Appendix 2

1 Shape Data

1.1 10-perfect layout shapes

20.1) 17 17, 7 17, 16 15, 10 15, 6 15, 18 7, 6 9, 18 2, 13 4, 11 4:
Optimum Layout - 10 shapes ! TOPMOST 40 30

1.2 20-perfect layout shapes

20.2) 13 1, 24 2, 3 22, 8 5, 5 5, 24 5, 9 9, 4 1, 21 12, 7 12, 9 7, 1 3, 27 3, 5 8,
17 2, 4 8, 14 3, 4 6, 13 6, 14 5:
Optimum Layout - 20 shapes ! TOPMOST 40 30

1.3 40-perfect layout shapes

20.3) 3 12, 25 1, 3 8, 9 2, 10 11, 8 3, 7 1, 7 4, 9 6, 3 8, 2 5, 3 2, 10 2, 6 1, 1 8,
6 15, 9 5, 8 2, 4 1, 4 5, 6 5, 3 6, 5 6, 1 14, 5 2, 4 13, 5 17, 5 3, 5 1, 6 2, 3 9,
5 6, 2 6, 8 12, 3 9, 3 7, 13 3, 3 2, 21 4, 6 2:
Optimum Layout - 40 shapes ! TOPMOST 40 30

1.4 80-perfect layout shapes

20.4) 10 3, 2 1, 12 3, 9 3, 3 3, 4 2, 2 6, 4 2, 2 1, 2 1, 2 2, 4 2, 12 2, 7 2, 5 4,
4 1, 4 6, 10 3, 1 2, 7 5, 11 2, 3 5, 3 3, 5 2, 5 2, 3 3, 5 2, 4 2, 1 2, 4 4,
6 1, 1 20, 1 15, 2 12, 6 2, 5 2, 5 2, 1 3, 3 4, 1 4, 8 4, 4 1, 4 3, 2 2, 9 2,
4 6, 5 2, 3 1, 8 3, 5 1, 2 5, 2 5, 3 6, 7 6, 8 2, 2 2, 18 2, 4 3, 2 2, 3 6, 6 7, 3 5,
1 4, 7 1, 10 3, 9 1, 1 3, 5 7, 9 3, 5 3, 6 7, 3 2, 2 4, 7 4, 4 4, 1 1, 3 4,
12 4, 4 1, 14 1:
Optimum Layout - 80 shapes ! TOPMOST 40 30

1.5 B1 Layout shapes

19.1) 8 6, 11 4, 10 3, 4 7, 12 6, 11 6, 12 8, 3 6, 4 3, 3 8, 9 1, 1 3, 8 6, 11 3, 11 1,9 8,
9 1, 11 5, 1 7, 7 8:
Bengtsson 20 shapes small-sheet ! DYNAMIC 25 10

1.6 B2 Layout shapes

19.2) 8 6, 11 4, 10 3, 4 7, 12 6, 11 6, 12 8, 3 6, 4 3, 3 8, 9 1, 1 3, 8 6, 11 3, 11 1,9 8,
9 1, 11 5, 1 7, 7 8, 10 3, 2 8, 8 3, 7 3, 8 4, 2 7, 12 7, 1 2, 3 8, 1 1, 12 7, 3 4, 8 4,
11 5, 5 6, 8 8, 4 1, 10 3, 12 7, 12 3:
Bengtsson 40 shapes small-sheet ! DYNAMIC 25 10

1.7 B3 Layout shapes

19.3) 8 6, 11 4, 10 3, 4 7, 12 6, 11 6, 12 8, 3 6, 4 3, 3 8, 9 1, 1 3, 8 6, 11 3, 11 1,9 8,9 1, 11 5,
1 7, 7 8, 10 3, 2 8, 8 3, 7 3, 8 4, 2 7, 12 7, 1 2, 3 8, 1 1, 12 7, 3 4, 8 4, 11 5, 5 6, 8 8, 4
1, 10 3, 12 7, 12 3:
Bengtsson 40 shapes large-sheet ! DYNAMIC 40 25

1.8 B4 Layout shapes

19.4) 8 6, 11 4, 10 3, 4 7, 12 6, 11 6, 12 8, 3 6, 4 3, 3 8, 9 1, 1 3, 8 6, 11 3, 11 1,9 8,9 1, 11 5, 1 7, 7 8, 10 3, 2 8, 8 3, 7 3, 8 4, 2 7, 12 7, 1 2, 3 8, 1 1, 12 7, 3 4, 8 4, 11 5, 5 6, 8 8, 4 1, 10 3, 12 7, 12 3, 10 7, 5 4, 3 2, 7 7, 11 8, 10 5, 4 7, 5 4, 2 3, 3 3, 8 3, 11 4, 8 1, 8 7, 6 5, 8 5, 4 8, 8 8, 7 2 , 6 2, 9 2, 7 6, 1 5, 5 2, 11 4, 11 3, 3 1, 9 2, 11 7, 10 4, 5 4, 11 2, 7 3, 12 6, 11 5, 2 6, 10 4, 10 4, 1 3, 2 4:
Bengtsson 80 shapes large-sheet ! DYNAMIC 40 25

2 Raw Data for Experiment Set 1

2.1 10-shape layout test

Test	GA1	GA2	GA3	GA4	Hill Climb	Random
1	600	900	100	200	100	1500
2	900	300	500	100	200	900
3	1100	500	400	500	100	700
4	400	200	100	900	400	300
5	600	100	100	100	100	900
6	400	300	700	300	200	2700
7	100	300	200	700	400	500
8	100	100	200	100	300	500
9	700	400	400	200	1300	1200
10	400	600	500	300	100	1200
Average	530	370	320	340	320	1040

2.2 20-shape layout test

Test	GA1	GA2	GA3	GA4	Hill Climb	Random
1	0.8928	0.8928	0.9456	1	0.856221	0.858663
2	0.9596	0.8798	0.9596	0.9157	0.846852	0.778547
3	0.8775	0.9457	0.9335	0.8775	0.881659	0.830216
4	0.8391	0.9457	0.8734	0.8819	0.877535	0.852273
5	0.8775	0.8846	0.9596	0.9101	0.852273	0.826446
6	0.9596	0.8775	0.8817	0.9128	0.881659	0.807979
7	0.9027	0.9027	0.9457	0.8775	0.889996	0.80816
8	0.9487	0.8985	0.8928	0.9457	0.886031	0.781922
9	0.9596	0.907	0.846	0.8775	0.877535	0.807979
10	0.9457	0.8523	0.9365	0.9101	0.873439	0.817687
Average	0.91628	0.89866	0.91744	0.91088	0.87232	0.816987

2.3 40-shape layout test

Test	GA1	GA2	GA3	GA4	Hill Climb	Random
1	0.8629	0.8573	0.8573	0.8734	0.814065	0.751779
2	0.817	0.8734	0.8734	0.8391	0.845753	0.790123
3	0.8391	0.8391	0.8734	0.8734	0.80677	0.732748
4	0.8573	0.8573	0.8734	0.852	0.816519	0.767877
5	0.8734	0.8629	0.8573	0.8734	0.778715	0.761653
6	0.8734	0.8655	0.8734	0.8734	0.857339	0.761653
7	0.8928	0.8734	0.8734	0.8575	0.841877	0.739062
8	0.8734	0.8468	0.8734	0.8391	0.797194	0.730514
9	0.8734	0.8734	0.8417	0.8734	0.826446	0.72431
10	0.7984	0.8734	0.8734	0.8734	0.806951	0.739062
Average	0.85611	0.86225	0.86701	0.86281	0.819163	0.749878

2.4 80-shape layout test

Test	GA1	GA2	GA3	GA4	Hill Climb	Random
1	0.8495	0.8928	0.8266	0.807	0.84168	0.750694
2	0.8416	0.8455	0.8142	0.8366	0.802139	0.750694
3	0.8682	0.8734	0.868	0.8494	0.861322	0.811622
4	0.8817	0.8613	0.868	0.8378	0.849455	0.797194
5	0.8366	0.8317	0.8202	0.8302	0.831478	0.783147
6	0.8523	0.8417	0.8817	0.8021	0.816704	0.787788
7	0.8215	0.8627	0.8366	0.834	0.818984	0.783147
8	0.8495	0.8216	0.8626	0.8366	0.849455	0.7585
9	0.7845	0.8315	0.8367	0.8734	0.810405	0.750694
10	0.8469	0.8629	0.8367	0.8521	0.830216	0.777403
Average	0.84323	0.85251	0.84513	0.83592	0.831184	0.775088

3 Raw Data for Experiment Set 2

10-shape layout test

Test	New GA1	New GA2	New GA3	New GA4
1	1000	800	500	200
2	300	400	300	500
3	400	100	600	1200
4	100	200	1000	300
5	700	100	200	100
6	200	400	200	100
7	200	300	600	300
8	300	600	1500	200
9	200	600	100	1100
10	300	500	300	100
Average	370	400	530	410

20-shape layout test

Test	New GA1	New GA2	New GA3	New GA4
1	0.945654	0.995019	1	0.945654
2	1	0.894334	0.901298	0.902726
3	0.933511	0.945654	0.945654	0.879765
4	0.945654	0.933511	0.902726	0.902726
5	0.852273	0.858663	0.936524	0.933511
6	0.852273	0.910146	0.9596	0.877535
7	0.892802	0.933511	0.910146	0.881659
8	0.899873	0.945654	0.817687	0.924556
9	0.97868	0.933511	0.881659	0.936524
10	0.910146	0.995019	0.826446	0.902726
Average	0.921087	0.934502	0.908174	0.908738

40-shape layout test

Test	New GA1	New GA2	New GA3	New GA4
1	0.848952	0.873651	0.83675	0.873439
2	0.873439	0.901524	0.873439	0.873439
3	0.82146	0.873651	0.790297	0.826636
4	0.873439	0.831478	0.857339	0.873439
5	0.822891	0.873439	0.873439	0.857339
6	0.873439	0.873439	0.798382	0.845753
7	0.865541	0.83675	0.885813	0.873439
8	0.873439	0.873439	0.832247	0.873439
9	0.873439	0.839112	0.865541	0.873439
10	0.865333	0.806951	0.858663	0.873439
Average	0.859137	0.858343	0.847191	0.86438

80-shape layout test

Test	New GA1	New GA2	New GA3	New GA4
1	0.852071	0.831478	0.826446	0.83167
2	0.84168	0.831478	0.869371	0.814249
3	0.845554	0.82146	0.820969	0.849455
4	0.83167	0.854699	0.865333	0.84168
5	0.852071	0.837832	0.816704	0.892802
6	0.821648	0.829147	0.814249	0.796185
7	0.849455	0.868231	0.892802	0.857339
8	0.818984	0.857339	0.877535	0.834011
9	0.831478	0.83675	0.84168	0.839112
10	0.873439	0.852071	0.816704	0.861322
Average	0.841805	0.842049	0.844179	0.841782

4 Raw Data for Experiment Set 3

4.1 Results using GA 2

	Crossover Operators						Mutation Operators				
Test	**order**	**position**	**seg_pos**	**seg_ord**	**HUX_pos**	**edge**	**swap**	**multi-swap**	**shunt**	**invert**	**Total**
1	60	63	79	67	60	16	30	28	36	34	473
2	54	38	43	49	54	21	40	50	34	38	421
3	48	46	62	69	58	29	34	26	24	30	426
4	21	32	42	51	57	23	46	40	32	28	372
5	46	43	59	44	51	20	34	28	28	32	385
6	33	19	29	23	30	7	10	12	10	10	183
7	42	33	50	41	52	11	30	22	32	32	345
8	20	34	26	26	30	25	26	30	24	18	259
9	37	38	48	62	79	33	36	38	18	22	411
10	56	39	51	58	42	23	30	18	18	30	365
11	49	45	66	68	54	13	60	38	22	34	449
12	34	40	56	59	36	11	52	42	46	42	418
13	43	39	48	69	32	8	42	36	22	26	365
14	29	49	68	60	47	17	48	48	26	32	424
15	36	38	54	36	45	5	38	50	28	24	354
16	26	34	63	46	55	6	38	40	28	28	364
17	42	37	41	50	35	13	30	32	12	28	320
18	40	40	51	75	60	10	66	28	28	24	422
19	45	57	67	82	55	10	66	46	18	34	480
20	23	45	56	61	34	13	38	28	34	30	362
Total	784	809	1059	1096	966	314	794	680	520	576	7598

4.2 Results using New GA 2

	Crossover Operators Used			Mutation Operators Used		
Test	**seg_pos**	**seg_ord**	**HUX_pos**	**swap**	**multi-swap**	**Total**
1	58	47	65	42	28	240
2	100	102	119	64	52	437
3	85	92	107	74	72	430
4	87	76	92	52	52	359
5	82	89	98	64	44	377
6	78	74	110	70	48	380
7	64	70	67	40	56	297
8	111	124	133	70	52	490
9	103	117	100	34	34	388
10	101	66	105	62	66	400
11	86	73	114	66	54	393
12	144	138	190	72	66	610
13	97	88	86	60	60	391
14	103	76	55	74	54	362
15	113	141	102	60	56	472
16	109	99	81	54	62	405
17	136	129	108	76	66	515
18	111	122	123	72	48	476
19	89	101	93	54	40	377
20	124	131	122	74	58	509
Total Scores	1981	1955	2070	1234	1068	8308

5 Raw Data for Experiment Set 4

20-shape layout test

Test	adaptor1	adaptor2	adaptor3	adaptor4
1	0.91573	0.881659	0.877535	0.877535
2	0.945654	0.877535	0.877535	0.933511
3	0.948727	0.852273	0.933511	0.877535
4	0.902726	0.877535	0.889996	0.868231
5	0.877535	0.881659	0.881659	0.881659
6	0.961169	0.852273	0.892802	0.858663
7	0.933511	0.877535	0.902726	0.899873
8	0.881659	0.945654	0.861438	0.877535
9	0.881659	1	0.899873	0.881659
10	0.881659	0.889996	0.852273	0.877535
Average	0.913003	0.893612	0.886935	0.883374

40-shape layout test

Test	adaptor1	adaptor2	adaptor3	adaptor4
1	0.839112	0.822891	0.852273	0.846852
2	0.873439	0.852878	0.839308	0.790123
3	0.83675	0.857339	0.873439	0.848952
4	0.873439	0.852878	0.873439	0.839112
5	0.873439	0.83675	0.84168	0.80677
6	0.901524	0.873439	0.873439	0.846852
7	0.849455	0.814249	0.873439	0.865541
8	0.820221	0.790221	0.818984	0.806951
9	0.873439	0.806951	0.852273	0.817261
10	0.807494	0.774653	0.873439	0.806951
Average	0.854831	0.828225	0.857171	0.827536

80-shape layout test

Test	adaptor1	adaptor2	adaptor3	adaptor4
1	0.865333	0.869371	0.831478	0.84168
2	0.826446	0.826446	0.857339	0.892802
3	0.826636	0.837832	0.857339	0.836556
4	0.881659	0.80677	0.852071	0.861322
5	0.84168	0.845554	0.885813	0.830216
6	0.837832	0.83167	0.846852	0.832743
7	0.837832	0.83675	0.847051	0.830216
8	0.830216	0.857339	0.873439	0.845554
9	0.836556	0.884425	0.816704	0.873439
10	0.826446	0.868022	0.849455	0.827206
Average	0.841064	0.846418	0.851754	0.847173

6 Raw Data for Experiment Set 5

	1st Beng Layout			**2nd Beng Layout**			**3rd Beng Layout**			**4th Beng Layout**		
Test	**top**	**flip top**	**flip left**	**top**	**flip top**	**flip left**	**top**	**flip top**	**flip left**	**top**	**flip top**	**flip left**
1	0.6673	0.695989	0.710238	0.425846	0.421866	0.401028	0.815719	0.766327	0.703668	0.671439	0.54717	0.609158
2	0.6951	0.664753	0.676824	0.444204	0.399235	0.397447	0.752119	0.668298	0.70943	0.617846	0.619738	0.614268
3	0.6681	0.662222	0.727786	0.432619	0.423498	0.42558	0.771404	0.723092	0.698688	0.680513	0.640834	0.582611
4	0.6400	0.670734	0.671597	0.541634	0.456079	0.39695	0.764057	0.664615	0.687526	0.607511	0.573298	0.626704
5	0.6968	0.662411	0.662767	0.377916	0.357035	0.415718	0.833537	0.728474	0.685022	0.591273	0.606324	0.622956
6	0.6360	0.679535	0.682791	0.353304	0.468017	0.429907	0.786486	0.671587	0.689856	0.671439	0.601166	0.616731

7	840.6794	0.657642	0.702218	0.358495	0.426611	0.538675	0.771404	0.697946	0.711749	0.629248	0.576294	0.567749
8	0.711141	0.663907	0.68363	0.398921	0.438933	0.452341	0.849282	0.670824	0.641832	0.633111	0.651193	0.610386
9	0.640162	0.734472	0.678584	0.423127	0.40521	0.427721	0.807047	0.672348	0.726233	0.625333	0.556724	0.611738
10	0.651012	0.65971	0.702218	0.469853	0.483388	0.427484	0.815719	0.711749	0.723248	0.639928	0.617064	0.584954
Avg	0.668537	0.675138	0.689865	0.422592	0.427987	0.431285	0.796677	0.697526	0.697725	0.636764	0.59898	0.604725

7 Raw Data for Experiment Set 6

	1st Beng Layout					2nd Beng Layout				
Test	**newbg1**	**newbg 2**	**newbg 3**	**newbg 4**	**newbg 5**	**newbg 1**	**newbg 2**	**newbg 3**	**newbg 4**	**newbg 5**
1	0.681241	0.672463	0.693003	0.693003	0.65177	0.365396	0.511933	0.434896	0.510921	0.447064
2	0.687524	0.738342	0.648476	0.672463	0.643327	0.468091	0.485068	0.428247	0.468521	0.399235
3	0.666837	0.693924	0.656943	0.672463	0.679644	0.474942	0.465916	0.438476	0.509948	0.482033
4	0.644292	0.688854	0.665359	0.672463	0.671597	0.453756	0.47721	0.435791	0.467668	0.497309
5	0.680353	0.776274	0.644162	0.611344	0.671597	0.497638	0.587548	0.434105	0.471446	0.469342
6	0.675947	0.756369	0.723788	0.656943	0.711578	0.378642	0.505698	0.473523	0.44308	0.487932
7	0.676416	0.693924	0.621588	0.630265	0.656075	0.398724	0.532141	0.500289	0.452241	0.437625
8	0.711141	0.695775	0.650164	0.68392	0.671597	0.429067	0.551146	0.452604	0.466526	0.463398
9	0.73126	0.720293	0.604839	0.609786	0.648367	0.436506	0.481327	0.402092	0.453488	0.409812
10	0.685717	0.702324	0.64314	0.660437	0.672463	0.471673	0.540763	0.454045	0.504044	0.462635
Avg	0.684073	0.713854	0.655146	0.656309	0.667802	0.437444	0.513875	0.445407	0.474788	0.455639

	3rd Beng Layout					4th Beng Layout				
Test	**newbg1**	**newbg 2**	**newbg 3**	**newbg 4**	**newbg 5**	**newbg 1**	**newbg 2**	**newbg 3**	**newbg 4**	**newbg 5**
1	0.74082	0.842667	0.726233	0.856712	0.808258	0.677082	0.626978	0.595	0.649045	0.701663
2	0.764057	0.876543	0.766327	0.793185	0.810734	0.561251	0.671439	0.593844	0.653972	0.651193
3	0.739098	0.780595	0.728794	0.824024	0.793185	0.576006	0.71562	0.606643	0.677082	0.671439
4	0.783457	0.793185	0.739004	0.824024	0.780595	0.623391	0.621171	0.593242	0.671439	0.653841
5	0.710444	0.793185	0.742756	0.821491	0.806188	0.592688	0.707929	0.690082	0.695931	0.673823
6	0.74482	0.810734	0.829641	0.856712	0.824024	0.61041	0.671439	0.597157	0.642884	0.662574
7	0.808258	0.842667	0.764057	0.808258	0.789108	0.566329	0.640217	0.599763	0.695931	0.659731
8	0.668298	0.810734	0.815719	0.837432	0.835164	0.592548	0.709555	0.580884	0.671439	0.643645
9	0.813658	0.824024	0.722499	0.835164	0.810734	0.5939	0.677082	0.63886	0.655269	0.634985
10	0.726233	0.824024	0.797303	0.852687	0.810734	0.587308	0.690082	0.590766	0.695931	0.68282
Avg	0.749914	0.819836	0.763233	0.830969	0.806872	0.598091	0.673151	0.608624	0.670892	0.663572

8 Raw Data for Experiment Set 7

	10 shape layout			20 shape layout			40 shape layout			80 shape layout		
Test	**40x30**	**80x30**	**80x60**	**40x30**	**80x30**	**80x60**	**40x30**	**80x30**	**80x60**	**40x30**	**80x30**	**80x60**
1	400	1200	0.935942	0.836496	0.929152	0.866852	0.790123	0.865801	0.886918	0.78672	0.89661	0.886918
2	700	1900	0.929454	0.826446	0.911572	0.886918	0.857339	0.865801	0.886918	0.814065	0.89661	0.886918
3	100	400	0.914904	0.8277	0.89661	0.925781	0.87208	0.89661	0.838135	0.845554	0.89661	0.886918
4	1000	3600	0.935942	0.797194	0.89661	0.866852	0.826446	0.89661	0.886918	0.797591	0.865801	0.886918
5	300	2100	0.927615	0.834446	0.865801	0.828912	0.826446	0.865801	0.886918	0.820221	0.89661	0.886918
6	100	400	0.907771	0.863993	0.89661	0.838135	0.793745	0.865801	0.838135	0.839112	0.865801	0.886918
7	100	1400	0.935942	0.830216	0.89661	0.847529	0.865333	0.865801	0.886918	0.818984	0.89661	0.886918
8	300	2000	0.927615	0.791469	0.89661	0.828912	0.811622	0.865801	0.886918	0.804461	0.865801	0.886918
9	70	300	0.929454	0.8277	0.865801	0.810964	0.814065	0.865801	0.838135	0.80677	0.89661	0.838135

10	0300	4100	0.907771	0.845666	0.89661	0.828912	0.782375	0.865801	0.886918	0.796009	0.865801	0.886918
Avg	400	1740	0.925241	0.828133	0.895198	0.852977	0.823958	0.871963	0.872283	0.812949	0.884286	0.88204