

Appendix I

Table 1 Corresponding Intervals of Degrees of Freedom

Df	0.900	0.950	0.975	0.990	0.995	0.999
1	3.078	6.314	12.706	31.821	63.657	318.309
2	1.886	2.920	4.303	6.965	9.925	22.327
3	1.638	2.353	3.182	4.541	5.841	10.215
4	1.533	2.132	2.776	3.747	4.604	7.173
5	1.476	2.015	2.571	3.365	4.032	5.893
6	1.440	1.943	2.447	3.143	3.707	5.208
7	1.415	1.895	2.365	2.998	3.499	4.785
8	1.397	1.860	2.306	2.896	3.355	4.501
9	1.383	1.833	2.262	2.821	3.250	4.297
10	1.372	1.812	2.228	2.764	3.169	4.144
11	1.363	1.796	2.201	2.718	3.106	4.025
12	1.356	1.782	2.179	2.681	3.055	3.930
13	1.350	1.771	2.160	2.650	3.012	3.852
14	1.345	1.761	2.145	2.624	2.977	3.787
15	1.341	1.753	2.131	2.602	2.947	3.733
16	1.337	1.746	2.120	2.583	2.921	3.686
17	1.333	1.740	2.110	2.567	2.898	3.646
18	1.330	1.734	2.101	2.552	2.878	3.610
19	1.328	1.729	2.093	2.539	2.861	3.579
20	1.325	1.725	2.086	2.528	2.845	3.552
21	1.323	1.721	2.080	2.518	2.831	3.527
22	1.321	1.717	2.074	2.508	2.819	3.505
23	1.319	1.714	2.069	2.500	2.807	3.485
24	1.318	1.711	2.064	2.492	2.797	3.467
25	1.316	1.708	2.060	2.485	2.787	3.450
26	1.315	1.706	2.056	2.479	2.779	3.435
27	1.314	1.703	2.052	2.473	2.771	3.421
28	1.313	1.701	2.048	2.467	2.763	3.408
29	1.311	1.699	2.045	2.462	2.756	3.396
30	1.310	1.697	2.042	2.457	2.750	3.385

Appendix II

Table 1 Sound-to-noise ratio of Separation Time

Experiment number	Experiment 1	Experiment 2	Experiment 3	Average value y	Standard deviation S	SNR
1	5.06	5.44	4.90	5.13	0.23	-14.22
2	4.19	4.16	4.13	4.16	0.03	-12.38
3	2.23	2.17	2.19	2.20	0.03	-6.84
4	4.35	4.88	4.23	4.48	0.28	-13.05
5	2.30	2.27	2.16	2.24	0.06	-7.02
6	4.30	4.42	4.89	4.54	0.25	-13.15
7	2.65	2.88	2.56	2.70	0.13	-8.64
8	2.93	3.05	3.13	3.04	0.08	-9.66
9	4.58	4.76	4.50	4.61	0.11	-13.29
10	4.26	4.01	4.41	4.23	0.17	-12.53
11	2.21	2.14	2.35	2.23	0.09	-6.99
12	3.43	3.48	3.37	3.42	0.05	-10.69
13	3.55	3.22	3.61	3.46	0.17	-10.79
14	4.67	4.70	4.84	4.74	0.07	-13.51
15	2.54	2.52	2.54	2.53	0.01	-8.06
16	2.32	2.50	2.49	2.44	0.08	-7.75
17	3.19	3.13	3.19	3.17	0.03	-10.02
18	4.50	4.318	4.51	4.44	0.09	-12.95

Table 2. Response to Separation Time Factors

Level	A	B	C	D	E
1	-10.91	-11.16	-10.94	-11.57	-11.42
2	-10.37	-9.93	-10.41	-10.27	-12.95
3		-10.83	-10.57	-10.08	-7.55
Delta	0.55	1.23	0.53	1.49	5.41
Rank	4	3	5	2	1

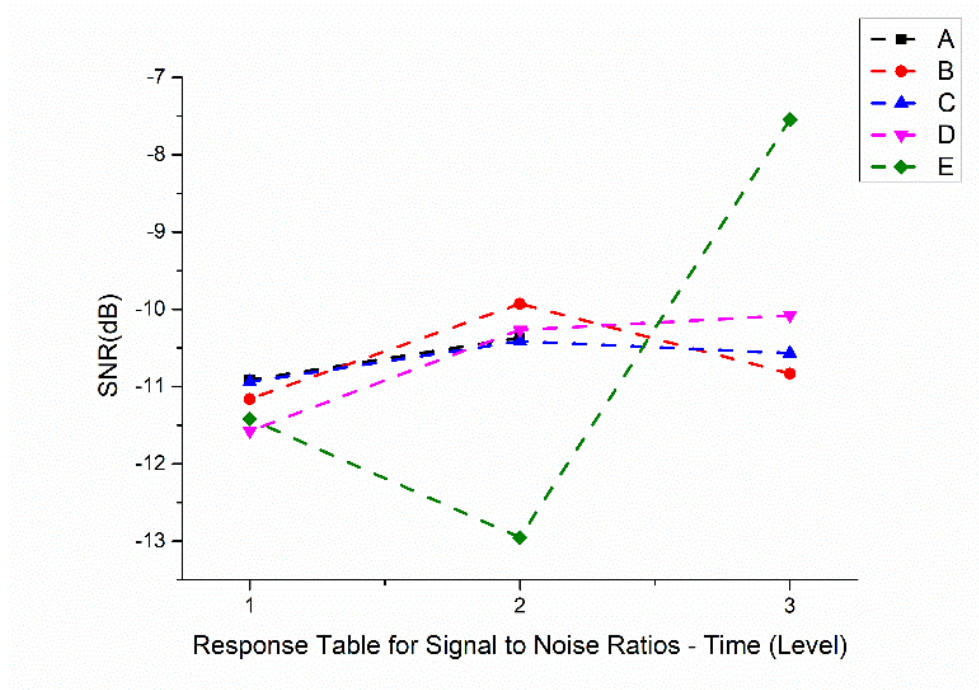


Figure 1 Response to Separation Time Factors

Table 3 ANOVA of Separation Time

Source	DF	Adj SS	Adj MS	F-Value	P-Value	Contribution
A	1	1.343	1.3429	2.04	0.191	1.18%
B	2	4.879	2.4397	3.7	0.073	4.30%
C	2	0.878	0.4391	0.67	0.54	0.77%
D	2	7.949	3.9745	6.03	0.025	7.01%
E	2	93.118	46.559	70.6	0	82.08%
Error	8	5.275	0.6594			4.65%
Total	17	113.443				100.00%

Appendix III

Table 1 Separation Force with the Spring-assisted Mechanism for Molds of Different Areas

Separation force (N)					
Area (mm ²) Layer	100	400	900	1600	2500
1	1.05	2.87	4.79	6.71	13.50
2	0.97	2.73	4.67	6.69	11.92
3	1.08	2.90	5.06	6.64	11.24
4	1.12	3.03	4.64	6.70	10.69
5	1.09	2.86	4.95	6.74	10.19
6	1.15	2.96	4.84	6.61	10.04
7	1.10	2.83	4.88	6.82	9.83
8	1.02	2.90	4.72	6.76	9.57
9	1.13	2.87	4.77	6.62	9.15
10	1.11	2.92	4.85	6.54	9.06
11	1.15	2.82	4.87	6.75	9.08
12	1.15	2.79	4.72	6.52	9.07
13	1.08	2.88	4.80	6.63	9.18
14	1.09	2.85	4.88	6.59	9.00
15	1.11	2.93	4.80	6.49	8.98
16	0.98	2.96	4.71	6.60	8.98
17	1.03	2.85	4.80	6.55	9.04
18	1.17	2.92	4.83	6.27	8.89
19	1.07	2.93	4.87	6.62	8.90
20	1.05	2.85	4.88	6.68	8.95
21	1.05	3.00	4.87	6.47	8.72
22	1.06	3.01	4.75	6.42	8.67
23	1.21	2.96	4.66	6.53	8.67
24	1.21	2.97	4.93	6.54	8.90
25	1.10	3.12	4.78	6.47	8.74
Average value, $\bar{y}$	1.10	2.92	4.81	6.54	8.92
Median value, $\hat{y}$	1.09	2.93	4.80	6.54	8.95
Relative difference (%)	0.97	-0.25	0.21	0.03	-0.36

Table 2. Separation Force with the Spring-assisted Mechanism for Molding a Triangle

Separation force (N)					
Area (mm ²) Layer	100	225	400	625	900
1	1.43	2.11	3.41	5.18	13.77
2	1.49	2.01	3.30	4.87	12.40
3	1.44	2.01	3.26	5.08	11.48
4	1.51	2.03	3.31	5.59	10.51
5	1.43	2.15	3.55	5.58	9.69
6	1.50	2.14	3.44	5.35	9.01
7	1.55	2.30	3.55	5.15	8.16
8	1.5	1.99	3.96	5.48	7.58
9	1.54	2.01	3.74	5.40	7.12
10	1.52	2.18	4.02	5.34	6.74
11	1.39	2.16	3.68	5.13	6.16
12	1.50	2.17	3.84	5.13	6.03
13	1.46	2.18	3.94	4.86	5.88
14	1.44	1.99	3.73	5.36	5.86
15	1.42	2.20	4.08	5.15	6.04
16	1.52	2.15	3.95	5.20	5.86
17	1.40	2.00	3.93	5.27	5.98
18	1.58	2.26	3.98	5.25	6.23
19	1.55	2.18	3.65	5.21	6.12
20	1.49	1.83	3.91	6.65	6.31
21	1.57	2.31	3.87	5.32	6.28
22	1.50	2.06	3.86	5.32	6.22
23	1.67	2.07	3.80	5.11	6.34
24	1.50	2.10	3.96	5.44	6.47
25	1.57	2.33	4.09	5.34	6.38
Average value, $\bar{y}$	1.47	2.11	3.65	5.24	6.14
Median value, $\hat{y}$	1.49	2.14	3.68	5.18	6.16
Relative difference (%)	-1.02	-1.33	-0.80	1.24	-0.29

Table 3. Separation Force with the Spring-assisted Mechanism for Molding a Pentagon

Separation force (N)					
Area (mm ²) Layer	100	225	400	625	900
1	1.38	2.15	3.81	5.56	14.11
2	1.54	2.06	3.61	5.44	12.54
3	1.55	2.15	3.58	6.44	11.78
4	1.41	2.48	3.88	6.54	10.95
5	1.50	2.36	3.85	5.74	10.20
6	1.60	2.23	4.25	5.59	9.28
7	1.52	2.30	4.26	6.71	8.81
8	1.63	2.37	4.33	6.36	7.84
9	1.47	2.20	3.86	5.46	7.49
10	1.47	2.02	4.40	6.16	6.81
11	1.45	2.45	3.73	5.50	6.67
12	1.50	2.55	5.39	5.36	6.04
13	1.52	2.56	5.20	6.00	6.38
14	1.58	2.36	4.12	6.35	6.26
15	1.47	2.35	6.12	5.49	6.21
16	1.45	2.21	5.57	5.37	6.72
17	1.59	2.29	4.38	5.63	6.42
18	1.50	2.50	5.70	6.64	6.58
19	1.40	2.47	5.34	5.49	6.57
20	1.72	2.46	5.96	5.81	6.74
21	1.57	2.25	6.27	5.57	6.54
22	1.52	2.13	6.25	5.37	7.33
23	1.49	3.34	4.58	7.19	7.54
24	1.51	3.81	4.20	6.46	7.09
25	1.41	2.46	3.82	6.16	6.80
Average value, $\bar{y}$	1.51	2.30	4.29	5.91	6.66
Median value, $\hat{y}$	1.50	2.35	4.12	5.74	6.58
Relative difference (%)	0.23	-1.86	4.16	2.92	1.17

Table 4. Separation Force with the Spring-assisted Mechanism for Molding a Hexahedron

Separation force (N)					
Area (mm ²) Layer	100	225	400	625	900
1	1.18	2.07	3.23	4.62	10.94
2	1.12	1.76	3.28	4.69	10.23
3	1.12	1.92	3.29	4.76	9.72
4	1.29	1.81	3.21	4.71	9.47
5	1.07	1.86	3.50	4.70	8.35
6	1.13	1.86	3.28	4.67	7.28
7	1.17	2.00	3.35	4.75	6.38
8	1.10	1.91	3.30	4.60	6.10
9	1.22	1.99	3.29	4.90	6.09
10	1.15	1.89	3.32	4.80	6.13
11	1.12	1.83	3.26	4.70	5.94
12	1.23	1.87	3.45	4.75	5.99
13	1.16	1.85	3.37	4.81	5.97
14	1.21	1.84	3.33	4.73	5.93
15	1.19	1.85	3.30	4.79	5.96
16	1.13	1.80	3.34	4.67	5.16
17	1.11	1.85	3.29	4.81	5.93
18	1.08	1.94	3.18	4.76	6.02
19	1.21	1.98	3.39	4.83	5.87
20	1.12	1.81	3.27	4.88	5.99
21	1.25	1.81	3.32	4.85	5.81
22	1.11	1.87	3.49	4.58	5.85
23	1.07	1.95	3.38	4.73	5.79
24	1.09	1.91	3.54	4.71	5.88
25	1.15	1.92	3.34	4.73	5.79
Average value, $\bar{y}$	1.16	1.89	3.32	4.73	5.86
Median value, $\hat{y}$	1.16	1.86	3.30	4.73	5.93
Relative difference (%)	0.18	1.40	0.62	0.06	-1.14

Table 5. Separation Force with the Spring-assisted Mechanism for Molding a Circle

Separation force (N)					
Area (mm ²) Layer	100	225	400	625	900
1	1.21	1.75	3.27	4.45	14.74
2	1.23	1.78	3.06	4.38	12.51
3	1.16	1.71	3.43	4.44	11.67
4	1.09	1.67	3.33	4.36	10.74
5	1.14	1.78	3.41	4.45	9.99
6	1.19	1.82	3.33	4.49	9.32
7	1.15	1.85	3.25	4.52	8.78
8	1.30	1.84	3.29	4.44	8.60
9	1.17	1.86	3.26	4.41	7.53
10	1.15	1.79	3.40	4.42	6.27
11	1.10	1.97	3.20	4.62	5.84
12	1.17	1.94	3.47	4.42	5.83
13	1.19	1.79	3.41	4.34	5.65
14	1.11	1.78	3.39	4.46	5.50
15	1.25	1.84	3.35	4.43	5.43
16	1.16	1.77	3.48	4.50	5.55
17	1.11	1.81	3.27	4.51	5.70
18	1.12	1.90	3.37	4.71	5.39
19	1.25	1.76	3.42	4.54	5.39
20	1.25	1.72	3.22	4.69	5.43
21	1.08	1.88	3.35	4.52	5.46
22	1.18	1.77	3.33	4.67	5.48
23	1.20	2.00	3.55	4.38	5.55
24	1.24	1.94	3.54	4.59	5.58
25	1.42	1.87	3.34	4.52	5.53
Average value, $\bar{y}$	1.17	1.81	3.32	4.44	5.55
Median value, $\hat{y}$	1.17	1.79	3.33	4.44	5.53
Relative difference (%)	0.48	1.23	-0.23	0.13	0.38

Table 6. Separation Force with the Spring-assisted Mechanism for Molding a Donut

Separation force (N)					
Area (mm ²) Layer	100	225	400	625	900
1	1.21	2.11	3.61	5.31	15.92
2	1.17	1.98	3.51	4.93	13.88
3	1.11	2.07	3.53	4.95	13.00
4	1.16	2.01	3.55	4.74	12.40
5	1.10	1.96	3.60	4.76	11.75
6	1.12	2.09	3.59	4.89	10.91
7	1.12	2.01	3.52	4.88	10.21
8	1.12	2.00	3.66	4.78	9.65
9	1.10	2.08	3.54	4.92	9.21
10	1.12	2.12	3.62	4.77	8.88
11	1.22	2.10	3.61	4.74	7.02
12	1.13	2.06	3.62	4.88	6.47
13	1.14	2.05	3.53	4.88	6.30
14	1.11	2.08	3.60	4.75	6.20
15	1.16	2.09	3.79	4.75	6.03
16	1.20	2.13	3.79	5.00	8.92
17	1.16	2.11	3.60	4.98	5.96
18	1.10	2.23	3.56	4.84	6.00
19	1.07	2.15	3.57	4.77	5.87
20	1.15	1.98	3.71	4.95	5.92
21	1.05	2.10	3.68	4.70	5.90
22	1.13	2.11	3.63	4.99	5.96
23	1.08	2.18	3.57	4.88	6.05
24	1.06	2.24	3.69	4.79	6.04
25	1.11	2.10	3.68	4.88	5.93
Average value, $\bar{y}$	1.14	2.05	3.59	4.86	6.30
Median value, $\hat{y}$	1.12	2.07	3.60	4.88	6.03
Relative difference (%)	1.49	-0.77	0.12	-0.26	4.30

Table 7. Statistical Results of Separation Forces for Molding a Triangle, Pentagon, and Hexahedron

Printed geometric shapes Parameters	Regular triangle	Regular pentagon	Regular hexahedron
Area, x	$\begin{bmatrix} 900 \\ 625 \\ 400 \\ 225 \\ 100 \end{bmatrix}$		
Arithmetic average, $\bar{x}$	450		
Separation force, y	$\begin{bmatrix} 6.14 \\ 5.24 \\ 3.65 \\ 2.11 \\ 1.47 \end{bmatrix}$	$\begin{bmatrix} 6.66 \\ 5.91 \\ 4.29 \\ 2.3 \\ 1.51 \end{bmatrix}$	$\begin{bmatrix} 5.86 \\ 4.73 \\ 3.32 \\ 1.89 \\ 1.16 \end{bmatrix}$
Arithmetic average, $\bar{y}$	3.722	4.134	3.392
Standard deviation of sample x , S_x	319.6678		
Standard deviation of sample y , S_y	1.989113	2.225316	1.944497
Covariance of variables x and y , $C_{x,y}$	627.0625	692.6875	616.875
Correlation coefficient of sample Pearson, r	0.986172	0.973749	0.99241
Statistical test value, t	10.3067	7.409434	13.97744
Quantile of Student's distribution t_3 (0.975)	3.182		

Table 8 Statistical Results of Separation Forces for Molding a Circle and Donut

Printed geometric shapes Parameters	Circle	Donut
Area, x	$\begin{bmatrix} 900 \\ 625 \\ 400 \\ 225 \\ 100 \end{bmatrix}$	
Arithmetic average, $\bar{x}$	450	
Separation force, y	$\begin{bmatrix} 5.55 \\ 4.44 \\ 3.32 \\ 1.81 \\ 1.17 \end{bmatrix}$	$\begin{bmatrix} 6.3 \\ 4.86 \\ 3.59 \\ 2.05 \\ 1.14 \end{bmatrix}$
Arithmetic average, $\bar{y}$	3.258	3.588
Standard deviation of sample x, S_x	319.6678	
Standard deviation of sample y, S_y	1.810434	2.081531
Covariance of variables x and y, $C_{x,y}$	572.9375	661.4375
Pearson correlation coefficient of sample, r	0.989978	0.994047
Statistical test value, t	12.14214	15.8033
Quantile of Student's distribution t_3 (0.975)	3.182	