5-1-1961

An Investigation into Halftone Density Variation with Pre-Screened Graphic Emulsions

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AN INVESTIGATION INTO HALFTONE DENSITY VARIATION WITH PRE-SCREENED GRAPHIC EMULSIONS

by

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to

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May 1961

ABSTRACT

Information relating to the variation that can be expected in utilizing Graphic Arts emulsions has been of some interest in the past several years. A test was formulated utilizing a Pre-screened graphic emulsion and was conducted each day for a period of two weeks. Test results indicate that the density level is of definate significance. The variability that can be expected at higher levels of density is outside the relm of desired conformance.

INTRODUCTION

In the Graphic Arts area an offset cameraman at the beginning of each week is faced with the task of setting up his basic exposure and developing times for the week. Usually these will hold for the rest of the week within a small range of limits. However, these values sometimes tend to shift quite erratically within the week for no apparent reason. This project has beeen undertaken to make a primary probe into this situation involving Graphic Arts emulsions. It has been carried out under a closely controlled set of conditions. It was hoped that the resulting data would provide some insight into the problem of why there would be half - tone density variation at all density levels with conventional processing and also just how closely the resulting densities on the test films could be made to conform to each other.

EXPERIMENTAL MATERIALS and PROCEDURES

The emulsion employed was a Pre-screened graphic arts film with 133 lines per inch screen. The recommended developer was utilized. Four gallons of developer were mixed in one master batch to insure uniformity within the developer. This is a two

part developer thus they were stored in separate containers under conditions that approximate actual conditions that would be obtained out in the field. Small portions of developer were mixed, A to B and thorough mixing was obtained by rocking the tray in the ASA standard method of agitation.

A checkerboard design of density patches was formulated to be exposed onto the test films. The design consisted of three density levels, a low, medium and high level. The resulting pattern took the form of a three by three Latin Square. This pattern was then exposed onto the test films at a 1.2 magnification through a Bessler enlarging system. Processing was carried out in the normal manner in a temperature controlled sink immediately after being exposed. Three samples a day were taken at times which approximate a period that would be representative of a normal days processing. This was kept up for a total period of two weeks.

Transmission densities for each patch were taken and by a system of random selection one patch of each of the three density levels was chosen from the three test films processed daily. This information was then utilized for analysis.

EXPERIMENTAL RESULTS

From the assembled data $\overline{X}$ and R control charts were constructed to illustrate day to day and within day variations. Figure 1 shows the high density level and figures 2 & 3 showing the medium and low densities respectivley. From the information that can be derived from the charts it is evident that only the density

level on the test films seems to be of any significance. No real cyclic pattern seems to appear other than that of small day to day fluctuations. Frequency Histograms constructed for each density level further qualify the fact that the higher the density level involved in the process the more the inherent variation will be. Refer to figures 4, 5 & 6.

An Analysis of Variance was run to check other factors involved in the experiment which could possibly be significant in influencing any variation. Of the four factors that were built into the experiment weeks, days, hours and density level the only factor contributing to the variation was that of density level. Density level proved to be significant from .001 all the way up to the .500 acceptance level therefore indicating that it is extremely significant. The standard deviation was determined for the three levels of density and they proved to be .100 for the high density level, .038 for the medium level, and .223 for the remaining low level of density.

ANOVA of THE ANALYSIS of VARIANCE

	SS.	DF.	MS.	F	F.500	
A	.022	1	.022	.020	.469	
B	.648	6	.008	.102	.917	
C	.021	2	.010	.009	.714	
D	23.231	2	11.615	10.958	.714	*
AB	.411	6	.068	.064	.917	
AC	.038	2	.019	.017	.714	
AD	.002	2	.001	.0009	.714	
BC	.189	12	.015	.014	.972	
DC	.018	4	.004	.003	.863	
BD	.193	12	.016	.015	.972	
ABC	.363	12	.030	.028	.972	
ABD	.351	12	.029	.027	.972	
ACD	.025	4	.006	.005	.863	
BCD	.075	24	.003	.002	1.000	
ABCD	25.535	24	1.063			

* - indicates it is significant. Code for the Anova:

A	Weeks
B	Days
C	Hours
D	Density Level

DISCUSSION

Certain particular inferences can be made about projects before they are actually undertaken. In the project under discussion it would be safe to assume that the density level would be a contributing factor to cause variation. From the results obtained a verification of the faot, that the higher the density level the greater the variation, has been obtained. It may be also concluded that the lower density levels render less density fluctuation. However, factors that might also be expected to contribute to the variation such as those tested have all proved to be negative. The standard deviation that can be expected at higher density levels tends to be larger than that which can be tolerated in utilizing these materials under actual working conditions. This is especially true when it is related to the final printed reproduction.

In an exploratory project of this type one cannot expect to answer all the questions that can be raised concerning variation encountered in the photographic process. Therefore the results that have been obtained seem to indicate that any further work should be based around the exposing apparatus utilized. Perhaps it might also be worthwile to investigate how much the actual development process affects the overall variation within the process. This could be based around a

" process control device" such as a control strip which could be utilized as a means of controlling the halftone density variation experienced at all density levels with conventional processing techniques.

ACKNOWLEDGMENT

Acknowledgment is made to Mr. H. N. Todd and Mr. Albert Rickmers for their advice and many valuable suggestions in writing of this paper. Also Mr. I. Pabborovwsky for his assistance in the graphic arts field.

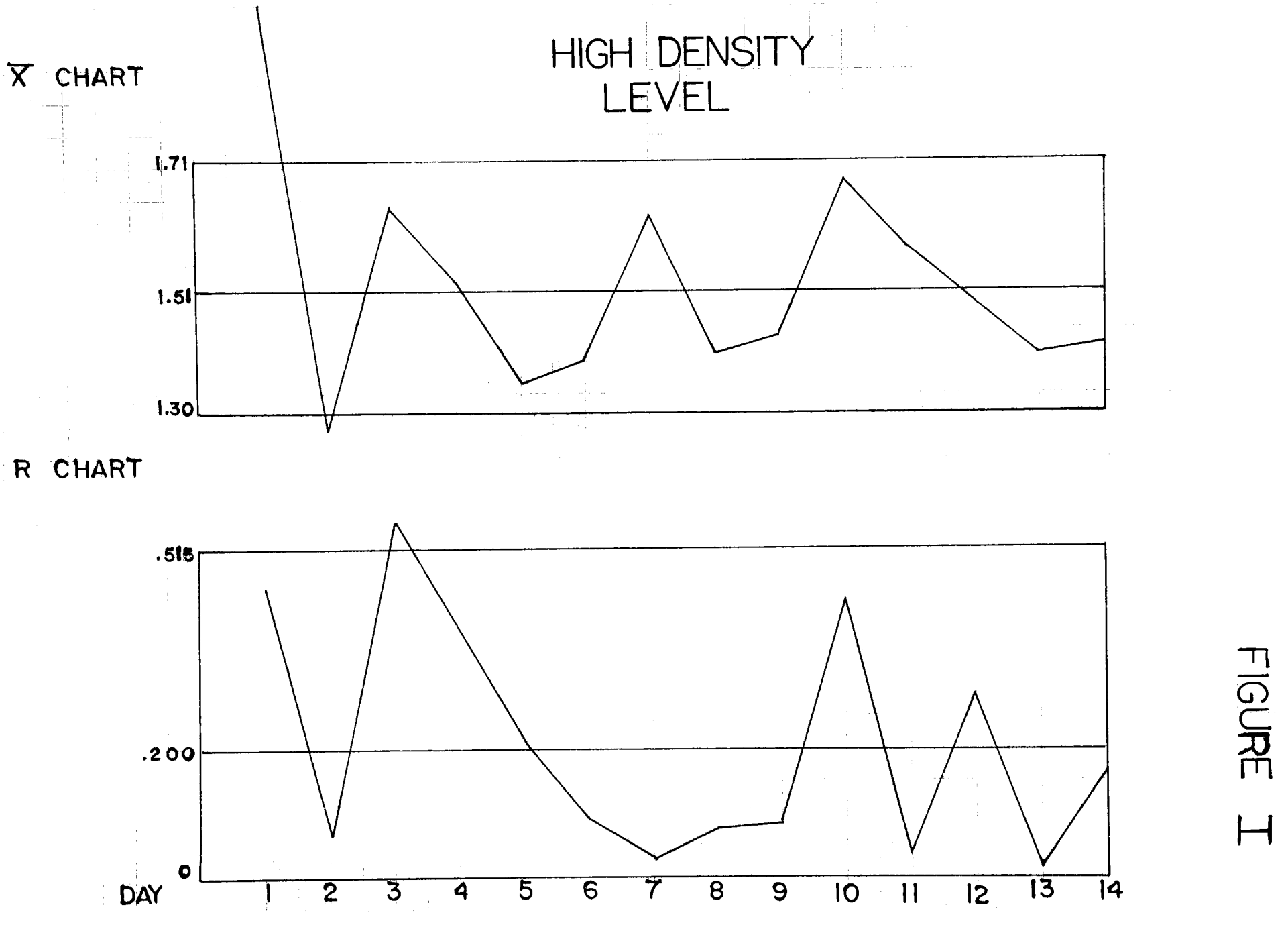

HIGH DENSITY
LEVEL
X̄ CHART
1.71
1.51
1.30
R CHART
.515
.200
0
DAY
1
2
3
4
5
6
7
8
9
10
11
12
13
14

FIGURE 1

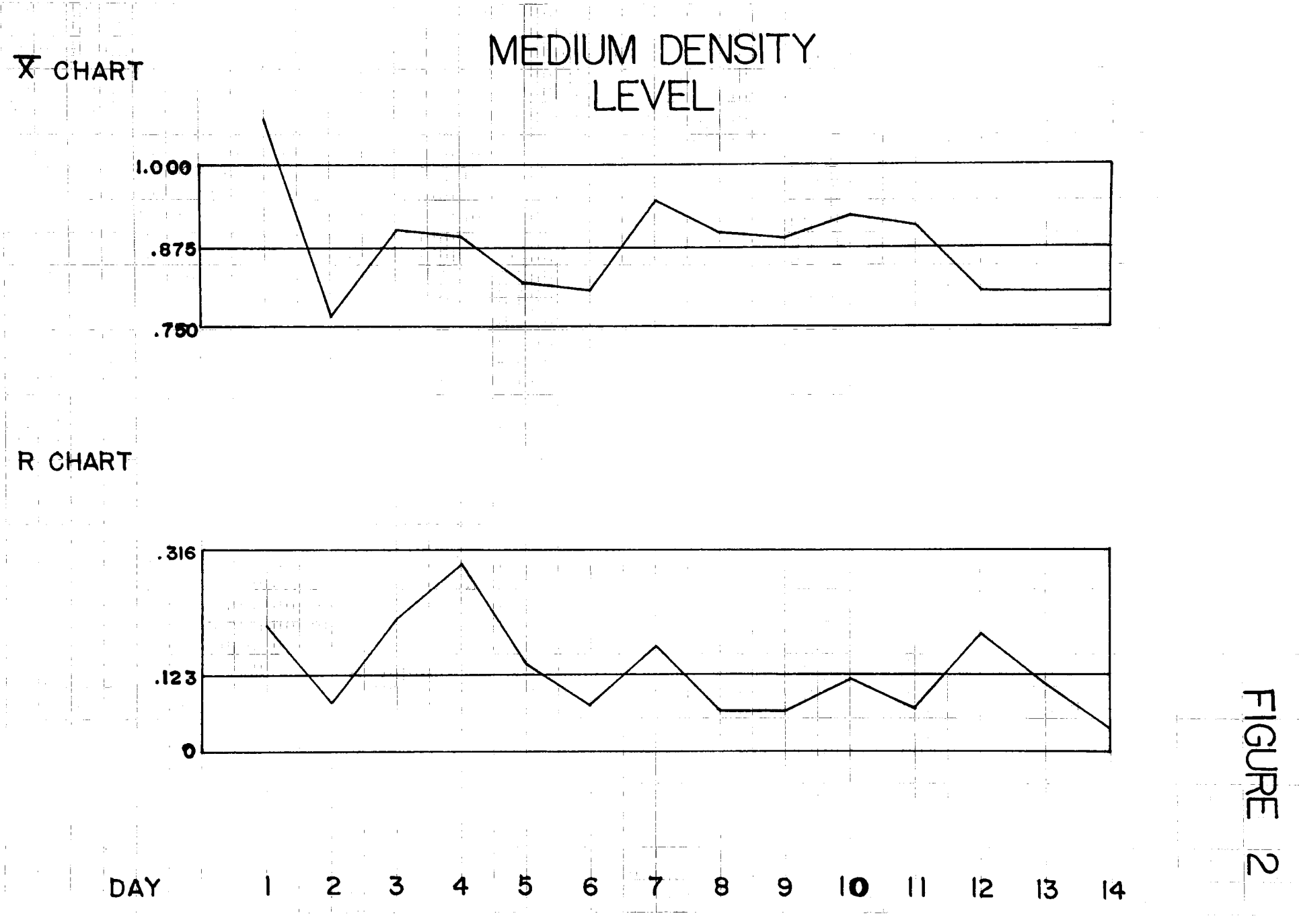
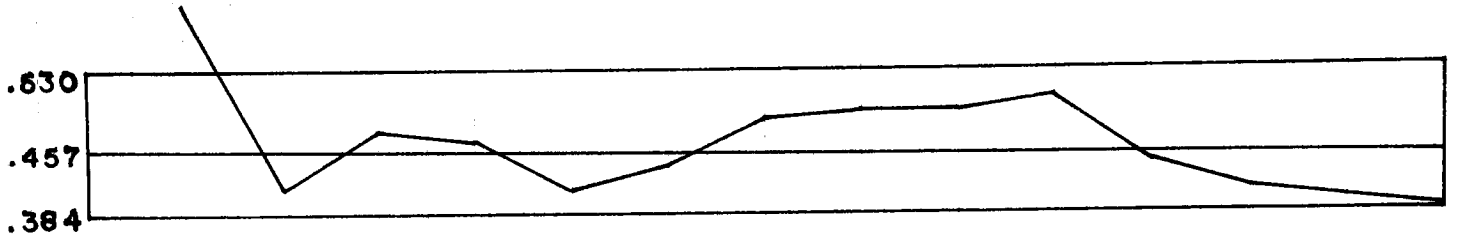

MEDIUM DENSITY LEVEL
X CHART
1.000
.875
.750
R CHART
.316
.123
0
DAY
1
2
3
4
5
6
7
8
9
10
11
12
13
14

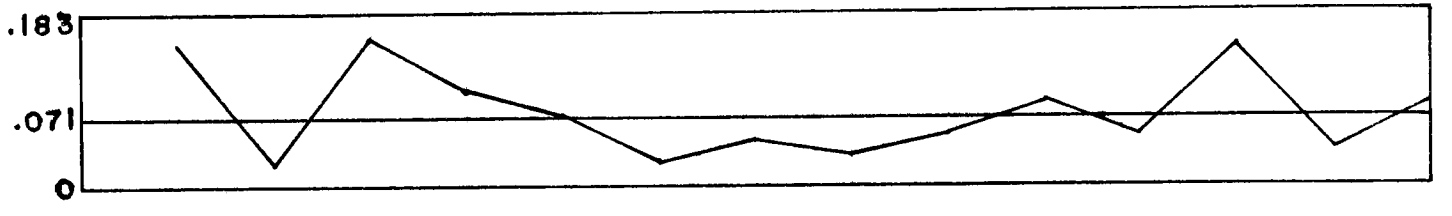
FIGURE 2

LOW DENSITY LEVEL

$\overline{X}$ CHART



R CHART



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

FIGURE III

HIGH DENSITY LEVEL

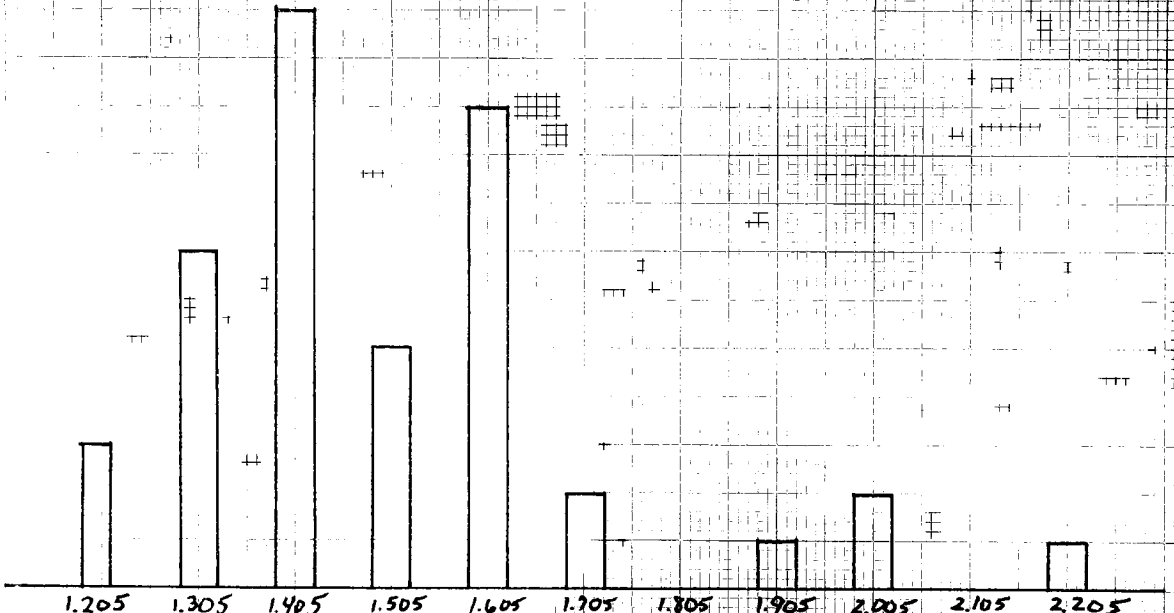
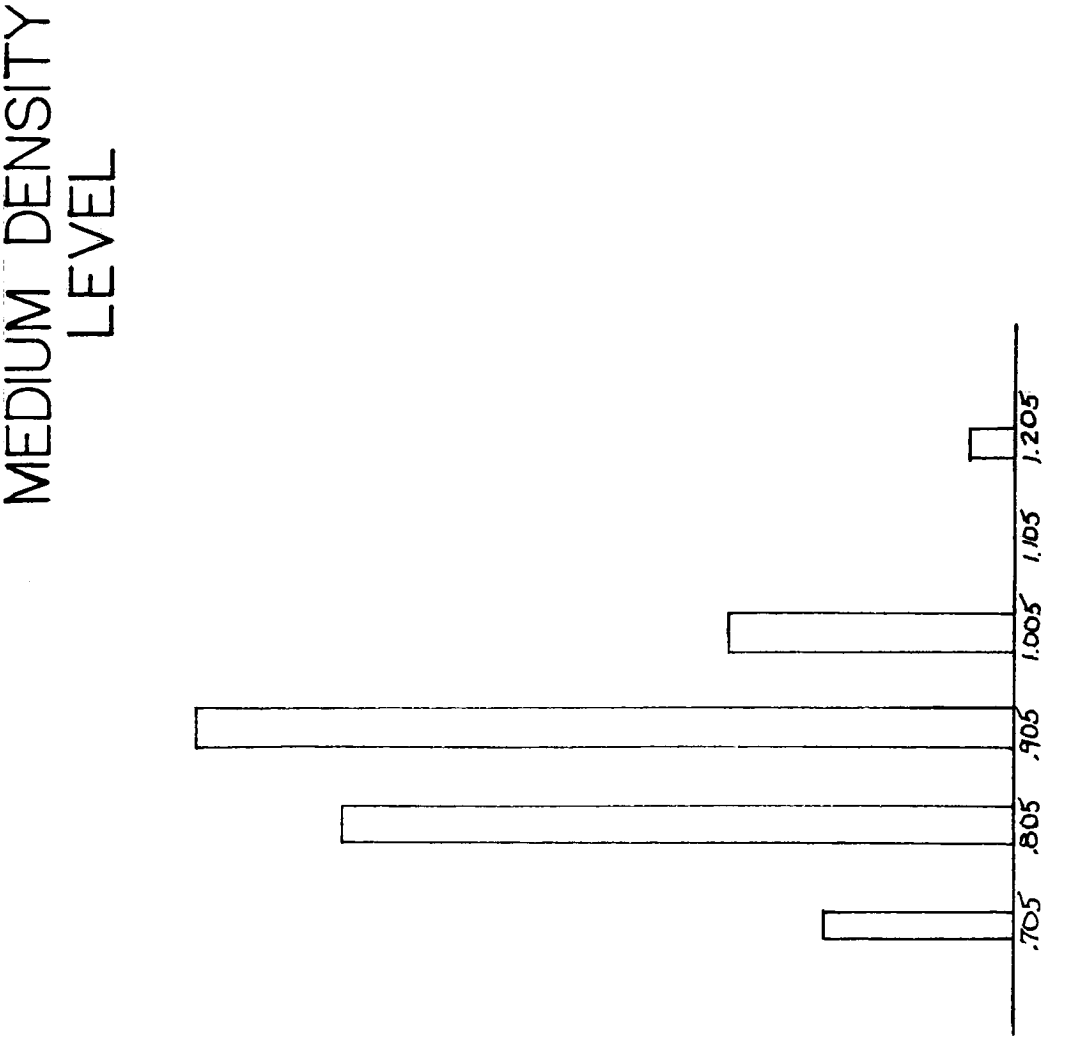


FIGURE IV

FIGURE V



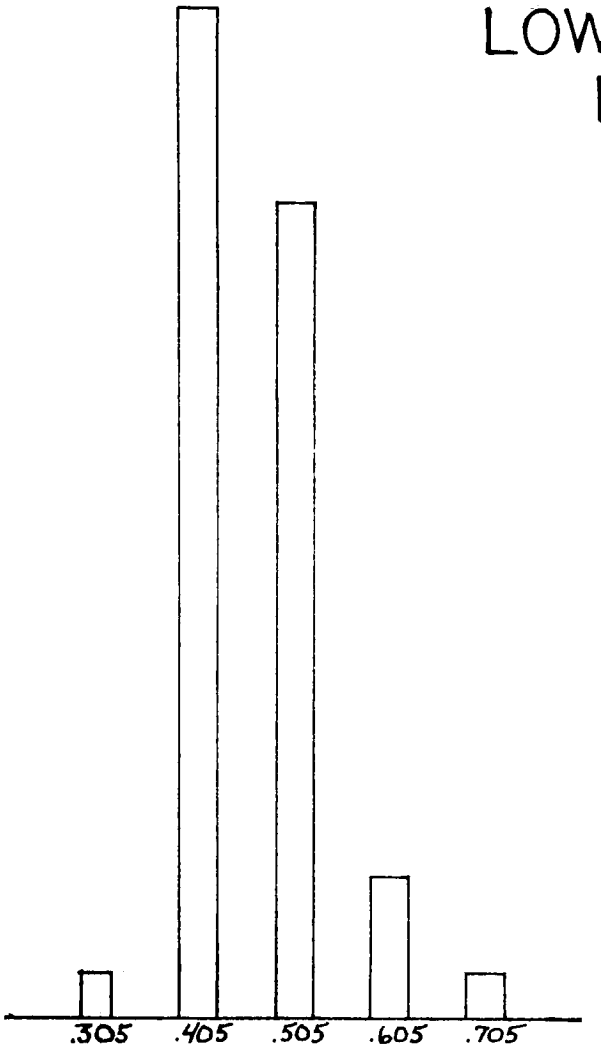


FIGURE VI