target positions. Tests were conducted at the Systems Research Laboratory to determine the speed and accuracy with which target bearings and ranges could be estimated on each of the two proposed designs and on the old plotting board. In these tests, six observers were required to report the range (to the nearest mile) and the bearing (to the nearest degree) of different numbers of targets as readily and as accurately as possible. Before the boards were used, numerals to indicate every 10 degrees of bearing were placed outside the last range ring of the inner section of the two new designs. No range numerals were on the board. Observers sat at a distance of 12 feet from the boards. The tests were conducted in such a way that an analysis of variance technique was possible to determine if differences in speed and accuracy between the three boards were statistically reliable. The results of these tests were as follows.

The total time required to read the positions of 32 targets was 4 minutes, 25 seconds for the old board; 4 minutes, 58 seconds for proposed Design A; and 3 minutes, 52 seconds for proposed Design B. These differences in speed of reading target positions are statistically reliable to the extent that such differences could have occurred by chance (assuming that there were no real differences) less than once in 1000 times. The savings in time for Design B over the old design is approximately 12.5 per cent. Design A (which was originally designed for speed) is a slower board than the old design. This unexpected slowness is probably due to the fact that observers had to interpolate between range rings with a scale of 20 rather than a scale of 10. It appears that decimal interpolations are far superior in terms of speed, as well as in accuracy.

The average bearing error in reporting target positions was 0.41 degrees for the old design; 1.17 degrees for Design A; and 0.48 degrees for Design B. The lower accuracy on Design A is statistically reliable while the slight difference between the old design and Design B is not.

The average range error in reporting target positions was 0.32 miles for the old design; 0.71 miles for the new Design A; and 0.38 miles for Design B. Once again the lower accuracy for Design A is statistically reliable, while the slight difference between the old design and Design B is not.

The slight differences in accuracy of reporting ranges and bearings between the old design and Design B are probably due to the fact that the targets used in the tests were restricted to an 80-mile radius, since that is the maximum range possible with the old board. Since the new boards, however, are designed for a 100-mile range, the targets were slightly more crowded. In any event, the differences between the old board and Design B are not statistically significant, and can be disregarded for all practical purposes.

In summary: the Design A is inferior to the other designs in both speed and accuracy. The old design and Design B give essentially the same accuracy, but Design B gives it faster. In redesigning a new grid overlay, Design B was used as the basic one to work from.

4. Plotting. No systematic tests of speed of plotting were made. However, all the targets which were used in the above tests had to be plotted with great accuracy. In preliminary trials, we found it difficult to plot on any of the boards with the accuracy required in the tests. In order to improve accuracy, a special rule was used for plotting. This rule was made of plastic, pivoted to the center of the display, and marked off in one-mile steps. Numerals were printed on the rule for every five miles.

Although this rule was devised primarily to improve accuracy, we found that it also increased the speed of plotting by a very large margin. One plotter, having ranges and bearings read to him, was able to plot as fast as the fastest observer could call off ranges and bearings--a little over 2 1/2 minutes for 32 targets. The plotter no longer had to do any estimating of distances, but could read directly from his rule. Since the plotter normally is in such cramped quarters that he cannot stand back to see the overall display, such an aid is very helpful. Estimating interpolation distances is very difficult when it is not possible to see the reference lines straight on.

5. Surfaces of boards. During the time that the boards were at Systems Research Laboratory for testing, close to 1500 targets were plotted on each board and erased. At the end of this time, the boards had become considerably scratched and smeared on the surface, and emitted a great deal of light as a result. These small abrasions are very difficult to prevent because of the soft surface of the plastic. A harder surface plastic would be desirable, in order to prevent the abrasions. Also, ultraviolet lighting, with fluorescent markings on the board, would prevent any light being visible except where grid overlay or targets actually appeared. If ultraviolet lighting were used, of course, the soft surface plastics would be satisfactory, since the abrasions would not emit visible light.

[redacted]

6. <u>Lighting of boards.</u> The use of 4-edge lighting is greatly superior to the old method of providing edge lighting only from the bottom. An even level of illumination can be adjusted and maintained over the entire surface of the board with the new lighting arrangements.

7. <u>Recommendations.</u> As a result of the tests and general appraisal made at Systems Research Laboratory, the following recommendations are made.

a. A new design for the grid overl should be used. Specifications and a sketch of the design proposed by is Laboratory are included in Appendix A.

b. Two rules should be provided for plotting on the back of the boards. These rules should be made of a translucent material, and should be marked off in miles of range. They should be anchored to the center of the plotting board and allowed to swing freely. If this recommendation is put into practice, then the outside range ring on the display should be marked off in one-degree steps, so that the plotter is not required to make a mental estimate of either bearing or range.

c. Ultraviolet lighting should be provided for the edge lighting, with fluorescent markings for the grid overlay. Likewise, a fluorescent grease pencil should be used.

W. R. Garner
Assistant Director

Robert B. Sleight
Research Psychologist

[redacted]

APPENDIX A

Improved Design (Design B, Modified)

1. Range rings.

a. Five solid rings, spaced 2.5 inches apart, starting 2.5 inches from the center of the display. In practice, these range rings will correspond to 10, 20, 30, 40, and 50 miles. These rings should be approximately 3/64 inch thick.

b. Four dashed rings, spaced 2.5 inches apart, starting 2.5 inches from the fifth solid ring. These rings will correspond to 60, 70, 80 and 90 miles. The dashes should be approximately 11/32 inch long, with 5/32 inch interspaces, regardless of radius of ring. The thickness of the rings should be the same as the solid rings, namely, 3/64 inch wide.

c. One solid ring, spaced 2.5 inches from the last dashed ring, corresponding to 100 miles. This ring should be the same thickness as the previously mentioned rings.

d. Four solid rings spaced 1 1/4 inches apart, starting 1 1/4 inches from the last solid ring (in c above). These rings, in practice will correspond to 125, 150, 175 and 200 miles or 150, 200, 250 and 300 miles. The thickness of these rings should be approximately one-third the thickness of the other range rings.

2. Bearing markers.

a. Solid radial lines for bearing markers spaced 30 degrees apart, starting at 000 degrees. These solid lines should extend from the center to, but not beyond, the range ring corresponding to 100 miles (the tenth ring from the center). The thickness of these lines should be the same as the thickness of the inner range rings.

b. Bearing dash marks interpolated every 10 degrees between the 30-degree solid markers. These dash marks should be 1/2 inch long, extending inward from the range rings, and occur at every one of the first ten range rings, except the first. These bearing dash marks should have the width of the inner range rings and the solid radial bearing lines.

c. Bearing cross marks every 30 degrees in the area of the outer four range rings, starting at 000. These should be 1 inch long, bisected by the range ring. The bearing mark for the last ring should be 1/2 inch long and extend to, but not beyond, the last range ring; for the first outer ring, that is the eleventh ring, the bearing mark should be omitted altogether. Also in this outer area, bearing dash marks interpolated every

[redacted]

10 degrees between the 30 degree cross marks, starting at 010. These should be 1/2 inch long and extend inward from the three outermost range rings; the dash mark also should be omitted on the eleventh ring.

d. The numerals for the bearings should be horizontal and placed just outside the tenth ring (the 100 mile range ring). At the 30-degree bearing positions the numerals should be 5/8 inch high, 10/32 inch wide, with stroke-width of 3/32 inch. At the 10-degree bearing positions the numerals should be 3/8 inch high, 1/4 inch wide, with a stroke-width of 1/16 inch.

3. <u>Gyro compass indicator.</u> The gyro compass indicator should be on the upper right-hand corner of the display, and should consist of a circle 6 inches in diameter with a tapered cross in the center. There should be a fixed scale outside and a movable scale inside. On the outer edge of the circumference of the circle, bearing marks should occur every ten degrees, starting at 000, and should be 1/2 inch long at the 30-degree points; at the intermediate 10-degree points the marks should be 1/4 inch long.

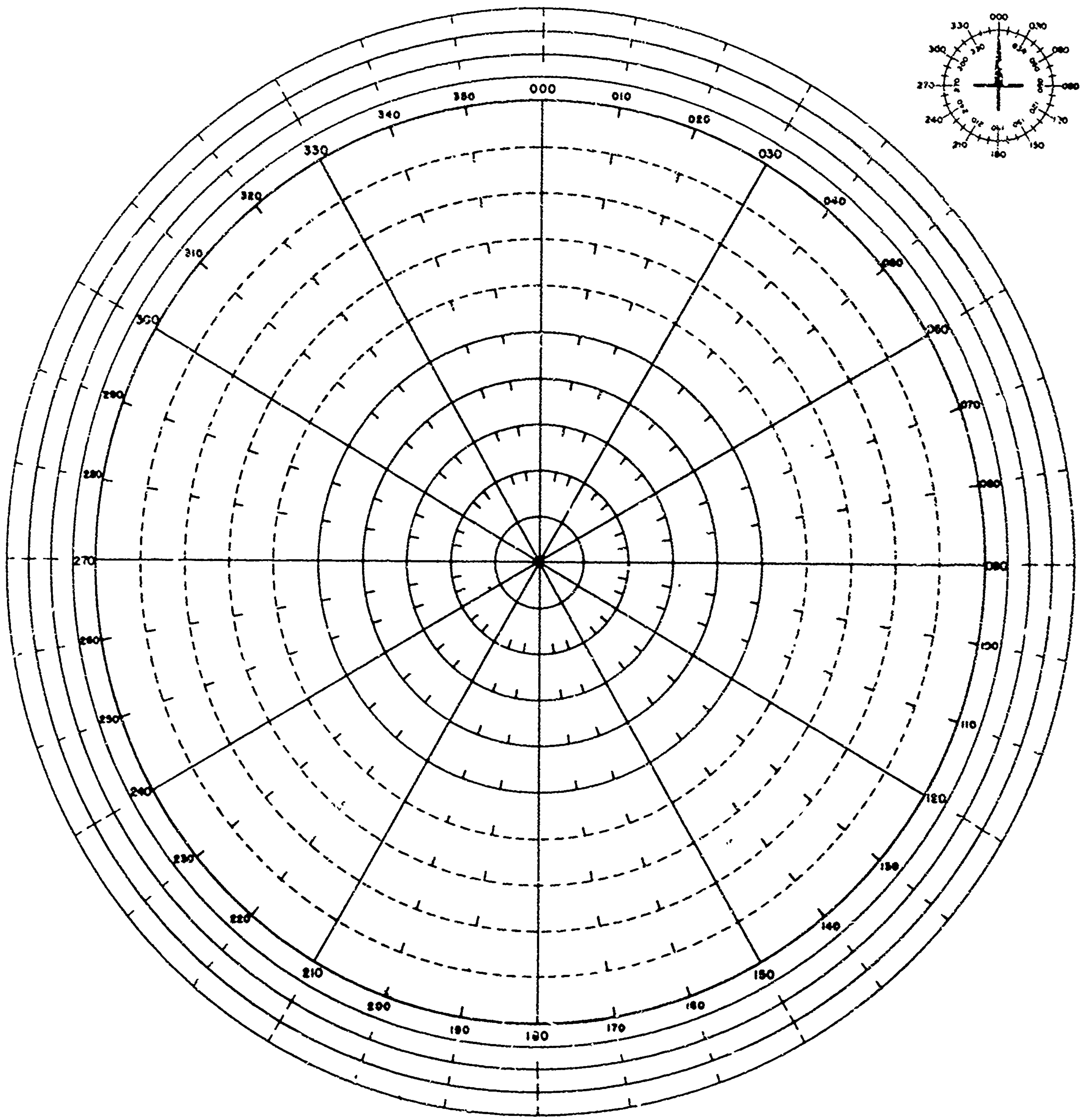
The thickness of all of the marks and circumference line (around the moving 6 inch disk) should be the same as the thickness of the inner range rings of the main display.

Bearing numerals should occur on both the inner and outer scales at every 30-degrees starting at 000, except 000 on the inner ring should be omitted.

Height of all numerals on both the outside and inside scales should be 3/8 inch and thickness of stroke should be 1/16 inch.

The cross should have its center at the center of the 6 inch circle. The cross should have a long arm of 3 inches, a back arm of 1 3/8 inches, and two side arms of 1 3/8 inches. The thickness of the three 1 3/8 inch arms should be 1/8 inch. The long arm (3 inches) should start at 3/8 inch and taper to zero (linearly) at the edge of the 6 inch circle. All measurements for the arms are taken from the center of the 6 inch circle.

4. <u>Special note.</u> In the event that it is desired to utilize the suggested "plotting rule", there should be one dotted ring, spaced 1 1/4 inches from the outer line, (this would replace the outermost line noted in 1d above). Dots should be placed every degree except where the dashed bearing line is located, that is, except on every 10-degrees. The middle dot should be about 1/16 inch in diameter, the others about 1/32 inch diameter.


000
010
020
030
040
050
060
070
080
090
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350

(Unpublished Card) U RESTRI~~CTED~~

ATI 155 288 (Copies obtainable from ASTIA-DSC)

Johns Hopkins University, Institute for Cooperative Research, Baltimore, Md. (Report No. 166-1-80)

Appraisal of Development Models of Sixty-Inch Vertical Plotting Boards - and Appendix A

Garner, W. R.; Sleight, Robert B. 20 Jan'49 7pp graph

Displays - Psychological aspects
Plotters, Manual
Vision - Effect of illumination

Psychology (63)
General (0)

EO 10501 dd 5 N 53