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The Evaluation of the Printability of Papers by the I.G.T. Method

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THE EVALUATION OF THE PRINTABILITY OF PAPERS BY THE I.G.T. METHOD

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THE EVALUATION OF THE PRINTABILITY OF PAPERS BY THE I.G.T. METHOD

INTRODUCTION

The purpose of this investigation was to determine to what extent the I.G.T. Tester could be used to determine the printability of paper. The investigation was carried out along two related paths. First to determine if the I.G.T. Tester could be used to give indications of actual press printability and secondly to determine if the results of the I.G.T. Tester were reproducible.

LITERATURE SURVEY

During the last twenty years, the printer and the paper manufacturer have not been able to see eye to eye on the subject of printability. The paper manufacturer has improved his methods of production and quality control until they are able to rank with any of the large industries. The printer has been able to improve his techniques and take printing out of the hit and miss class and advance it to a scientific art. But there is always the problem of how will the paper be accepted by the printer. With the close competitive market of today the paper manufacturer can not afford to lose the friendship or the business of the printer. It is surprising to find that this conflict does exist when you consider that over 90 per cent of the paper which is produced is turned into printed matter (1).

The main reasons for the conflict between the printer and the paper manufacturer are their inability to reach a decision on an

acceptable definition of printability (2), and the lack of an agreed upon testing method to check for it during the production and finishing of the paper (3). It is known that printability is not a single characteristic, but depends upon certain mechanical, optical, and electrical properties of the paper as well as upon the interaction between paper and printing ink. It is also known that these properties must be built into the paper during production and can not be left up to the printer to adjust for when he has the paper on his presses.

The most important of these properties are believed to be smoothness, oil absorption, softness, and surface bonding strength (4). All of these properties can be tested separately and give an indication of the printability of the sheet. But in order to obtain a reliable indication of the way in which the paper will print, it is necessary to subject the paper to conditions similar to those which are found on the printing press (5).

Smoothness

Printing smoothness may be defined in two ways. Some say that it is the smoothness or levelness of the paper under conditions similar to those when the impression is made. It is also referred to as the ability of the paper to make close contact with a printing surface under the influence of pressure(6).

When printing on smooth papers, the ink is forced out at the edges of the contact surface and causes a magnifying effect of the surface detail. When printing is done on a rough surface, the ink penetrates into the recesses and causes the surface contour and the detail to suffer. Smoothness is to be desired but adequate absorption

must also be present in the paper or a poor printing job will result.

The main objection against the use of smoothness testers is the fact that they are unable to check the smoothness of the sheet under the pressures that are found on the printing press (6).

Oil Absorption

Oil absorption is one of the characteristics which controls the penetration of the printing ink into the paper. It is necessary to have the proper degree of absorption in order to regulate offset, strike through, show through, and dusting of the ink pigment (7). The process of absorption of ink into paper is a slow one. On super calendered papers the vehicle and pigment are pressed into the surface together and the penetration of the vehicle into the sheet is not far from the pigment. On the other hand, when printing on coated paper, the pigment stays on the surface and the vehicle penetrates further into the sheet away from the pigment (8).

Oil penetration tests give valuable information on how fast the vehicle penetrates into the sheet, and a fast penetration often results in good setting. The speed of ink setting is, however, dependent upon the pigment content of the ink, the viscosity of the vehicle and how much ink is present on the surface of the paper. Oil absorption tests are possible off of the press but they do not take into consideration the contact pressures found on the press.

Softness

Softness of paper is the characteristic which controls the ability of the sheet to flatten out under the pressure of the type during contact. The combination of softness and pressure must be able to "bottom" the paper during printing. The comparatively

rough surface of the paper is leveled off so that more paper fibers and capillaries are brought into contact with the ink and there are more channels through which the ink can flow (4). Softness can be evaluated off of the press but again the conditions of speed and pressure are absent and can not be predicted.

Surface Bonding Strength

This characteristic is most often called picking resistance and can be a headache to the printer. When the tack of the ink is stronger than the adhesion of the coating or the surface of the paper, the surface is loosened and is deposited as small specks on the printing plate. Each speck prevents inking and impression in a small circle around it (9). The main causes are ink that is too tacky, or poor paper coating. Other causes are low pressroom temperature, more ink than necessary on the type, a cold press, or too much press speed. The picking resistance is usually checked by the use of wax pick tests, but these can not always predict the picking resistance when the paper is subjected to actual press conditions.

Methods of Predicting Printability

In the past, it has been the general opinion that the proof press was the ultimate method for checking the properties which make up printability (10). But because of the time spent and quantity of paper and ink necessary to make a proof press run it has not been accepted as a standard method. There have been many modifications of the proof press and some have found limited acceptance in the industry.

Davidson-Pomper Pick Tester

The Davidson-Pomper tester operates similar to a variable speed printing press. The samples are placed on a rubber grip roll which is driven around when the ink plates pass under it. The ink plates are heated on the press bed by a controlled heater which maintains 90 degrees Fahrenheit. The plates are inked with a roller and are driven through the grip roll and the drive roll. Ink tacks from six to eight are used for the 90 degrees Fahrenheit and speeds from 0 to 740 feet per minute are possible (11).

Warren M. P. Tester

The Warren tester is used to get a relation between the picking resistances of two different papers. The two samples are clamped side by side on a rotary cylinder and the printing is done from a plate having a 2" by $2\frac{1}{2}$" solid area. The speed may be controlled and is increased until picking occurs on one of the samples. The speed is then increased until the other sample picks and the relation between the speeds is known.

The Hercules Print Tester

The Hercules tester is made up of three parts. A small rubber inking roller about 5/8" in width and $2\frac{1}{2}$" in diameter; a variable speed motor driven printing roller and driving wheel combination; and an impression cylinder which carries the sample and run at a controlled speed. With the Hercules tester it is possible to study such variables as: (a) speed of printing, (b) ink tack, (c) ink temperature, (d) volume of ink used, and (e) the impression pressure (12).

Kimberly-Clark Rotary Pick Tester

The Kinberly-Clark tester consists of a rubber impression roll and a variable speed driven glass printing plate. This tester uses a Newtonian fluid such as blown castor oil, which is spread dropwise on the plate with a draw bar. The velocity at which picking occures is read directly off a scale on the tester, and the numerical reading is given in kilopoises/cm/sec (13).

The I.G.T. Printability Tester

The I.G.T. Tester was designed by the Institute for the Graphic and Allied Industries, which is located in Amsterdam, Holland. The designers were interested in predicting the printability of paper and they were trying to discover a method by which time and paper could be saved. The I.G.T. Tester is made up of two instruments, an inking device and the printability tester. The inking device consists of two identical inking systems. Each inking system has two steel rollers, one of which is rotated by the motor. The other makes a constricted lateral movement and ensures the distribution of the ink. The rotating movement of this roller is caused by the rubber roller which rests on both of the steel rollers and which transmits the rotation. The printing disk is allowed to come in contact with the rubber roller and is driven by the roller as it receives its coating of ink.

The printability tester is made up of a sector which may be connected to a spring drive device or a pendulum. The sector has a covering which is clamped on by means of a bolt. The test strip is clamped on over the covering and is held in place by means of a brush. The inking disk is placed on a moveable roller which can be

adjusted to the correct pressure by use of a graph on the tester. The inking disk is placed on the test strip by means of an adjustment lever, and the sector is released by a toggle lever. The tester has three speed ranges, a pendulum and two settings on the spring drive mechanism.

In designing the instrument, care was taken to make sure that all possible phenomena which occur during printing on the press could be imitated. The variables which can be used are: (a) ink tack, (b) ink thickness, (c) ink temperature, (d) printing pressure, (e) printing speed, and (f) paper samples. Only a very small amount of ink and paper are required, and tests take a short time when compared with a proof press (14).

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EXPERIMENTAL PROCEDURE

In order to determine the usefulness of the I.G.T.Tester, a number of tests were run on seven different samples of letterpress printing papers. These samples were grouped together into two groups. Five of the papers were printed with an identical press design and the other two papers were printed with a different design.

All of the experimental work with the I.G.T. Tester was done in a relative humidity room, which was maintained at 50 percent relative humidity and 73 degrees Fahrenheit. The cylinder covering which was used was of the type specified by the manufacturer and gives a covering thickness of 1.5 mm.

The following tests were run on group 1, which was the group with the five samples.

Group 1 Procedures

I. Picking Resistance.

A. Fixed Pressure.

In this series of tests, the following conditions were used:

Pressure - The same pressure setting of 35 kg was used for all tests in this series.

Ink Tack - Each of the five paper samples was tested with I.P.I. test inks 1,2,3 and 4.

Ink Thickness - A volume of 1 cc of ink was used on the applicator thus giving a thickness of 8.2 microns. After four inkings of the printing disk, the ink applicator was

replenished in order to maintain the exact ink thickness.

Printing Speed - Each of the five paper samples was tested using the pendulum, A and B speed ranges.

Paper Samples - The paper samples were tested so that each sample was run at each of the speed ranges and each of the four ink tacks. All of the samples were printed alternately in MD and CD and on wire and felt sides. Eight tests were run for each sample at each speed, using each of the four ink tacks.

Printing Disk - The 10 mm wide disk was used in all tests.

B. Variable Pressure

In this series of tests, the following conditions were used:

Pressure - The pressure was varied using pressures of 25, 35, 45, and 55 kg.

Ink Tack - I.P.I. test ink 1 was used for all tests in this series.

Ink Thickness - a thickness of 8.2 microns was used in all tests.

Printing Speed - All tests were run using speed range A.

Paper Samples - Each of the five samples was tested at each of the four printing pressures, using the MD and the felt side in all tests. Four tests were run for each sample at each pressure.

Printing Disk - The 10 mm wide disk was used in all tests.

II. Print Density and Coverage.

In this series of tests the following conditions were used:

Pressure - The same printing pressure of 70 kg was used in all tests

Ink Tack - I.P.I. test ink 1 was used for all tests.

Ink Thickness - A volume of 0.6 cc of ink was used on the applicator thus giving a thickness of 4.9 microns. After three inkings of the printing disk, the ink applicator was replenished.

Printing Speed - The pendulum speed range was used for all tests.

Paper Samples - Each of the five paper samples was tested using the MD and the felt side. Four tests were run on each paper sample.

Printing Disk - The 20 mm wide disk was used in all tests

III. Evaluation of Penetration and Offsetting.

In this series of tests the following conditions were used:

Pressure - The same printing pressure of 35 kg was used in all tests.

Ink Tack - I.P.I. test ink 1 was used for all tests in this series.

Ink Thickness - A volume of 0.6 cc of ink was used on the applicator thus giving a thickness of 4.9 microns. After three inkings of the printing disk, the ink applicator was replenished.

Printing Speed - The pendulum was used for printing and was checked by hand to obtain an even velocity.

Paper Samples - Each of the five samples was tested using the MD and the felt side. Two tests were run on each sample.

Printing Disk - The 20 mm wide disk was used in all tests.

Special Techniques - The samples were printed with an even velocity and the printing was offset after 10, 20 and 50 seconds onto an art paper strip. This was accomplished by offsetting one third of the printed sample after 10 seconds, another third after 20 seconds and the remaining third 50 seconds after the printed strip was made.

IV. Per cent Transference.

In this series of tests the following conditions were used:

Pressure - The pressure was varied, using pressures of 25, 35, 45 and 55 kg.

Ink Tack - I.P.I. test ink 1 was used for all tests in this series.

Ink Thickness - A volume of 1 cc of ink was used on the applicator thus giving a thickness of 8.2 microns. After four inkings of the printing disk, the ink applicator was replenished.

Printing Speed - Each of the five samples was printed using the pendulum speed range.

Paper Samples - Each of the five samples was printed at each of the four pressures and two tests were run at each pressure. The felt side and MD were used.

Printing Disk - The 10 mm wide disk was used in all tests.

Special Techniques - Each sample strip was weighed before and after printing on an analytical balance. The printing disk was weighed after each addition to the applicator to insure equal printing amounts.

V. Smoothness and Exactness of Detail Transfer.

In this series of tests the following conditions were used:

Pressure - The pressure was varied using pressures of 25, 35, 45 and 55kg.

Ink Tack - I.P.I. test ink 1 was used for all tests in this series.

Ink Thickness - A volume of 0.2 cc of ink was used on the applicator thus giving a thickness of 1.6 microns. After eight inkings of the printing disk, the ink applicator was replenished.

Printing Speed - All tests were run using the pendulum speed range.

Paper Samples - Each of the five samples were printed at each of the four pressures using the MD and the felt side. Two tests were run for each sample at each pressure.

Printing Disk - The lined printing disk was used for each test.

The following tests were run on group 2, which was the group with the two samples.

Group 2 Procedures

I. Picking Resistance.

B. Variable Pressure.

In this series of tests the conditions used were identical with those used for group 1.

III. Evaluation of Penetration and Offsetting.

In this series of tests the conditions used were identical with those used for group 1.

V. Smoothness and Exactness of Detail Transfer.

In this series of tests the conditions used were identical with those used for group 1.

Other tests which were run as a supplement to the I.G.T. investigation are listed below. These tests were run on each of the seven paper samples and were run in duplicate on each sample.

VI. Vanceometer Oil Absorption Test.

VII. Sheffield Smoothness Test.

VIII. Dennison Wax Pick Test.

EXPERIMENTAL EVALUATION

In order to evaluate the results obtained by the I.G.T. Tester and the supplementary tests, it was necessary to devise a standard method of evaluation for each of the procedures. The methods which were used to evaluate the results are given below for each procedure.

I. Picking Resistance.

A. Fixed Pressure.

B. Variable Pressure.

The picking resistance was evaluated according to three increasing degrees of picking. The first point was taken where picking had just begun; the second point where the degree of picking had begun across the entire printed area; and the third point where the picking was great enough to cause a rupture of the surface of the printed area. In all cases the picking was evaluated by using a four power hand lens.

II. Print Density and Coverage.

The results of these tests were evaluated by two methods. The test strips were first evaluated by the use of the four power hand lens and secondly by use of Photovolt brightness measurements.

III. Evaluation of Penetration and Offsetting.

The results of these tests were evaluated by two methods. The test strips were evaluated by the use of the four power hand lens and secondly by use of Photovolt brightness measurements.

IV. Per cent Transference.

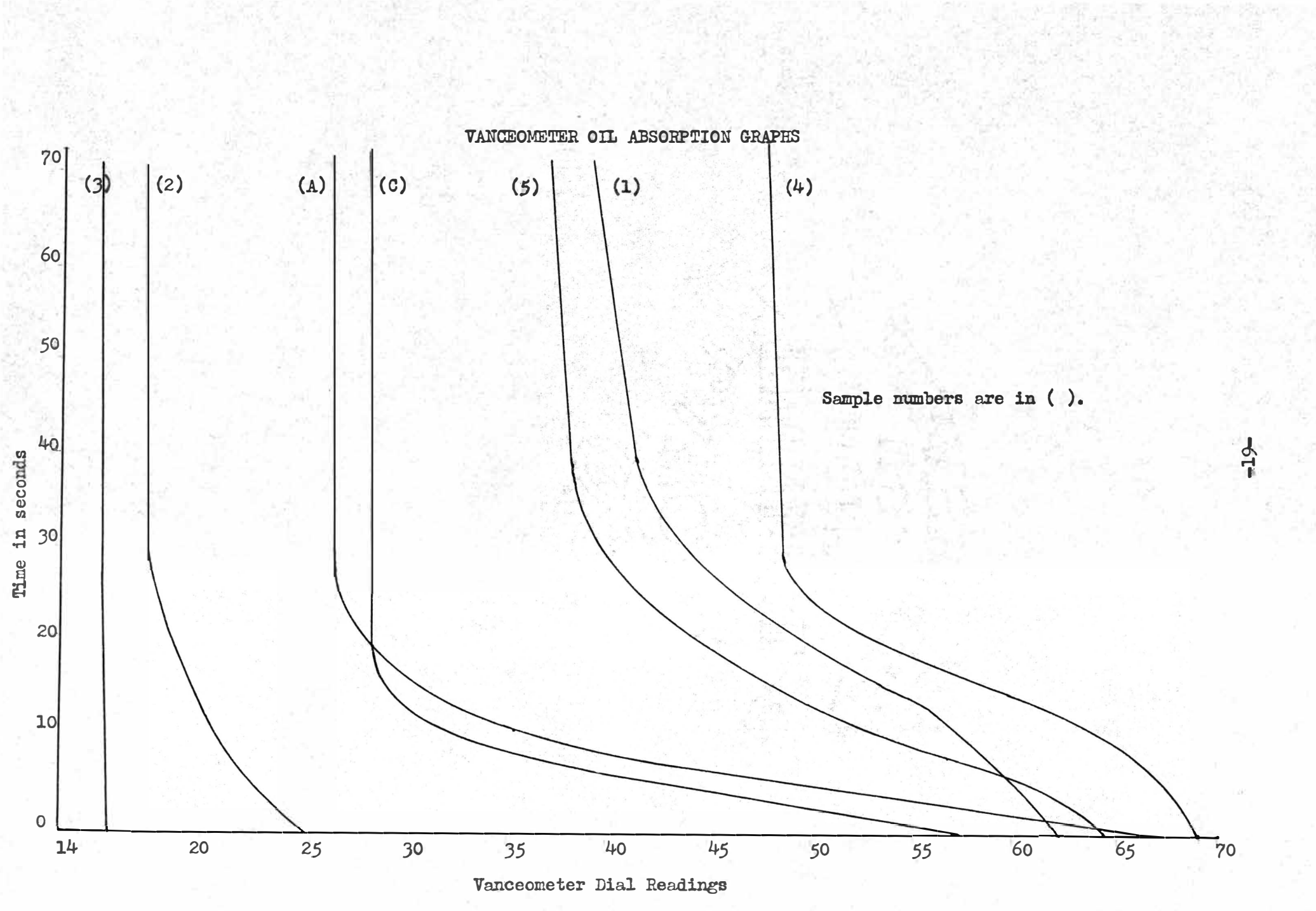
The results of these tests were calculated and expressed as per cent of the total available ink which was transferred to the test strips.

V. Smoothness and Exactness of Detail Transfer.

In this series of tests the results were examined and evaluated by use of the four power hand lens.

EXPERIMENTAL RESULTS

Sample Number	1	2	3	4	5	A	C
Sheffield Smoothness	25	30	45	20	34	32	35
Dennison Wax Pick (Pick Passed)	12	7	10	7	9	7	3
Percent Transferred (Top values are Kg pressure; lower are per cent values)	25 35 45 55 40 40 39 38	25 35 45 55 55 53 53 55	25 35 45 55 37 39 42 47	25 35 45 55 48 46 47 50	25 35 45 55 56 54 60 60	- -	- -
Photovolt Densities (Values from left to right in each box are start, middle, and end of test strip. Lower is unprinted value)	69. 69.5 69.7 73.0	69. 70. 69.5 72.0	70. 71. 71. 75.0	71. 71. 72. 74.0	71. 71. 71. 76.0	- -	- -
Fine Line Observation (Groups 1&2 are considered separately)	Best 1	4	Worst 5	2	3	Best	Worst
Optical Observation of Penetration (Top line gives time in seconds after printing. Middle line gives a value for offset by hand lens 1 being the most. Last line gives Photovolt brightness value for offset.)	10 20 50 4 31. 36. 41.	10 20 50 Most 1 20. 23. 26.	10 20 50 Least 5 43. 42. 46.	10 20 50 3 27. 35. 38.	10 20 50 2 26.5 31. 36.	10 20 50 Most -	10 20 50 Least -


VANCEOMETER OIL ABSORPTION GRAPHS
(3)
(2)
(A)
(C)
(5)
(1)
(4)
Sample numbers are in ( ).
Time in seconds
70
60
50
40
30
20
10
0
14
20
25
30
35
40
45
50
55
60
65
70
Vanceometer Dial Readings

PRESS SAMPLES

DISCUSSION OF RESULTS

In considering the results obtained from this experimentation they will be dealt with separately and according to the two groups of papers which were tested.

Group 1 Results

1. Picking Resistance.

The I.G.T. Tester was able to detect differences between the five samples but because information was not known about the press picking resistance this could not be related to the appearance of the press samples. The I.G.T. Tester was able to indicate differences in ink tack and in printing speed, and these results were reproducible in all cases. The test strips were not able to show differences in MD and CD and the slight differences between felt and wire side could not always be reproduced.

II. Print Density and Coverage.

The I.G.T. Tester did not prove to be very useful in this type of testing. Evaluation of the strips with a hand lens did not give results which could be considered useful in prediction of the printability of the samples. Photovolt brightness measurements were a little more helpful and gave differences between the five samples as well as between low and high speeds on a single sample. The differences in coverage were reproducible when evaluated with the Photovolt Tester.

III. Evaluation of Penetration and Offsetting.

The I.G.T. test strips could be evaluated both with the hand lens

and the Photovolt Tester. The two methods of evaluation gave the same results and were always reproducible. The I.G.T. results from this part of the testing were exactly the same as those obtained with the Vanceometer Oil Absorption Tester.

IV. Per cent Transference.

The test strips when evaluated showed marked differences in the amount of ink which was transferred on the different samples. The amount transferred was dependent upon the pressure and was detectable with the changes in pressure on the I.G.T. Tester. The results were not as reproducible as with other I.G.T. tests.

V. Smoothness and Exactness of Detail Transfer.

The I.G.T. Tester was able to give a very good indication of the smoothness of the samples and was able to predict differences between them. There was a difference in the high and low pressure prints but the differences were not enough to be able to judge the ranges in between the low and high values. A good indication of the ability of the sample to accept detail transfer was given by examination of the lined work. All of the testing with the lined disk was reproducible.

Results

The five samples of press production can be rated from very good to very poor in the following way.

Very Good	Good	Good	Poor	Very Poor
1	4	5	2	3

By examination of the data it can be seen that sample 1 printed good because of it's high smoothness and controlled oil penetration rate and also a good resistance to picking. Samples 4 and 5 had about the same test results and printed about the same. Sample 2 had a good smoothness but the penetration was almost immediate and the colors ran together. Sample 3 had the roughest finish and the fastest oil penetration which combined to give a poor printing job.

Group 2 Results

In this group the following facts about the press production were known.

1. The ink hold out was better in sample A than in sample C.
2. Less ink was needed for sample A than for sample C.
3. Less drying heat was needed for sample A than for sample C.
4. The printing smoothness of sample A was better than sample C.
5. The color of Sample A was much poorer than sample C.

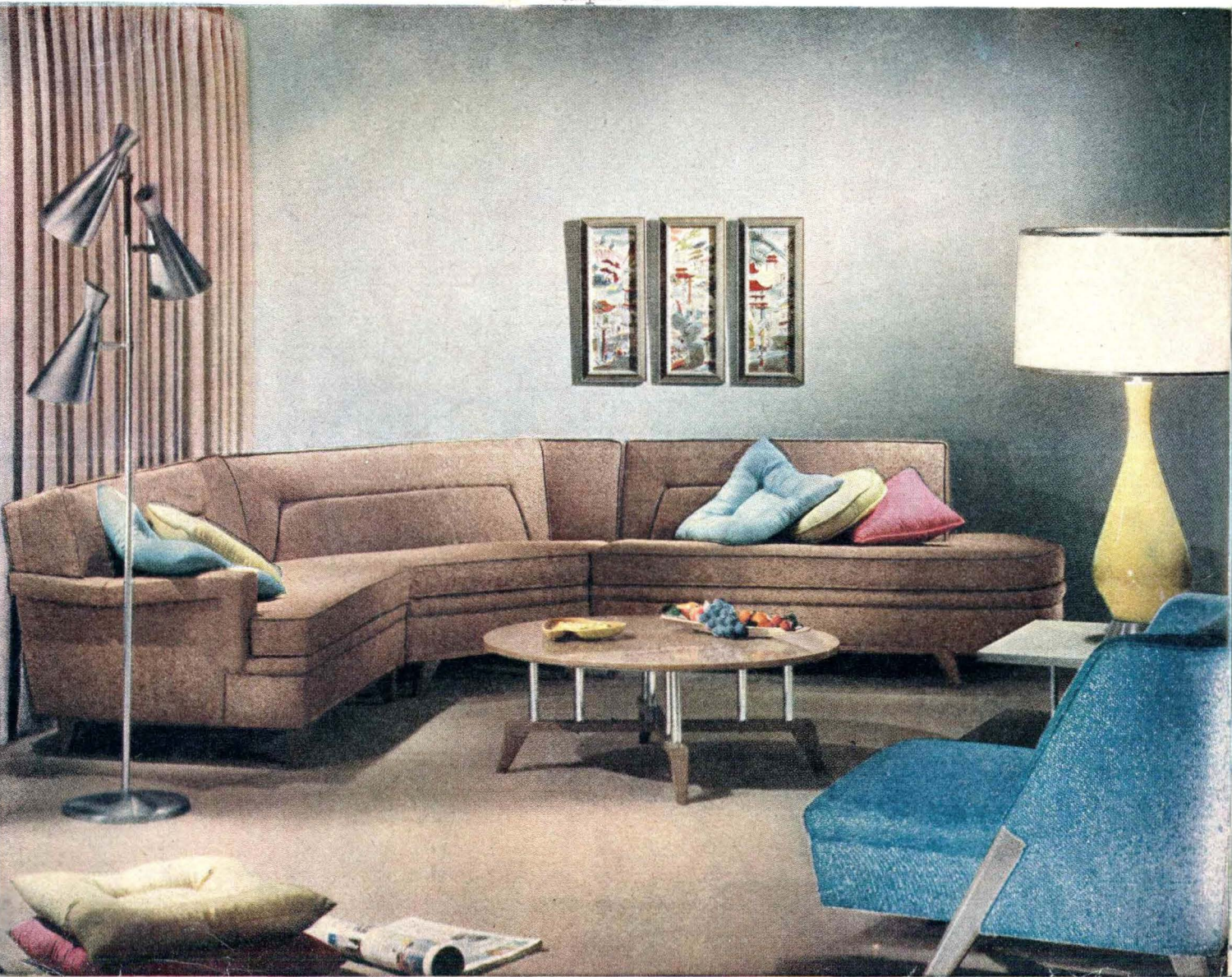
All of these facts were proven to a certain extent by the I.G.T. test strips and the supplementary tests.

CONCLUSIONS

The I.G.T. Tester was able to give reproducible results for all of the tests which were undertaken. The reproducibility of the tester seems to be very good and it is not difficult to find marked differences between different grades of paper. Some of the tests which were run did not give results which could be used to predict the printability and could not have been evaluated if the press samples had not been available to give an indication of what to look for on the test strips.

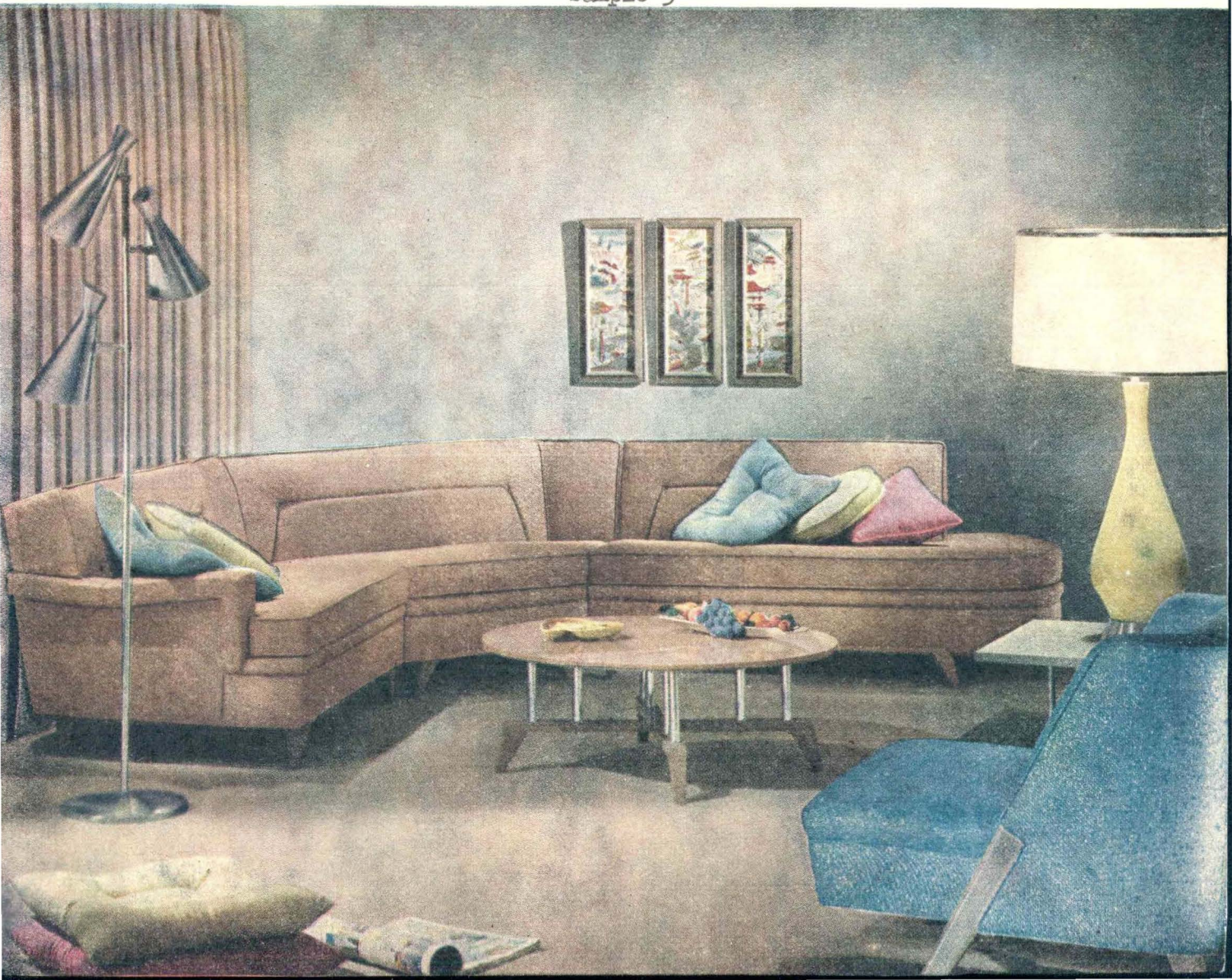
The I.G.T. Tester has the possibilities of doing a good job in predicting the printability of paper but it must be used and the strips evaluated by a person who has a great deal of familiarity with the instrument. In order for the tester to be used to the best possible advantage, the investigation should be carried out by a trained technician who can work closely with the press operator and is free to experiment with new methods and testing procedures.

Sample 1



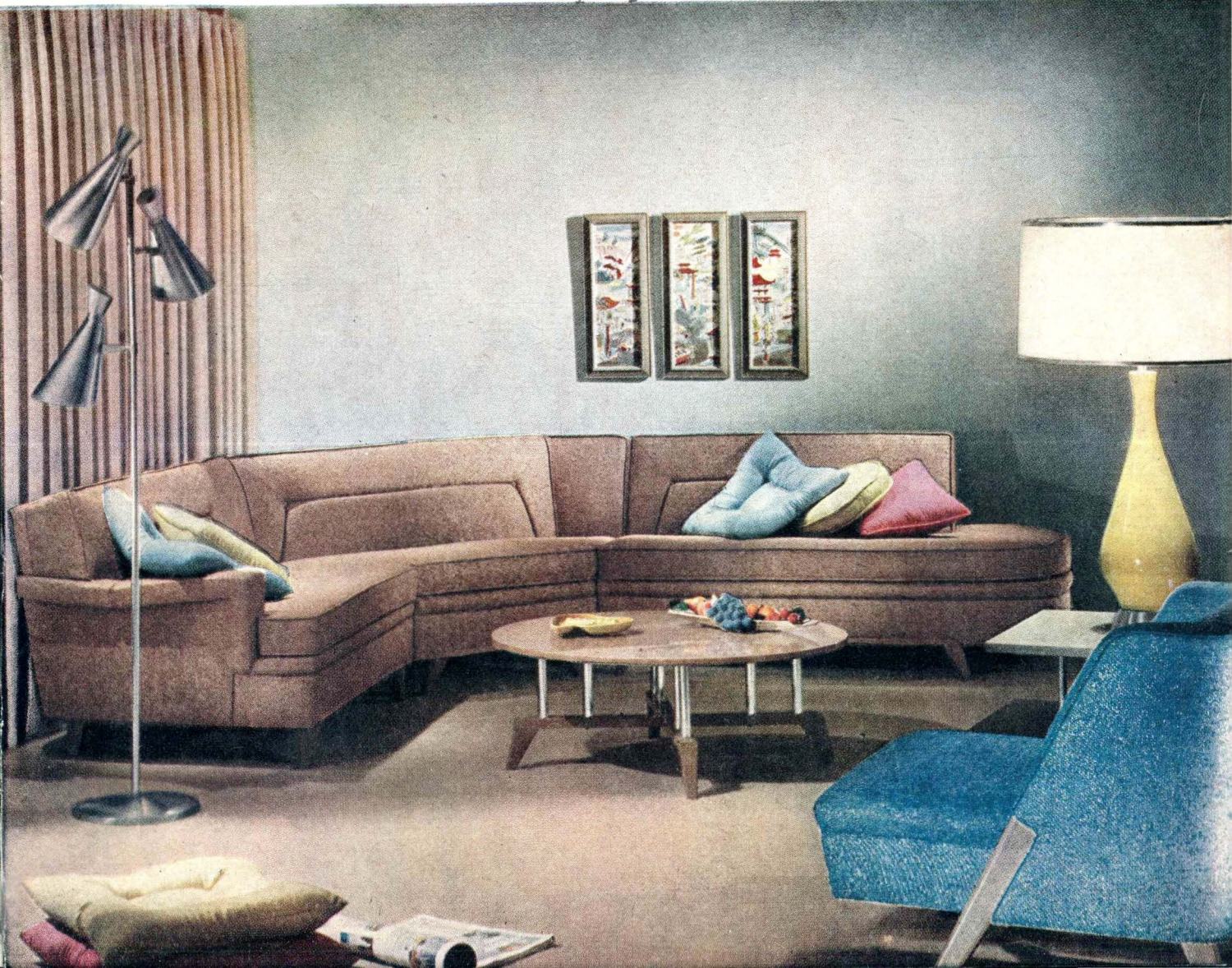
Sample 2

Sample 3



Sample 4

Sample 5



Sample A

Sample C