

## **CHAPTER 3**

### **EXPERIMENTAL WORK**

#### **3.1 Material**

Ten different paper grades, ranging from poor to high quality.

#### **3.2 Apparatus**

3.2.1 Image analyzer / with Pira's software : The IMP quality system.

3.2.2 Light carbinet with the illuminant D 65

3.2.3 Lux meter / EXTECH Model 407026

3.2.4 Offset Proof Machine : SCREEN

#### **3.3 Observers**

3.3.1 20 customers, who are Thai nation between 22 - 45 years old.

3.3.2 20 printers, who are Thai nation between 18 - 55 years old.

#### **3.4 Procedure**

3.4.1 Preparation of samples

All paper samples were printed by "SCREEN" proof offset machine, using black inks. The amount of ink which was varied and the property of paper themselves would give mottling effects. The obtained 40 varied mottle printed samples were collected.

3.4.2 Measurement of mottle values

The mottle values were measured by image analyzer with Pira's IMP software at threshold 50% Output is standard deviation (SD), mean ( $\bar{x}$ ) and specific perimeter (SP).

### 3.4.3 Visual Experiment

Each observer looks at each mottle printed sample under various illumination (40 - 2,500 lux). To determine whether he/she can see the mottle effect. (No information given to observers for their decision about mottling before testing)

### 3.4.4 Data preparing for analysis

3.4.4.1 Bring 40 output results from image analyzer to calculate the Mottle Index (MI), where  $CV = \frac{SD}{\bar{X}}$  and  $MI = CV \cdot \frac{1}{\sqrt{SP}}$  as table 3-1

3.4.4.2 Arrange consecutively the visual results data, based on illumination values, in SPSS program.

### 3.4.5 Statistical analysis by SPSS program

Analyze the illumination and observer's assessment which transforms to probability using multiple regression analysis method table 3-2 show customer statistical data and table 3-3 show printer statistical data. It was defined that illumination and mottle index are independent variables and probability of observer's results are dependent variable.

The obtained MI was analyzed, using illumination and observer's assessment results data.

	SD	$\bar{X}$	CV=SD/ $\bar{x}$	SP	SQRT (SP)	M = CV/SQRT (SP)	Mstd	MI
No.1	0.0332	0.478	0.069456067	0.754	0.868331734	0.07998794	0.036205427	<b>0.45263607</b>
No.2	0.0268	0.546	0.049084249	1.53	1.236931688	0.039682263	0.036205427	<b>0.912383112</b>
No.3	0.0272	0.578	0.047058824	1.604	1.266491216	0.03715685	0.036205427	<b>0.974394424</b>
No.4	0.0282	0.562	0.050177936	1.482	1.217374223	0.041218169	0.036205427	<b>0.878385146</b>
No.5	0.0304	0.614	0.049511401	1.572	1.253794241	0.039489255	0.036205427	<b>0.916842491</b>
No.6	0.0286	0.542	0.052767528	0.976	0.987927123	0.053412369	0.036205427	<b>0.677847246</b>
No.7	0.0312	0.638	0.048902821	1.522	1.233693641	0.039639356	0.036205427	<b>0.913370719</b>
No.8	0.028	0.618	0.045307443	1.566	1.251399217	0.036205427	0.036205427	<b>1</b>
No.9	0.027	0.586	0.046075085	1.542	1.241772926	0.037104276	0.036205427	<b>0.975775057</b>
No.10	0.029	0.532	0.054511278	1.42	1.191637529	0.045744848	0.036205427	<b>0.791464574</b>
No.11	0.0272	0.59	0.046101695	1.438	1.199166377	0.038444786	0.036205427	<b>0.941751292</b>
No.12	0.0302	0.498	0.06064257	0.818	0.904433524	0.067050334	0.036205427	<b>0.539973847</b>
No.13	0.0314	0.438	0.071689498	0.856	0.92520268	0.077485182	0.036205427	<b>0.467256142</b>
No.14	0.0266	0.53	0.050188679	1.05	1.024695077	0.048979136	0.036205427	<b>0.739201018</b>
No.15	0.028	0.536	0.052238806	1.504	1.226376777	0.04259605	0.036205427	<b>0.849971474</b>
No.16	0.0278	0.564	0.04929078	1.506	1.227191917	0.040165503	0.036205427	<b>0.901406048</b>
No.17	0.0278	0.552	0.050362319	1.398	1.1823705	0.042594363	0.036205427	<b>0.850005119</b>
No.18	0.028	0.558	0.050179211	1.63	1.276714533	0.039303392	0.036205427	<b>0.921178183</b>
No.19	0.0412	0.496	0.083064516	1.034	1.016857906	0.081687437	0.036205427	<b>0.443219035</b>
No.20	0.0266	0.532	0.05	1.11	1.053565375	0.0474579	0.036205427	<b>0.762895686</b>
No.21	0.033	0.448	0.073660714	0.89	0.943398113	0.078080201	0.036205427	<b>0.463695361</b>
No.22	0.03	0.544	0.055147059	1.314	1.14629839	0.048108816	0.036205427	<b>0.752573638</b>
No.23	0.0304	0.548	0.055474453	0.926	0.962288938	0.057648436	0.036205427	<b>0.628038318</b>
No.24	0.0338	0.438	0.07716895	0.786	0.88656641	0.087042492	0.036205427	<b>0.415951177</b>
No.25	0.032	0.45	0.071111111	0.79	0.888819442	0.080006251	0.036205427	<b>0.452532479</b>
No.26	0.0298	0.408	0.073039216	0.932	0.965401471	0.075656831	0.036205427	<b>0.478548026</b>
No.27	0.0318	0.43	0.073953488	0.862	0.928439551	0.079653531	0.036205427	<b>0.454536373</b>
No.28	0.0328	0.43	0.07627907	0.824	0.907744457	0.084031435	0.036205427	<b>0.430855748</b>
No.29	0.035	0.438	0.079908676	0.822	0.906642157	0.088136952	0.036205427	<b>0.410786014</b>
No.30	0.0358	0.45	0.079555556	0.778	0.882043083	0.090194637	0.036205427	<b>0.401414411</b>
No.31	0.0282	0.6	0.047	1.654	1.286079313	0.03654518	0.036205427	<b>0.990703206</b>
No.32	0.0298	0.538	0.055390335	1.394	1.180677771	0.046914015	0.036205427	<b>0.771740109</b>
No.33	0.0294	0.608	0.048355263	1.488	1.219836055	0.039640789	0.036205427	<b>0.913337708</b>
No.34	0.0318	0.56	0.056785714	1.344	1.15931014	0.048982332	0.036205427	<b>0.739152781</b>
No.35	0.0276	0.528	0.052272727	1.034	1.016857906	0.051406128	0.036205427	<b>0.704301776</b>
No.36	0.0316	0.428	0.073831776	0.938	0.968504001	0.076232804	0.036205427	<b>0.474932379</b>
No.37	0.0276	0.576	0.047916667	1.492	1.221474519	0.039228544	0.036205427	<b>0.922935788</b>
No.38	0.0274	0.558	0.049103943	1.45	1.204159458	0.040778605	0.036205427	<b>0.8878535</b>
No.39	0.0282	0.5	0.0564	1.338	1.156719499	0.04875858	0.036205427	<b>0.742544741</b>
No.40	0.0278	0.574	0.048432056	1.368	1.169615321	0.041408534	0.036205427	<b>0.874346989</b>

Table 3-1 40 Mottle indices from image analyzer

	MI	ILLUM	accept	total	PROB		MI	ILLUM	accept	total	PROB
1	.40	40.00	40.00	40	1.00	37	.50	2100.00	28.00	40	.70
2	.40	47.00	40.00	40	1.00	38	.50	2180.00	27.00	40	.68
3	.40	50.00	40.00	40	1.00	39	.50	2200.00	26.00	40	.65
4	.40	430.00	40.00	40	1.00	40	.50	2500.00	27.00	40	.68
5	.40	440.00	40.00	40	1.00	41	.60	40.00	40.00	40	1.00
6	.40	450.00	40.00	40	1.00	42	.60	47.00	40.00	40	1.00
7	.40	833.00	40.00	40	1.00	43	.60	50.00	40.00	40	1.00
8	.40	840.00	40.00	40	1.00	44	.60	430.00	35.00	40	.88
9	.40	850.00	38.00	40	.95	45	.60	440.00	36.00	40	.90
10	.40	870.00	39.00	40	.98	46	.60	450.00	35.00	40	.88
11	.40	1250.00	35.00	40	.88	47	.60	833.00	36.00	40	.90
12	.40	1270.00	35.00	40	.88	48	.60	840.00	33.00	40	.83
13	.40	1300.00	36.00	40	.90	49	.60	850.00	25.00	40	.63
14	.40	1320.00	37.00	40	.93	50	.60	870.00	24.00	40	.60
15	.40	1600.00	30.00	40	.75	51	.60	1250.00	23.00	40	.58
16	.40	1800.00	35.00	40	.88	52	.60	1270.00	20.00	40	.50
17	.40	2100.00	33.00	40	.83	53	.60	1300.00	18.00	40	.45
18	.40	2180.00	30.00	40	.75	54	.60	1320.00	16.00	40	.40
19	.40	2200.00	29.00	40	.73	55	.60	1600.00	24.00	40	.60
20	.40	2500.00	28.00	40	.70	56	.60	1800.00	19.00	40	.48
21	.50	40.00	40.00	40	1.00	57	.60	2100.00	17.00	40	.43
22	.50	47.00	40.00	40	1.00	58	.60	2180.00	15.00	40	.38
23	.50	50.00	40.00	40	1.00	59	.60	2200.00	17.00	40	.43
24	.50	430.00	40.00	40	1.00	60	.60	2500.00	18.00	40	.45
25	.50	440.00	39.00	40	.98	61	.70	40.00	40.00	40	1.00
26	.50	450.00	38.00	40	.95	62	.70	47.00	40.00	40	1.00
27	.50	833.00	37.00	40	.93	63	.70	50.00	38.00	40	.95
28	.50	840.00	40.00	40	1.00	64	.70	430.00	35.00	40	.88
29	.50	850.00	36.00	40	.90	65	.70	440.00	30.00	40	.75
30	.50	870.00	37.00	40	.93	66	.70	450.00	29.00	40	.73
31	.50	1250.00	35.00	40	.88	67	.70	833.00	25.00	40	.63
32	.50	1270.00	34.00	40	.85	68	.70	840.00	24.00	40	.60
33	.50	1300.00	33.00	40	.83	69	.70	850.00	24.00	40	.60
34	.50	1320.00	36.00	40	.90	70	.70	870.00	22.00	40	.55
35	.50	1600.00	29.00	40	.73	71	.70	1250.00	18.00	40	.45
36	.50	1800.00	25.00	40	.63	72	.70	1270.00	16.00	40	.40

Table 3-2 Customer statistical data

	MI	ILLUM	accept	total	PROB		MI	ILLUM	accept	total	PROB
73	.70	1300.00	14.00	40	.35	107	.90	833.00	20.00	40	.50
74	.70	1320.00	20.00	40	.50	108	.90	840.00	20.00	40	.50
75	.70	1600.00	14.00	40	.35	109	.90	850.00	21.00	40	.53
76	.70	1800.00	9.00	40	.23	110	.90	870.00	19.00	40	.48
77	.70	2100.00	8.00	40	.20	111	.90	1250.00	15.00	40	.38
78	.70	2180.00	8.00	40	.20	112	.90	1270.00	14.00	40	.35
79	.70	2200.00	12.00	40	.30	113	.90	1300.00	11.00	40	.28
80	.70	2500.00	5.00	40	.13	114	.90	1320.00	10.00	40	.25
81	.80	40.00	40.00	40	1.00	115	.90	1600.00	5.00	40	.13
82	.80	47.00	40.00	40	1.00	116	.90	1800.00	4.00	40	.10
83	.80	50.00	40.00	40	1.00	117	.90	2100.00	3.00	40	.08
84	.80	430.00	26.00	40	.65	118	.90	2180.00	3.00	40	.08
85	.80	440.00	26.00	40	.65	119	.90	2200.00	.00	40	.00
86	.80	450.00	26.00	40	.65	120	.90	2500.00	.00	40	.00
87	.80	833.00	16.00	40	.40	121	1.00	40.00	40.00	40	1.00
88	.80	840.00	15.00	40	.38	122	1.00	47.00	40.00	40	1.00
89	.80	850.00	14.00	40	.35	123	1.00	50.00	40.00	40	1.00
90	.80	870.00	13.00	40	.33	124	1.00	430.00	29.00	40	.73
91	.80	1250.00	10.00	40	.25	125	1.00	440.00	30.00	40	.75
92	.80	1270.00	9.00	40	.23	126	1.00	450.00	30.00	40	.75
93	.80	1300.00	10.00	40	.25	127	1.00	833.00	20.00	40	.50
94	.80	1320.00	8.00	40	.20	128	1.00	840.00	23.00	40	.58
95	.80	1600.00	5.00	40	.13	129	1.00	850.00	22.00	40	.55
96	.80	1800.00	5.00	40	.13	130	1.00	870.00	15.00	40	.38
97	.80	2100.00	2.00	40	.05	131	1.00	1250.00	16.00	40	.40
98	.80	2180.00	2.00	40	.05	132	1.00	1270.00	15.00	40	.38
99	.80	2200.00	2.00	40	.05	133	1.00	1300.00	10.00	40	.25
100	.80	2500.00	.00	40	.00	134	1.00	1320.00	8.00	40	.20
101	.90	40.00	40.00	40	1.00	135	1.00	1600.00	9.00	40	.23
102	.90	47.00	40.00	40	1.00	136	1.00	1800.00	5.00	40	.13
103	.90	50.00	40.00	40	1.00	137	1.00	2100.00	2.00	40	.05
104	.90	430.00	30.00	40	.75	138	1.00	2180.00	.00	40	.00
105	.90	440.00	30.00	40	.75	139	1.00	2200.00	.00	40	.00
106	.90	450.00	29.00	40	.73	140	1.00	2500.00	.00	40	.00

Table 3-2 Customer statistical data (continued)

	MI	ILLUM	accept	total	PROB		MI	ILLUM	accept	total	PROB
1	.40	40.00	40.00	40	1.00	37	.50	2100.00	19.00	40	.55
2	.40	47.00	39.00	40	1.00	38	.50	2180.00	18.00	40	.53
3	.40	50.00	38.00	40	1.00	39	.50	2200.00	15.00	40	.40
4	.40	430.00	37.00	40	.98	40	.50	2500.00	14.00	40	.38
5	.40	440.00	36.00	40	.95	41	.60	40.00	39.00	40	1.00
6	.40	450.00	36.00	40	.95	42	.60	47.00	38.00	40	1.00
7	.40	833.00	34.00	40	.88	43	.60	50.00	38.00	40	1.00
8	.40	840.00	34.00	40	.83	44	.60	430.00	33.00	40	.88
9	.40	850.00	34.00	40	.80	45	.60	440.00	30.00	40	.85
10	.40	870.00	34.00	40	.80	46	.60	450.00	30.00	40	.85
11	.40	1250.00	23.00	40	.63	47	.60	833.00	31.00	40	.83
12	.40	1270.00	22.00	40	.60	48	.60	840.00	29.00	40	.75
13	.40	1300.00	22.00	40	.60	49	.60	850.00	26.00	40	.75
14	.40	1320.00	20.00	40	.53	50	.60	870.00	26.00	40	.75
15	.40	1600.00	19.00	40	.50	51	.60	1250.00	25.00	40	.65
16	.40	1800.00	17.00	40	.45	52	.60	1270.00	23.00	40	.63
17	.40	2100.00	15.00	40	.40	53	.60	1300.00	22.00	40	.63
18	.40	2180.00	14.00	40	.38	54	.60	1320.00	21.00	40	.63
19	.40	2200.00	10.00	40	.25	55	.60	1600.00	20.00	40	.60
20	.40	2500.00	8.00	40	.23	56	.60	1800.00	19.00	40	.58
21	.50	40.00	39.00	40	1.00	57	.60	2100.00	18.00	40	.55
22	.50	47.00	38.00	40	1.00	58	.60	2180.00	15.00	40	.53
23	.50	50.00	38.00	40	1.00	59	.60	2200.00	14.00	40	.40
24	.50	430.00	34.00	40	.88	60	.60	2500.00	13.00	40	.38
25	.50	440.00	33.00	40	.85	61	.70	40.00	38.00	40	1.00
26	.50	450.00	33.00	40	.85	62	.70	47.00	38.00	40	1.00
27	.50	833.00	32.00	40	.83	63	.70	50.00	36.00	40	.95
28	.50	840.00	29.00	40	.75	64	.70	430.00	32.00	40	.83
29	.50	850.00	29.00	40	.75	65	.70	440.00	30.00	40	.75
30	.50	870.00	29.00	40	.75	66	.70	450.00	26.00	40	.73
31	.50	1250.00	24.00	40	.65	67	.70	833.00	24.00	40	.63
32	.50	1270.00	23.00	40	.63	68	.70	840.00	20.00	40	.60
33	.50	1300.00	23.00	40	.63	69	.70	850.00	20.00	40	.60
34	.50	1320.00	23.00	40	.63	70	.70	870.00	19.00	40	.55
35	.50	1600.00	22.00	40	.60	71	.70	1250.00	14.00	40	.45
36	.50	1800.00	20.00	40	.58	72	.70	1270.00	13.00	40	.40

Table 3-3 Printer statistical data

	MI	ILLUM	accept	total	PROB		MI	ILLUM	accept	total	PROB
73	.70	1300.00	11.00	40	.35	107	.90	833.00	15.00	40	.63
74	.70	1320.00	9.00	40	.33	108	.90	840.00	13.00	40	.50
75	.70	1600.00	8.00	40	.25	109	.90	850.00	11.00	40	.53
76	.70	1800.00	6.00	40	.23	110	.90	870.00	10.00	40	.48
77	.70	2100.00	2.00	40	.20	111	.90	1250.00	6.00	40	.38
78	.70	2180.00	2.00	40	.20	112	.90	1270.00	5.00	40	.35
79	.70	2200.00	2.00	40	.23	113	.90	1300.00	3.00	40	.28
80	.70	2500.00	2.00	40	.13	114	.90	1320.00	.00	40	.25
81	.80	40.00	37.00	40	1.00	115	.90	1600.00	.00	40	.13
82	.80	47.00	37.00	40	.98	116	.90	1800.00	.00	40	.10
83	.80	50.00	35.00	40	.95	117	.90	2100.00	.00	40	.08
84	.80	430.00	22.00	40	.65	118	.90	2180.00	.00	40	.08
85	.80	440.00	20.00	40	.55	119	.90	2200.00	.00	40	.05
86	.80	450.00	16.00	40	.45	120	.90	2500.00	.00	40	.00
87	.80	833.00	13.00	40	.40	121	1.00	40.00	35.00	40	1.00
88	.80	840.00	10.00	40	.38	122	1.00	47.00	33.00	40	.95
89	.80	850.00	9.00	40	.35	123	1.00	50.00	30.00	40	.93
90	.80	870.00	8.00	40	.33	124	1.00	430.00	16.00	40	.88
91	.80	1250.00	6.00	40	.25	125	1.00	440.00	20.00	40	.83
92	.80	1270.00	3.00	40	.23	126	1.00	450.00	16.00	40	.75
93	.80	1300.00	2.00	40	.25	127	1.00	833.00	15.00	40	.63
94	.80	1320.00	2.00	40	.20	128	1.00	840.00	13.00	40	.58
95	.80	1600.00	1.00	40	.13	129	1.00	850.00	12.00	40	.55
96	.80	1800.00	.00	40	.13	130	1.00	870.00	10.00	40	.45
97	.80	2100.00	.00	40	.10	131	1.00	1250.00	8.00	40	.40
98	.80	2180.00	.00	40	.08	132	1.00	1270.00	9.00	40	.38
99	.80	2200.00	.00	40	.08	133	1.00	1300.00	6.00	40	.25
100	.80	2500.00	.00	40	.10	134	1.00	1320.00	5.00	40	.20
101	.90	40.00	35.00	40	1.00	135	1.00	1600.00	.00	40	.23
102	.90	47.00	33.00	40	.88	136	1.00	1800.00	.00	40	.13
103	.90	50.00	30.00	40	.90	137	1.00	2100.00	.00	40	.05
104	.90	430.00	29.00	40	.83	138	1.00	2180.00	.00	40	.00
105	.90	440.00	25.00	40	.75	139	1.00	2200.00	.00	40	.00
106	.90	450.00	20.00	40	.73	140	1.00	2500.00	.00	40	.00

Table 3-3 Printer statistical data (continued)