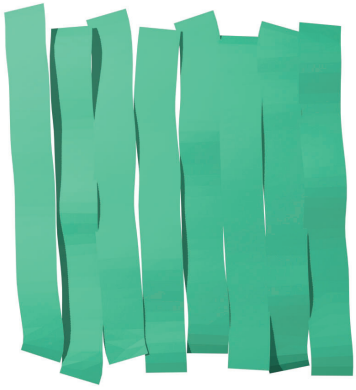
StripBrush: A Constraint-Relaxed 3D Brush Reduces Physical Effort and Enhances the Quality of Spatial Drawing

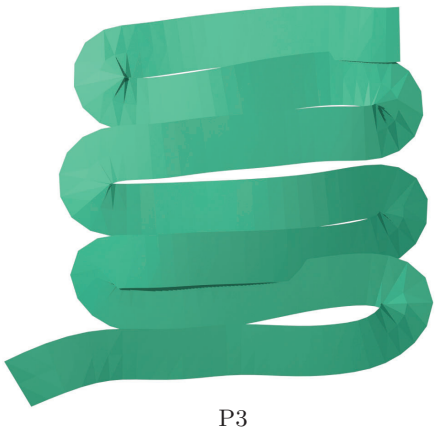
Target shapes used in the exploratory study and drawings created by participants

Target Plane

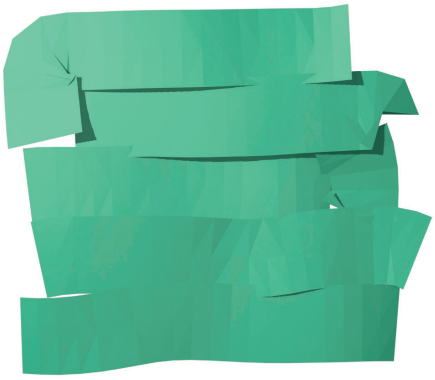


P1

P2

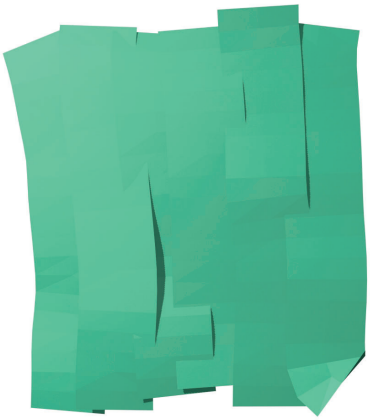


P3

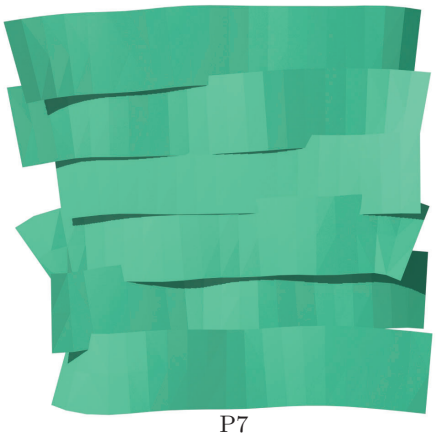


P4

P5



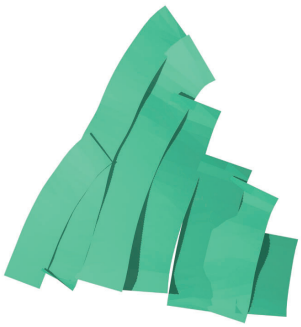
P6



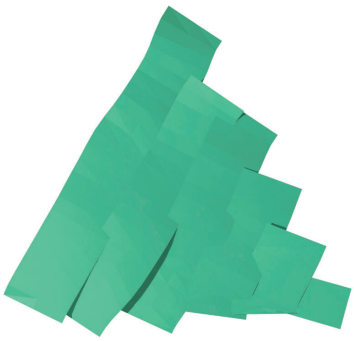
P7

P8

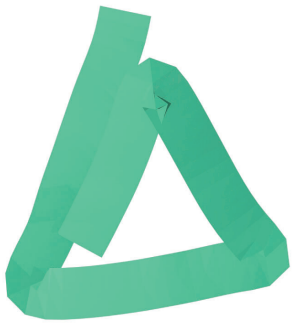
Target Triangle



P1

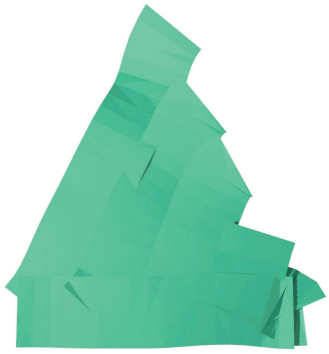


P2

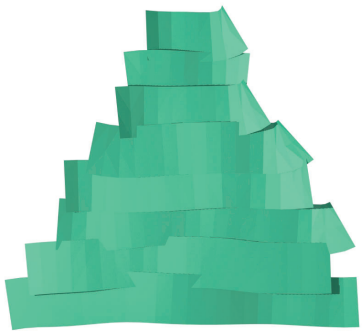


P3

P4



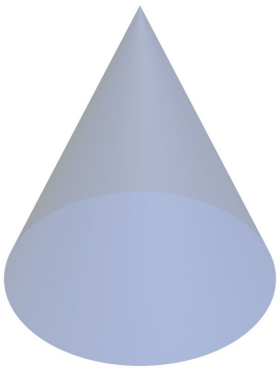
P5



P6

P7

P8



Target Cone

P1

P2

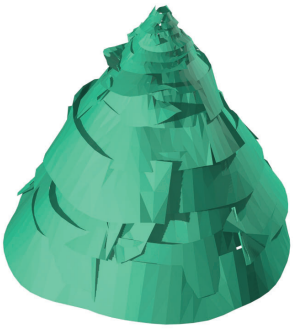
P3

P4

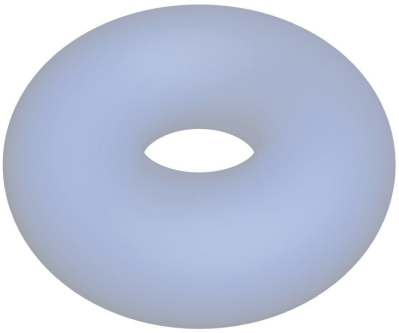
P5

P6

P7

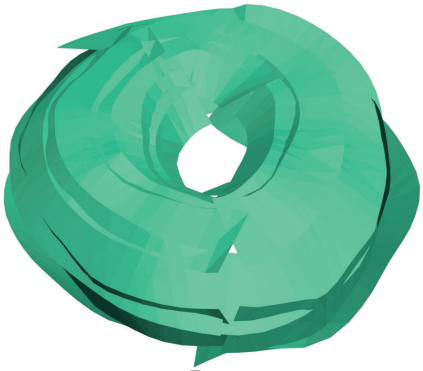


P8

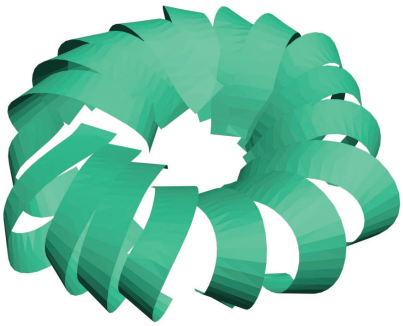


Target Torus

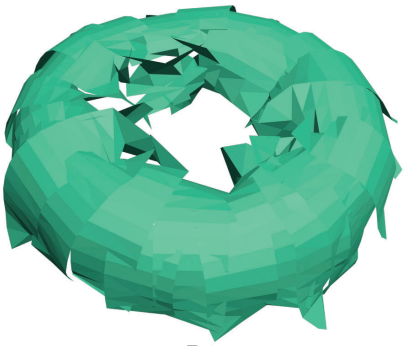
P1



P2

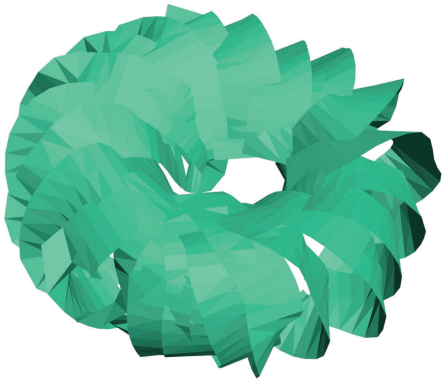


P3

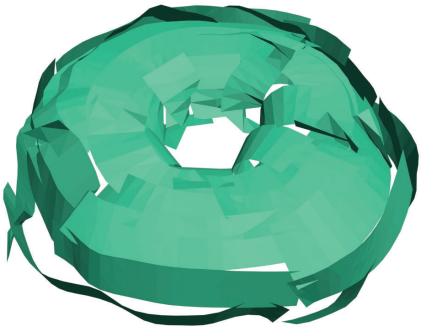


P4

P5



P6



P7

P8

Target shapes used in the comparative study and all pairs of participant drawings created using both tools

P1 Target Square

P1 Baseline

P1 StripBrush

P2 Target Square

P2 Baseline

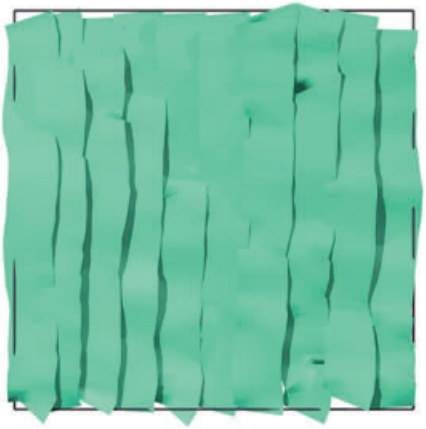
P2 StripBrush

P3 Target Square

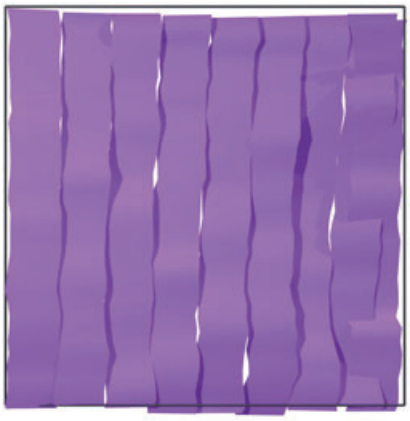
P3 Baseline

P3 StripBrush

P4 Target Square



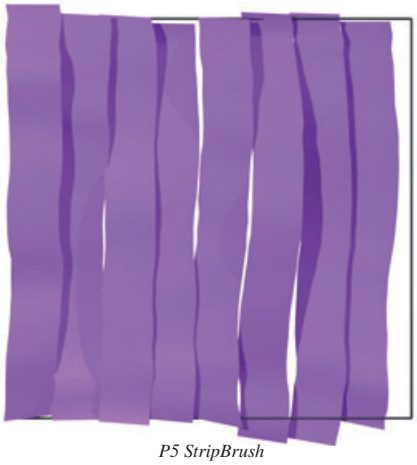
P4 Baseline



P4 StripBrush

P5 Target Square

P5 Baseline



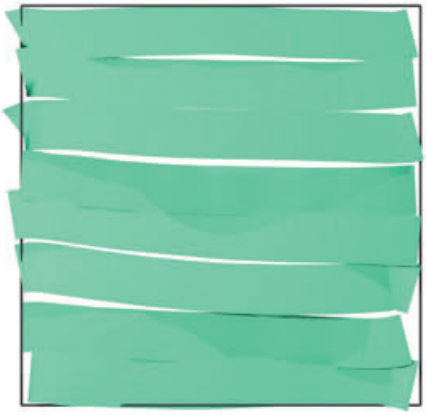
P5 StripBrush

P6 Target Square

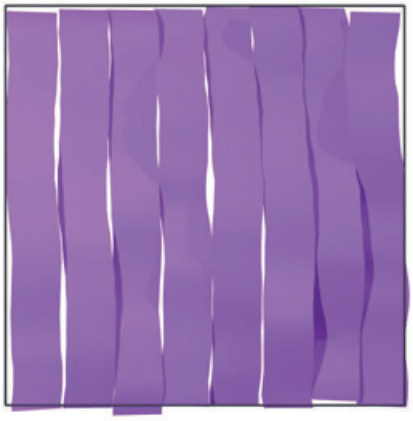
P6 Baseline

P6 StripBrush

P7 Target Square



P7 Baseline



P7 StripBrush

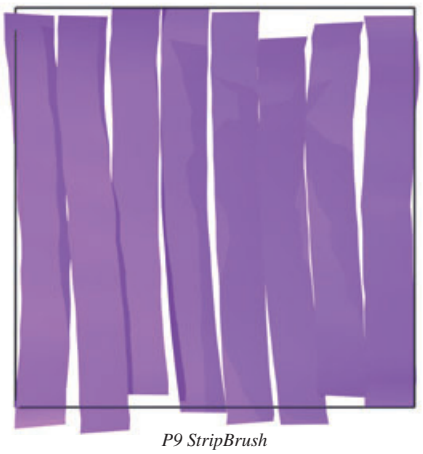
P8 Target Square

P8 Baseline

P8 StripBrush

P9 Target Square

P9 Baseline



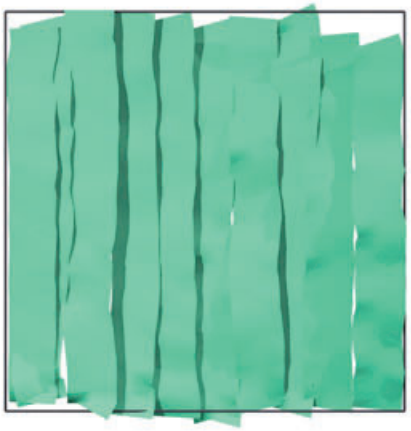
P9 StripBrush

P10 Target Square

P10 Baseline

P10 StripBrush

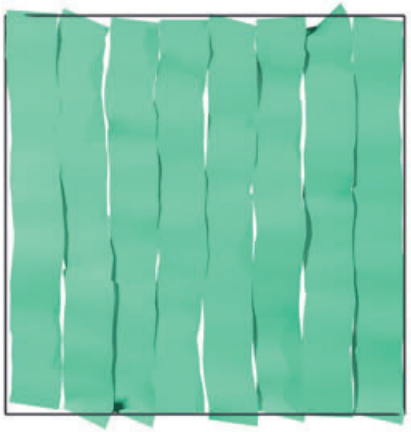
P11 Target Square



P11 Baseline

P11 StripBrush

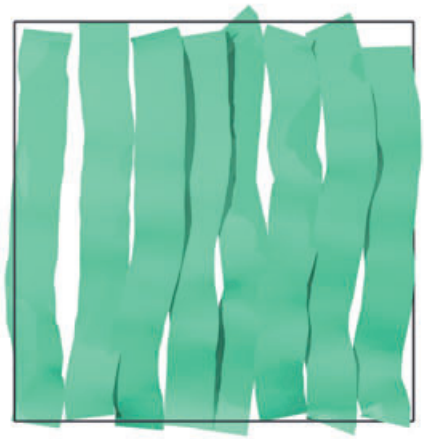
P12 Target Square



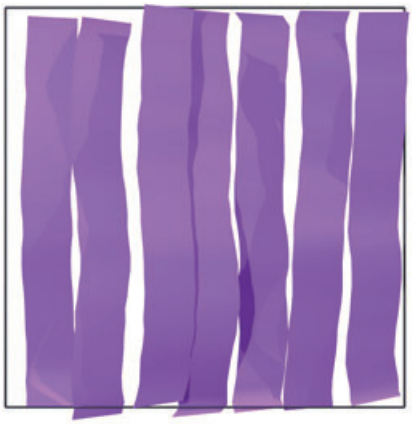
P12 Baseline

P12 StripBrush

P13 Target Square

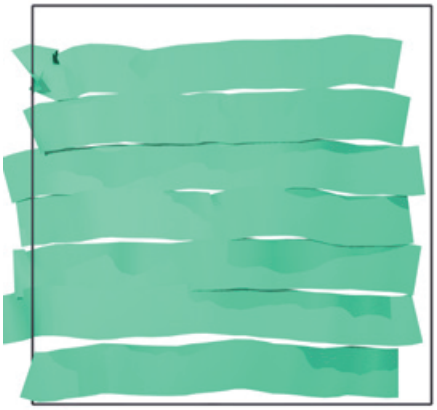


P13 Baseline

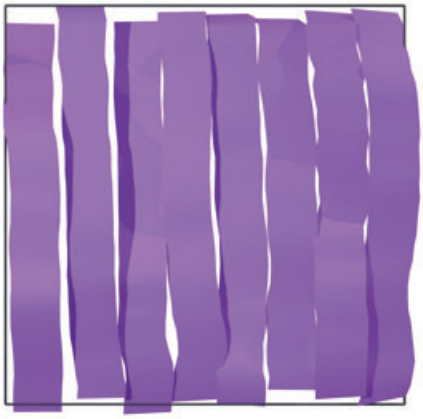


P13 StripBrush

P14 Target Square



P14 Baseline



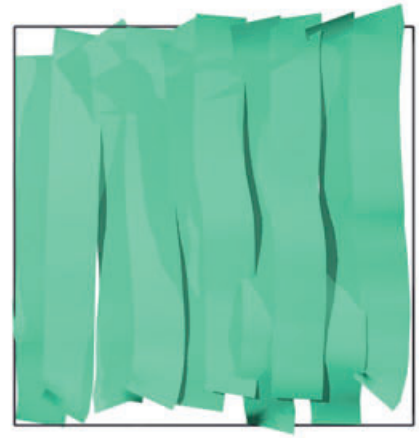
P14 StripBrush

P15 Target Square

P15 Baseline

P15 StripBrush

P16 Target Square

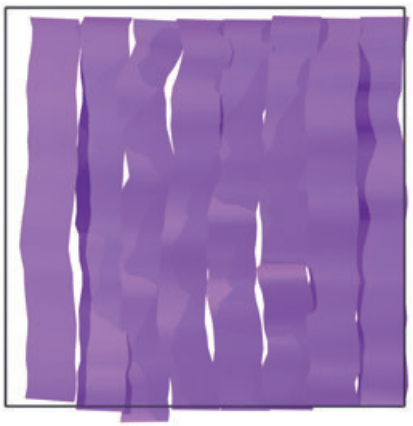


P16 Baseline

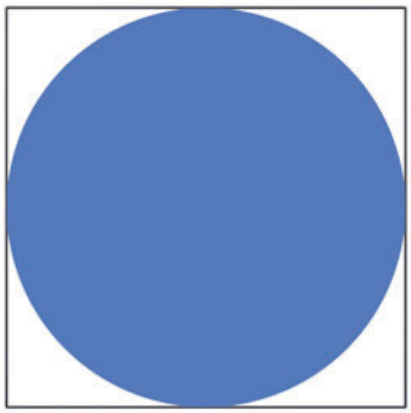
P16 StripBrush

P17 Target Square

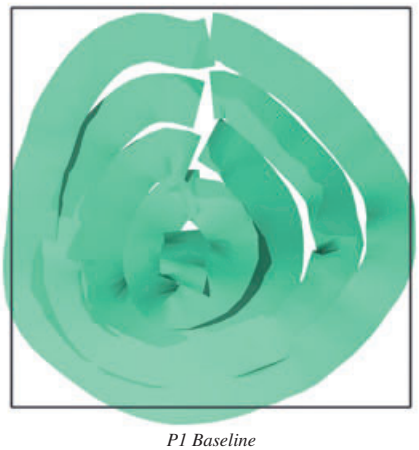
P17 Baseline



P17 StripBrush

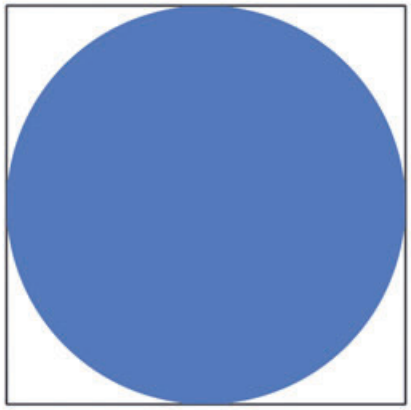


P1 Target Circle

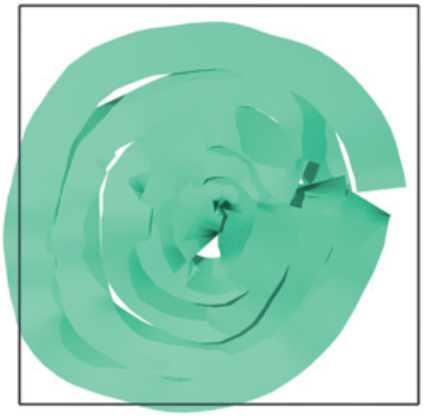


P1 Baseline

P1 StripBrush

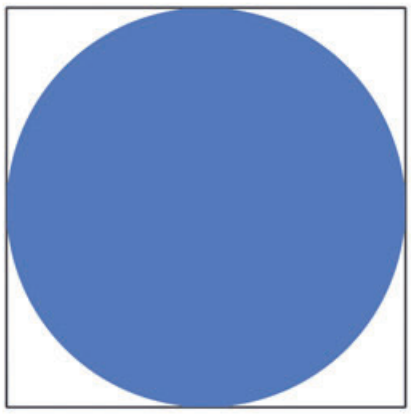


P2 Target Circle

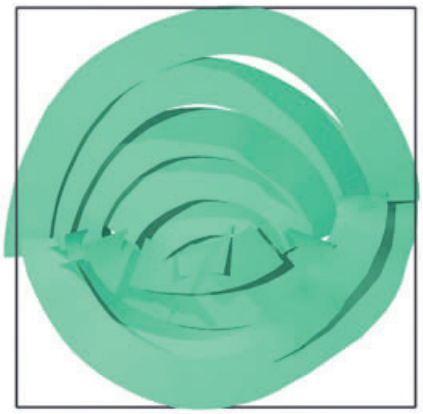


P2 Baseline

P2 StripBrush

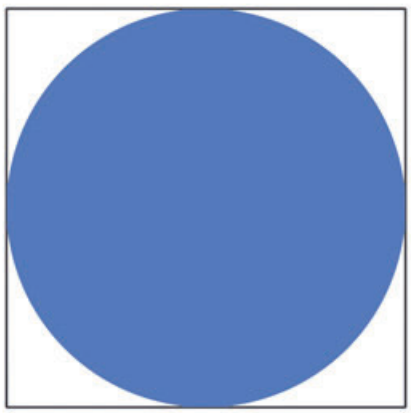


P3 Target Circle



P3 Baseline

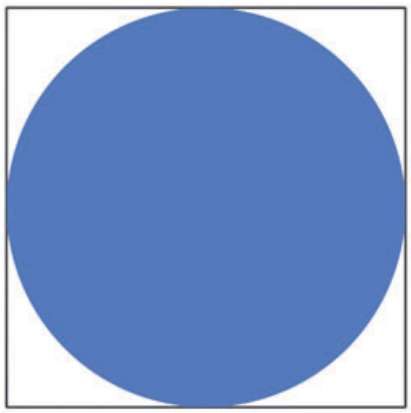
P3 StripBrush



P4 Target Circle

P4 Baseline

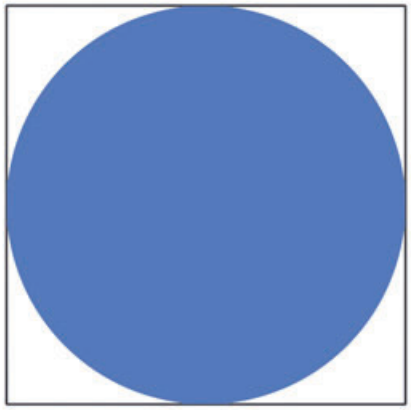
P4 StripBrush



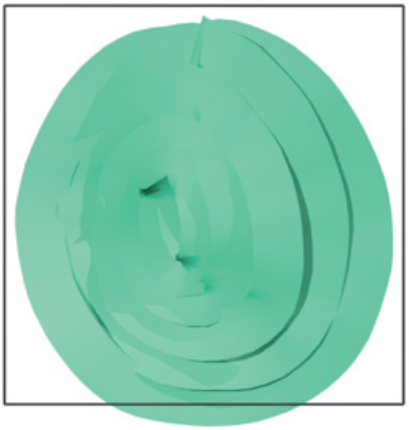
P5 Target Circle

P5 Baseline

P5 StripBrush

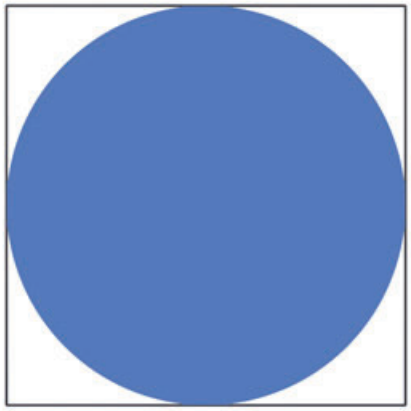


P6 Target Circle



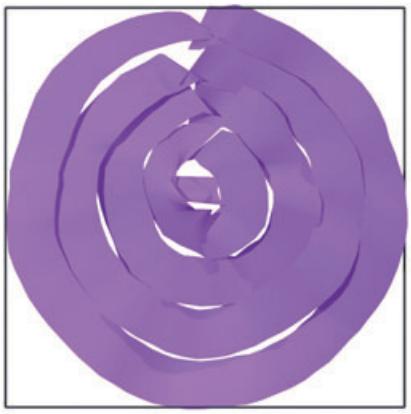
P6 Baseline

P6 StripBrush

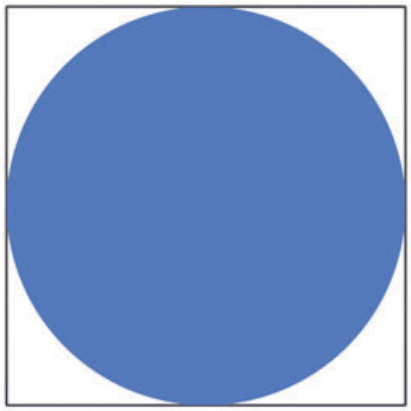


P7 Target Circle

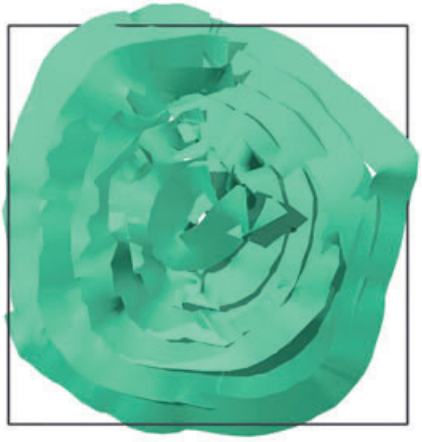
P7 Baseline



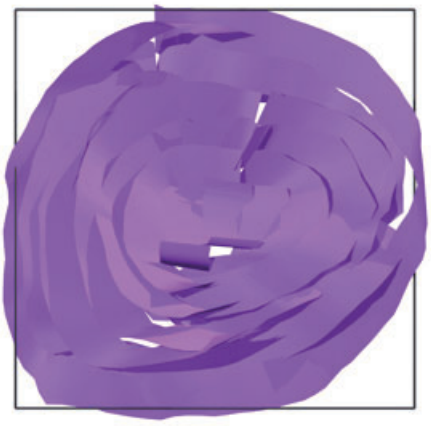
P7 StripBrush



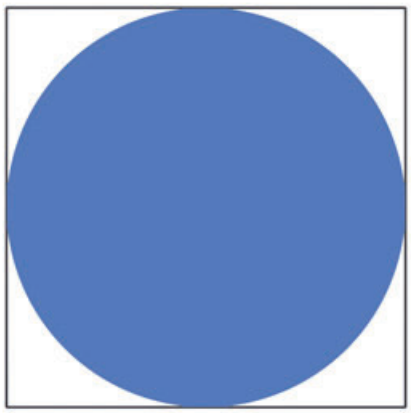
P8 Target Circle



P8 Baseline

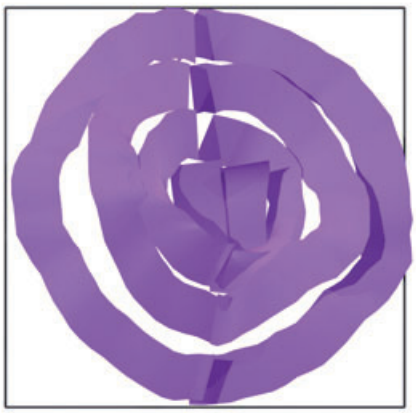


P8 StripBrush

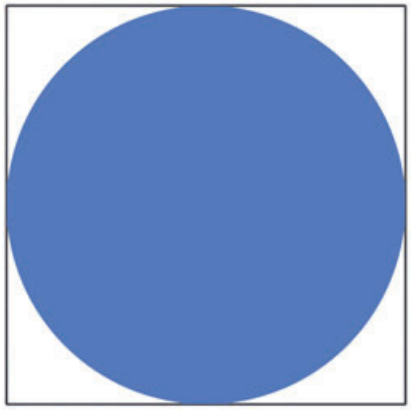


P9 Target Circle

P9 Baseline

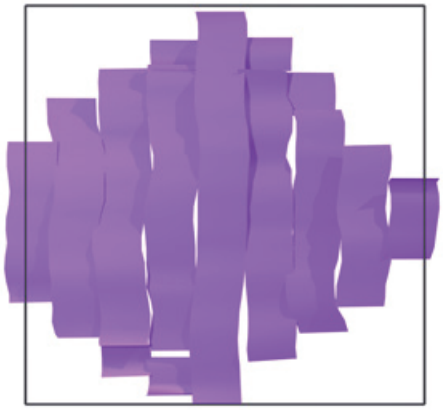


P9 StripBrush

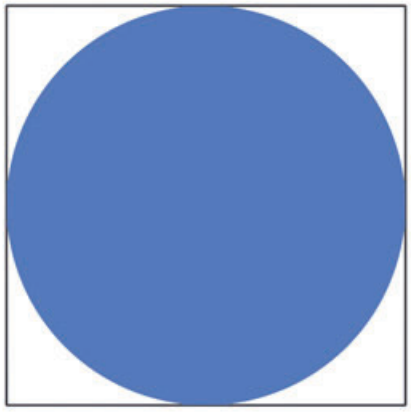


P10 Target Circle

P10 Baseline



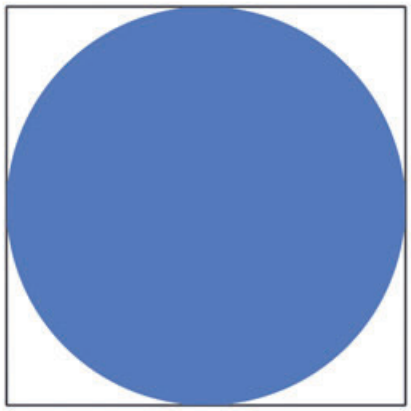
P10 StripBrush



P11 Target Circle

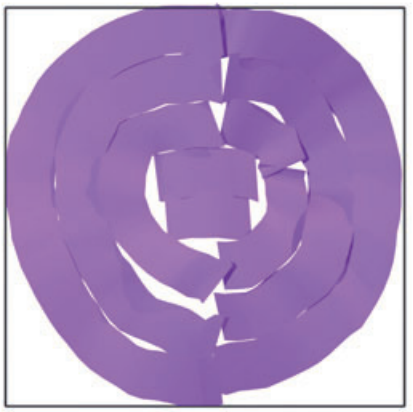
P11 Baseline

P11 StripBrush

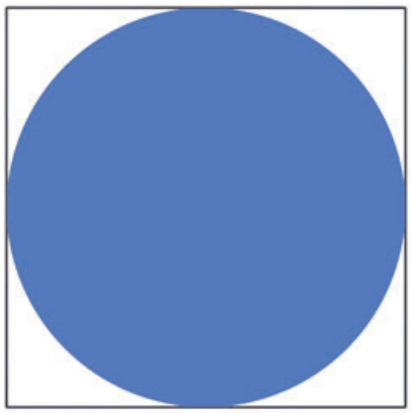


P12 Target Circle

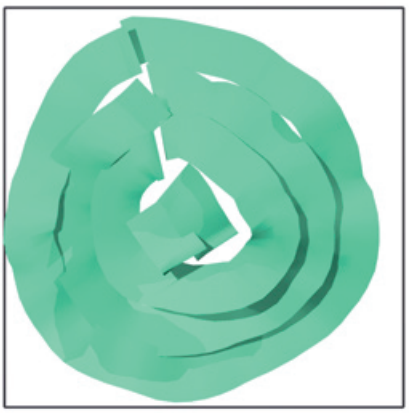
P12 Baseline



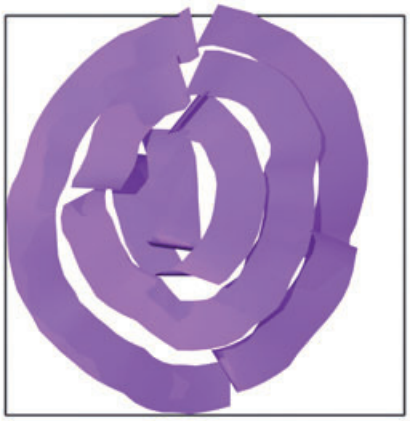
P12 StripBrush



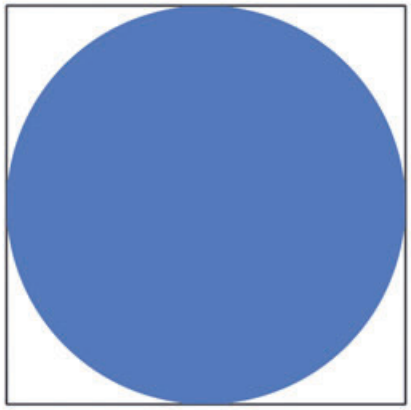
P13 Target Circle



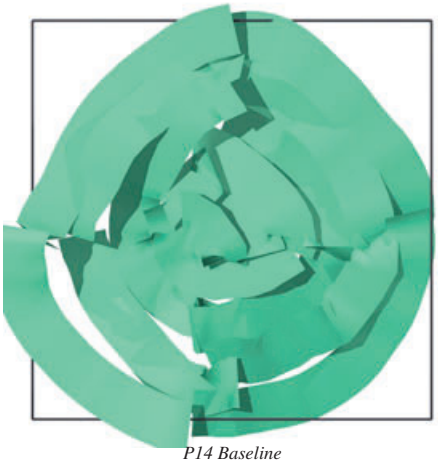
P13 Baseline



P13 StripBrush

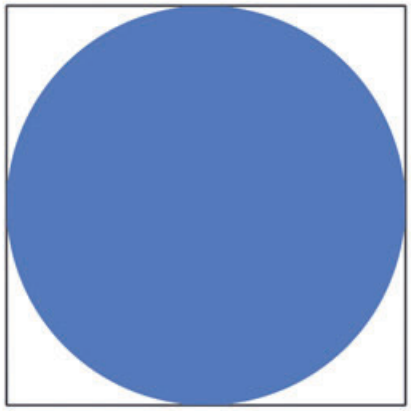


P14 Target Circle

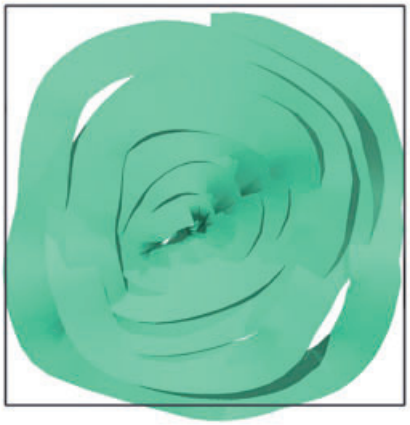


P14 Baseline

P14 StripBrush

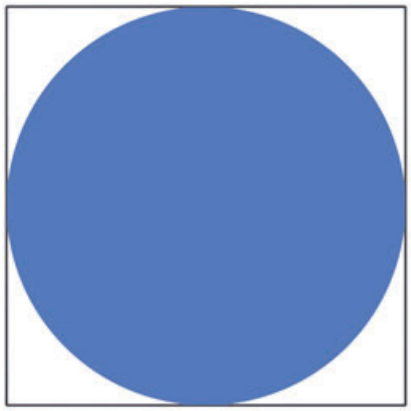


P15 Target Circle



P15 Baseline

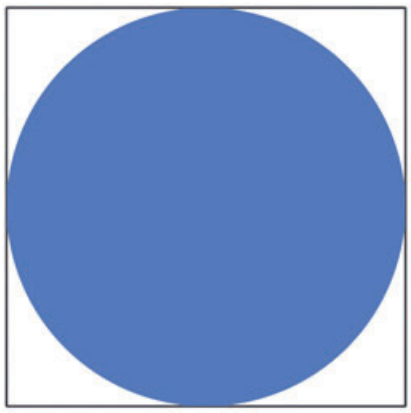
P15 StripBrush



P16 Target Circle

P16 Baseline

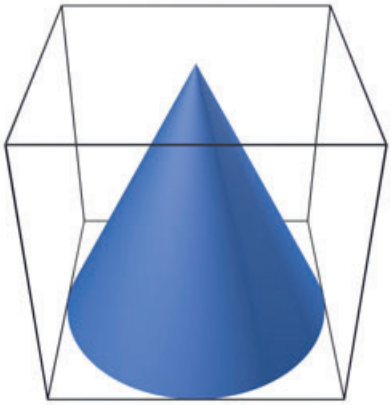
P16 StripBrush



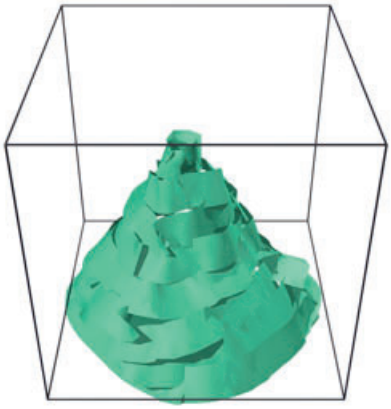
P17 Target Circle

P17 Baseline

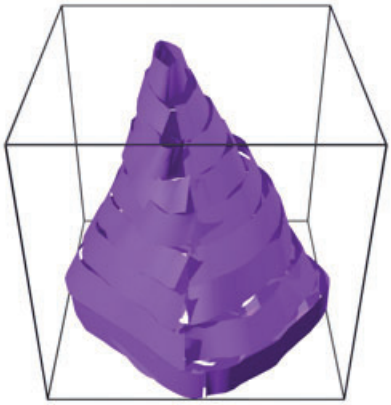
P17 StripBrush



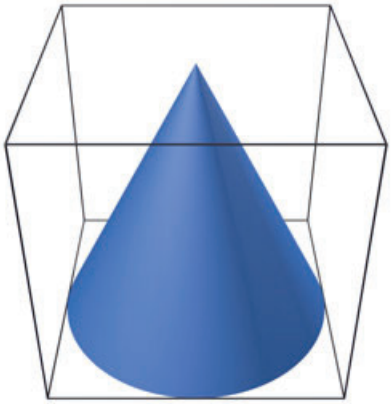
P1 Target Cone



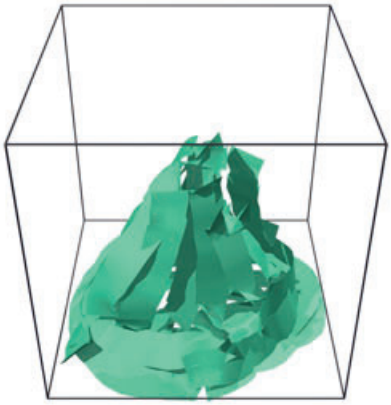
P1 Baseline



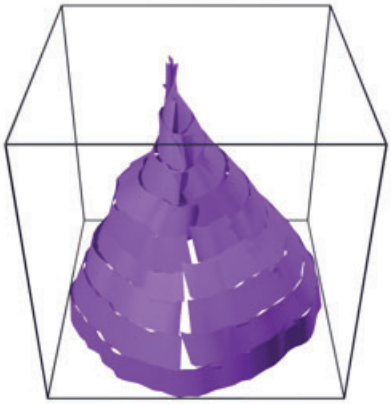
P1 StripBrush



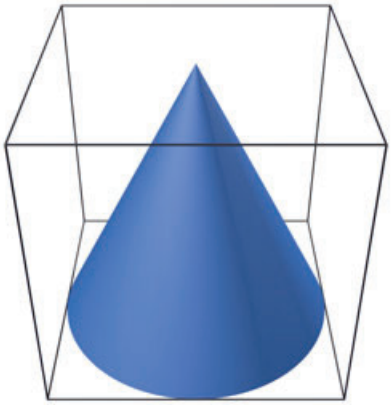
P2 Target Cone



P2 Baseline

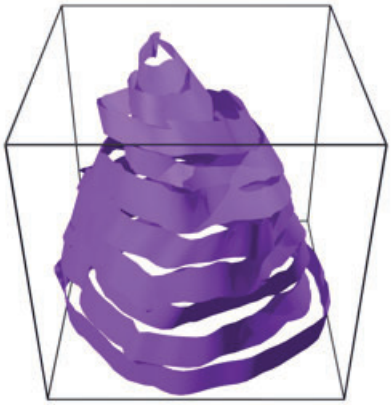


P2 StripBrush

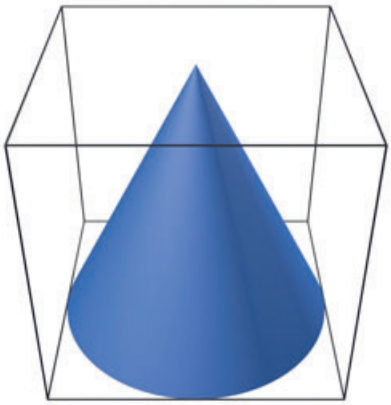


P3 Target Cone

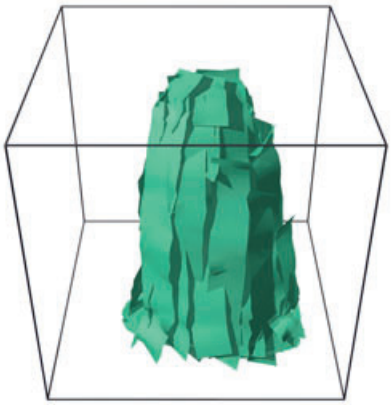
P3 Baseline



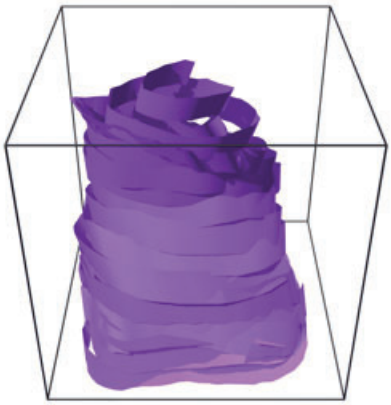
P3 StripBrush



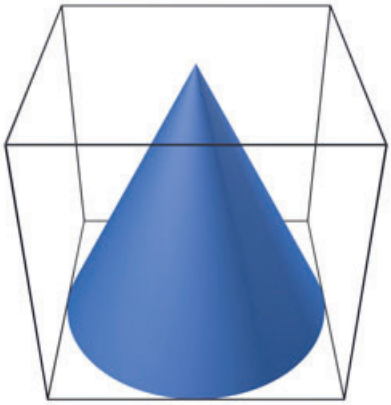
P4 Target Cone



P4 Baseline



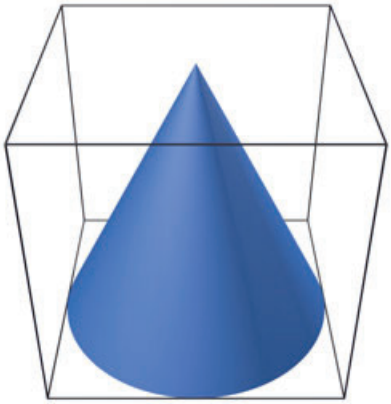
P4 StripBrush



P5 Target Cone

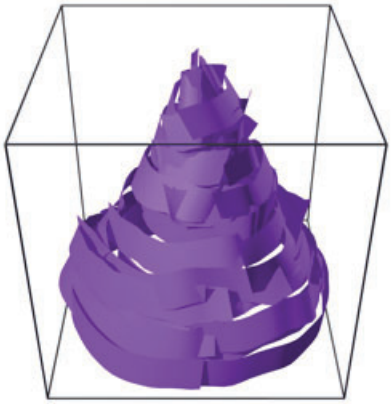
P5 Baseline

P5 StripBrush

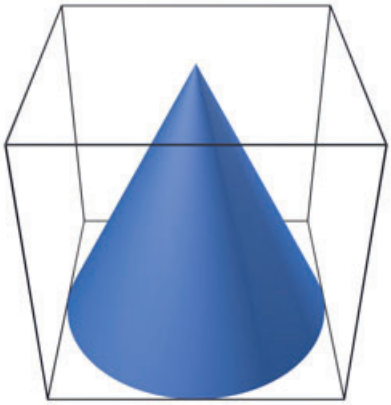


P6 Target Cone

P6 Baseline



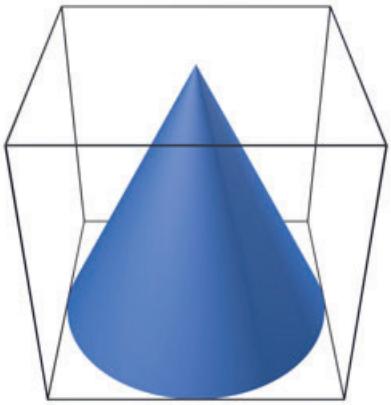
P6 StripBrush



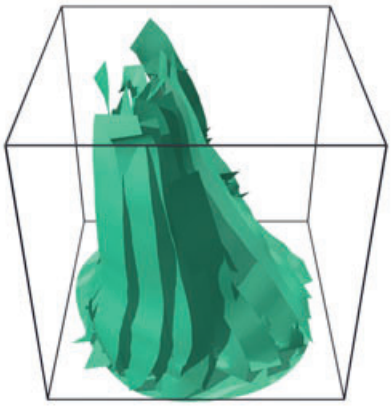
P7 Target Cone

P7 Baseline

P7 StripBrush

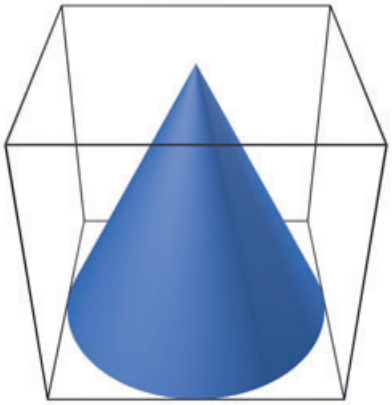


P8 Target Cone



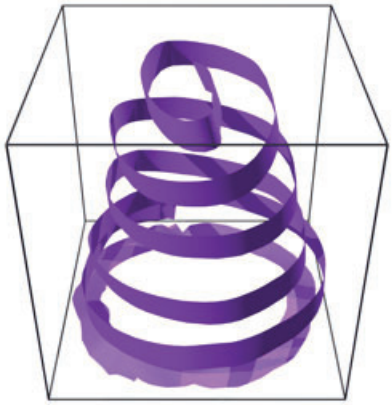
P8 Baseline

P8 StripBrush

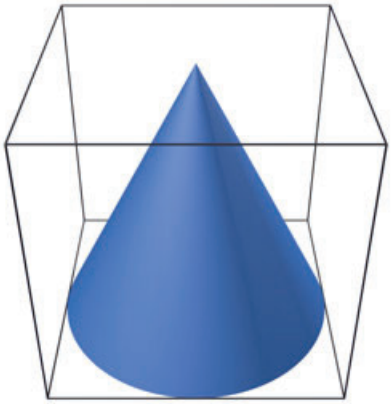


P9 Target Cone

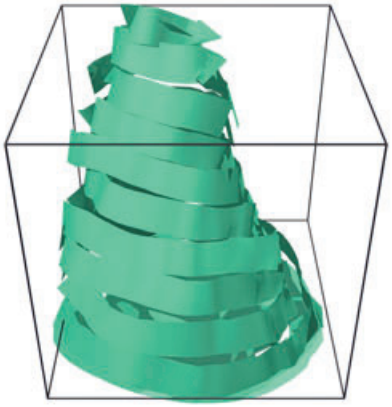
P9 Baseline



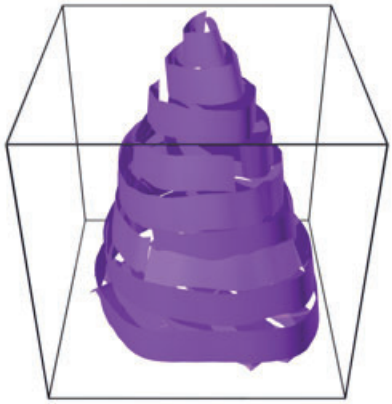
P9 StripBrush



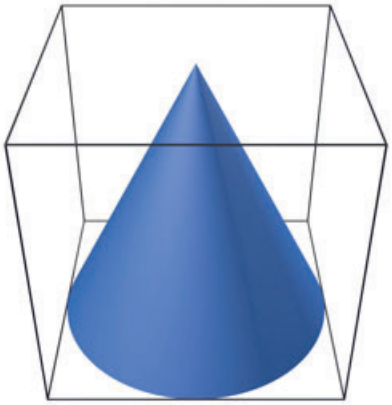
P10 Target Cone



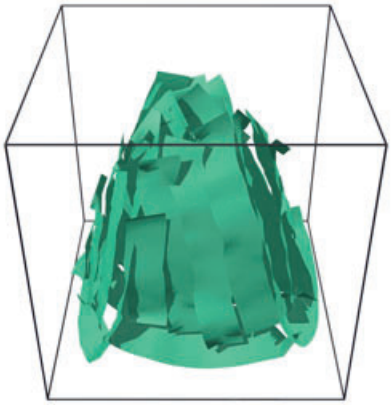
P10 Baseline



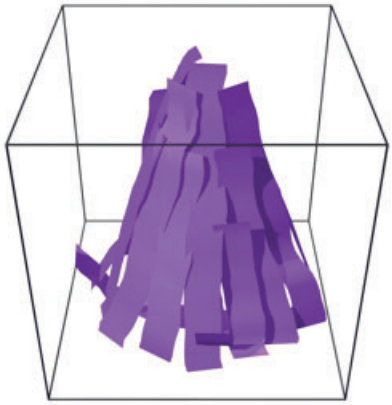
P10 StripBrush



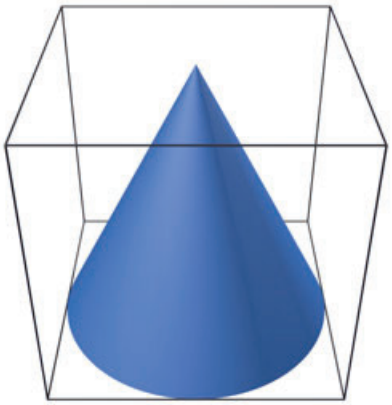
P11 Target Cone



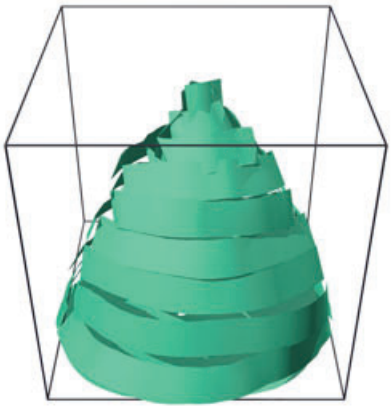
P11 Baseline



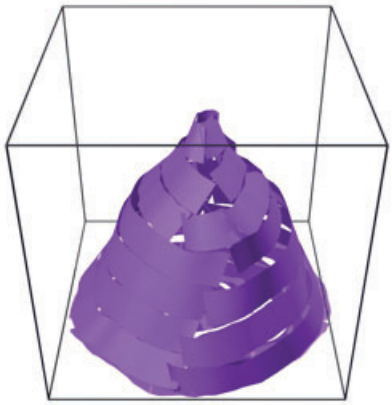
P11 StripBrush



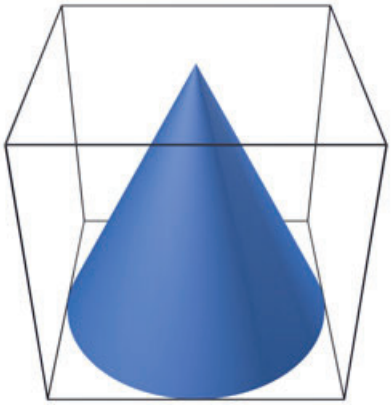
P12 Target Cone



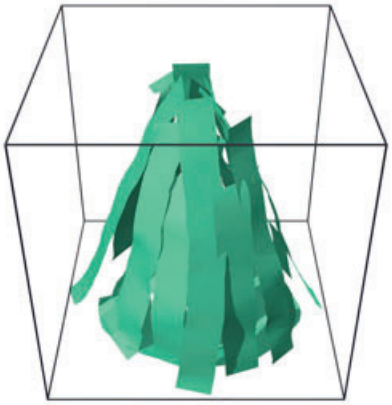
P12 Baseline



P12 StripBrush

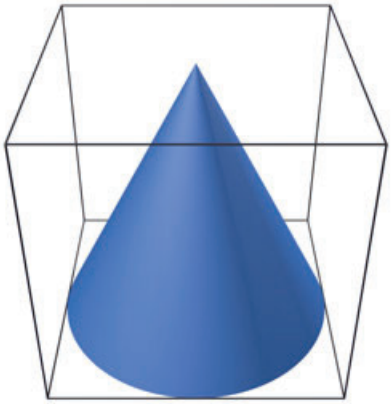


P13 Target Cone

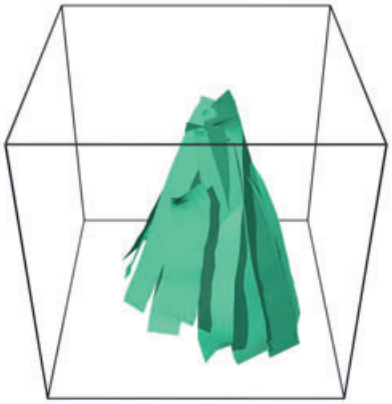


P13 Baseline

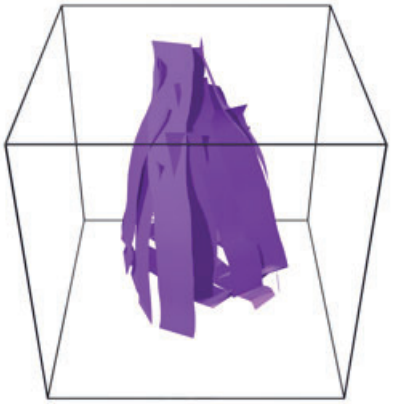
P13 StripBrush



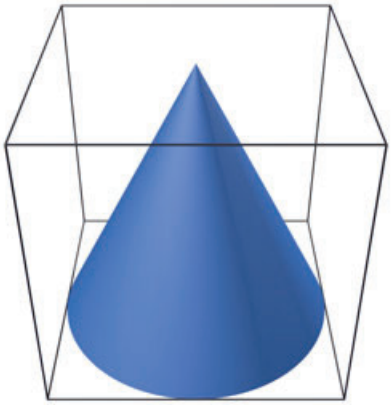
P14 Target Cone



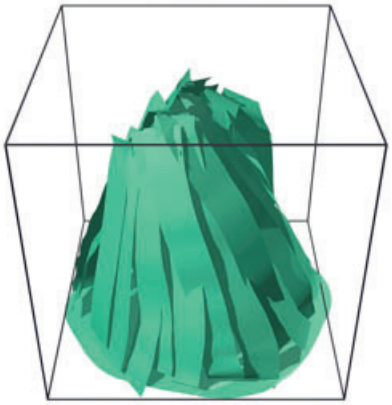
P14 Baseline



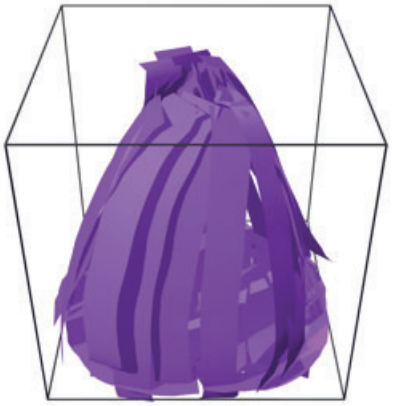
P14 StripBrush



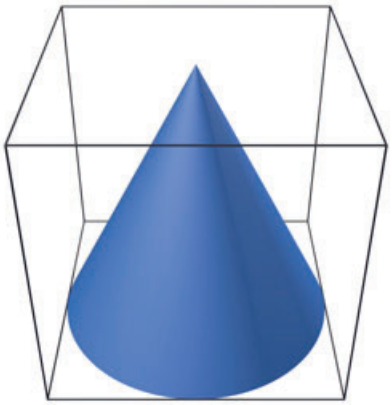
P15 Target Cone



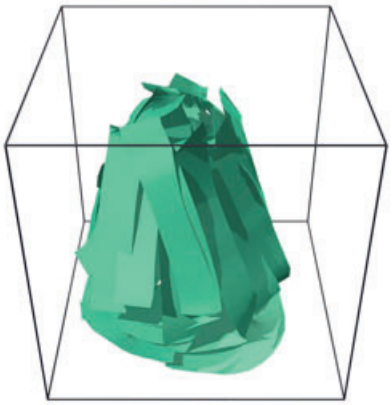
P15 Baseline



P15 StripBrush

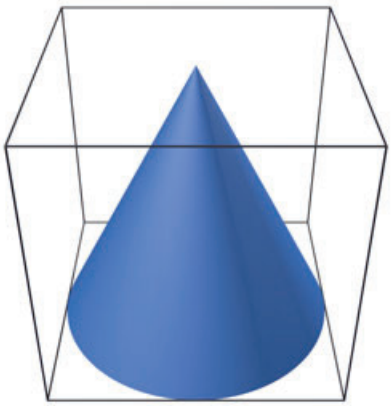


P16 Target Cone

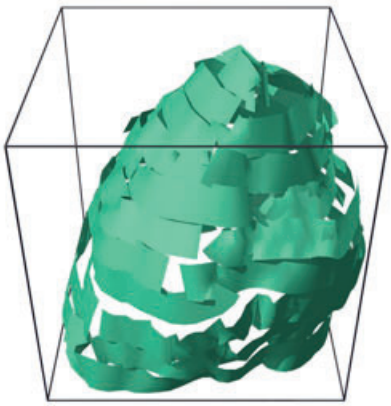


P16 Baseline

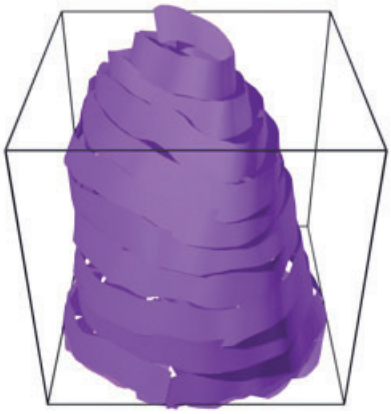
P16 StripBrush



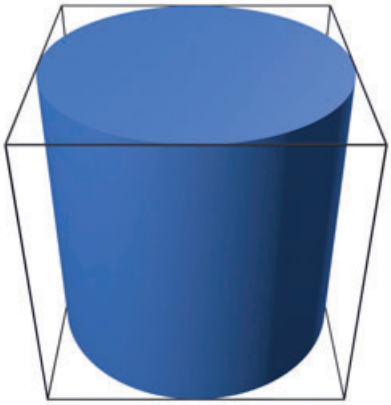
P17 Target Cone



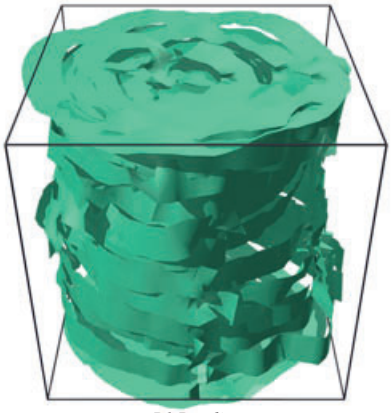
P17 Baseline



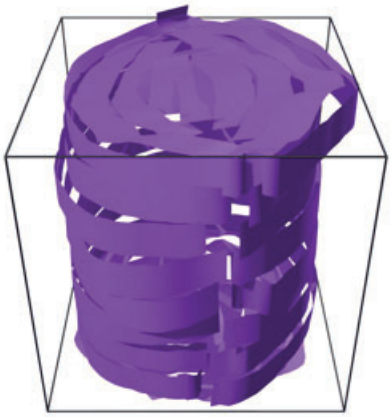
P17 StripBrush



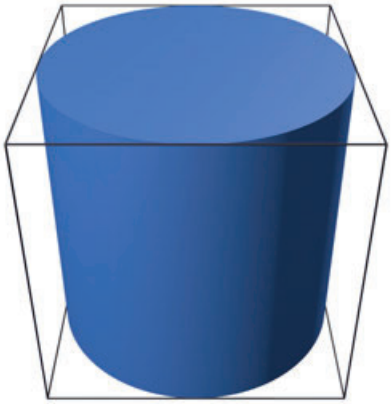
P1 Target Cylinder



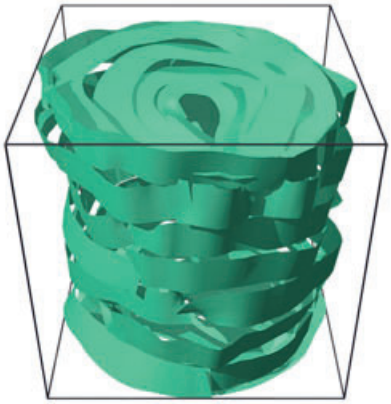
P1 Baseline



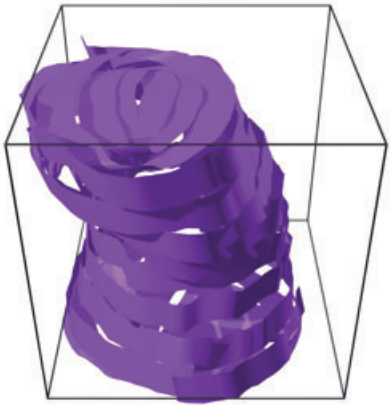
P1 StripBrush



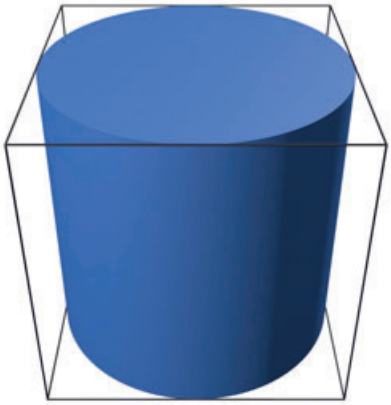
P2 Target Cylinder



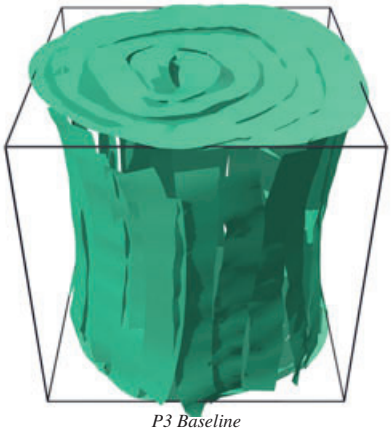
P2 Baseline



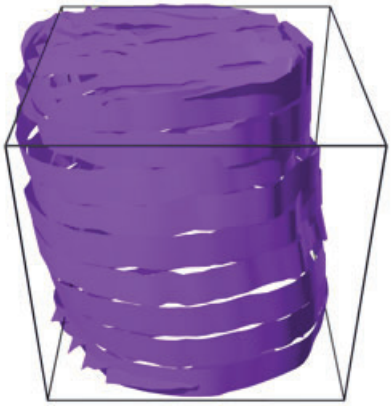
P2 StripBrush



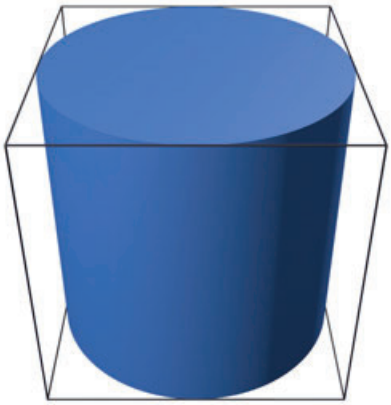
P3 Target Cylinder



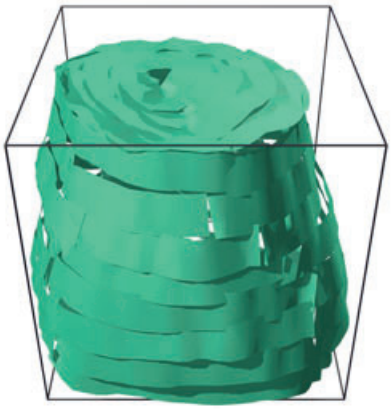
P3 Baseline



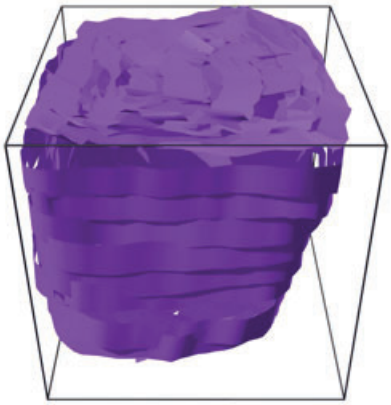
P3 StripBrush



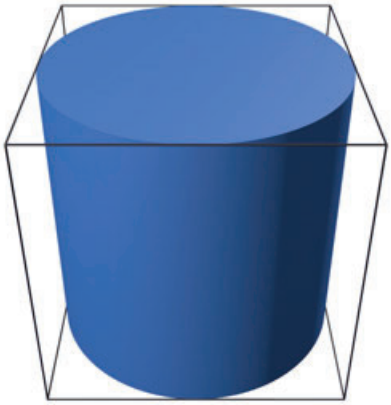
P4 Target Cylinder



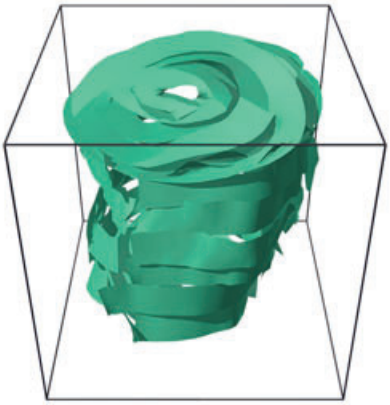
P4 Baseline



P4 StripBrush

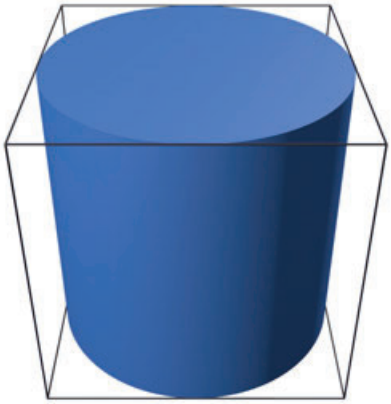


P5 Target Cylinder

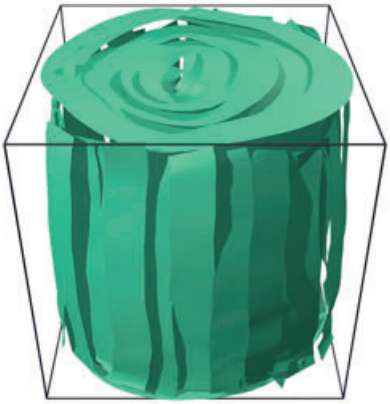


P5 Baseline

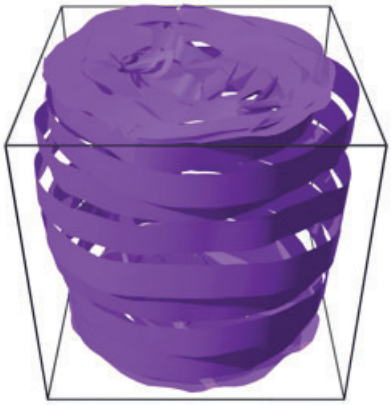
P5 StripBrush



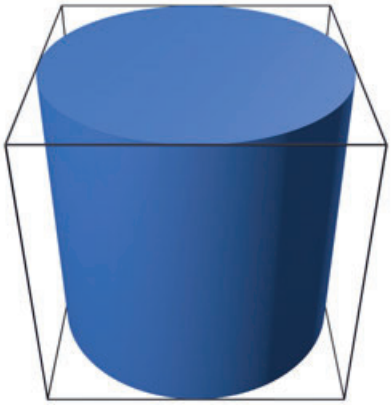
P6 Target Cylinder



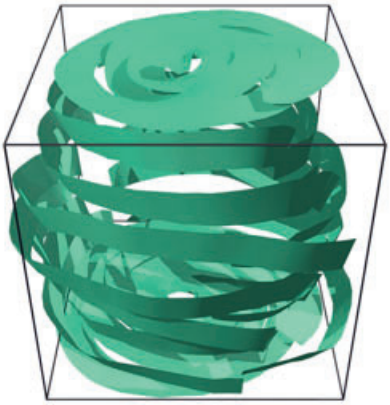
P6 Baseline



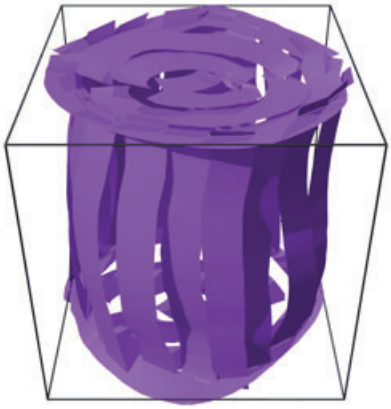
P6 StripBrush



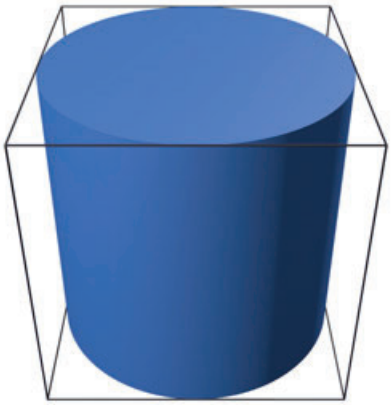
P7 Target Cylinder



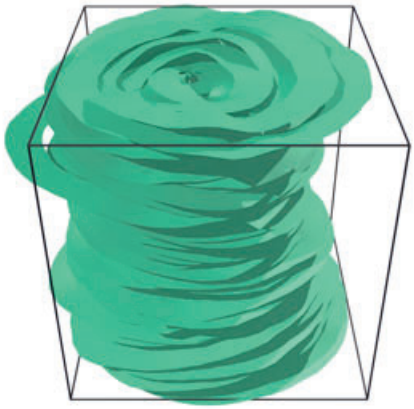
P7 Baseline



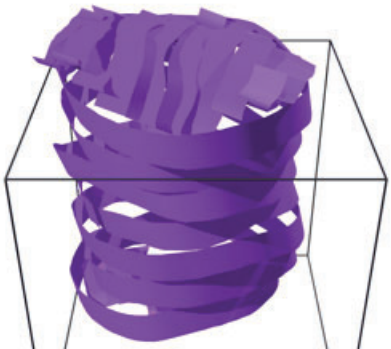
P7 StripBrush



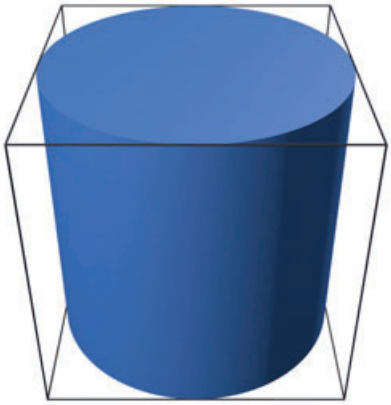
P8 Target Cylinder



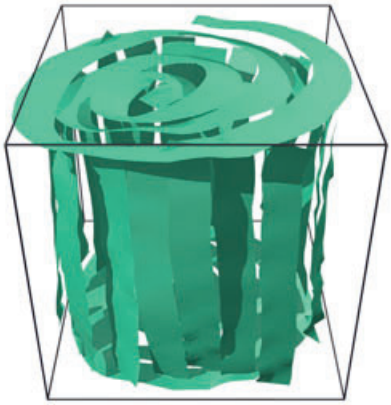
P8 Baseline



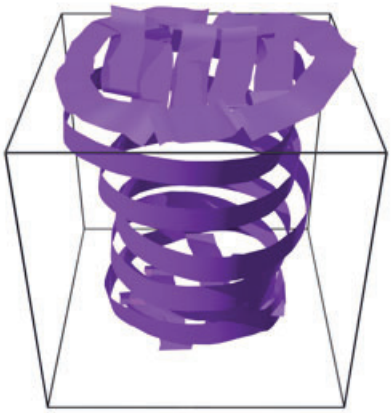
P8 StripBrush



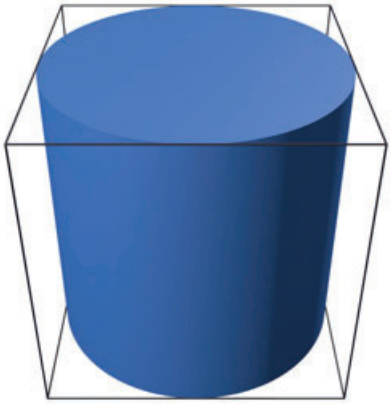
P9 Target Cylinder



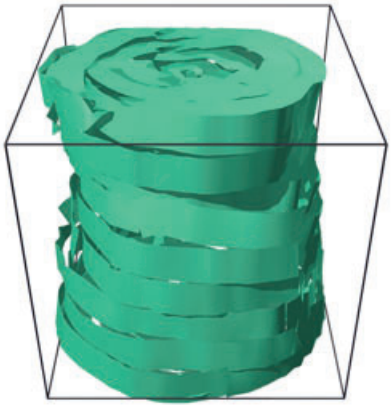
P9 Baseline



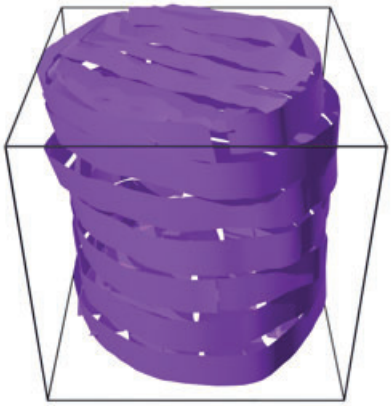
P9 StripBrush



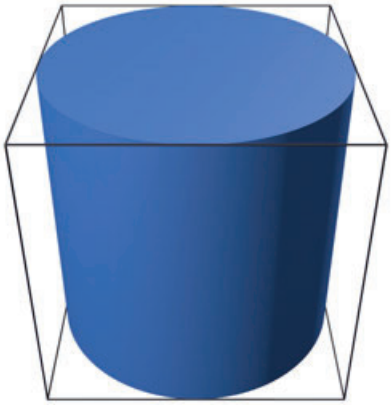
P10 Target Cylinder



P10 Baseline

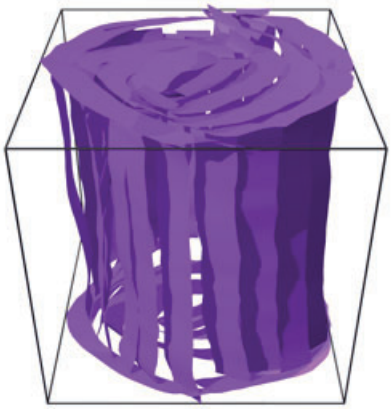


P10 StripBrush

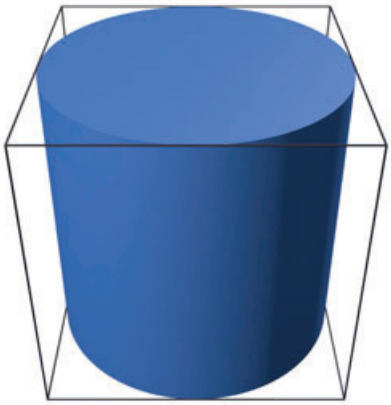


P11 Target Cylinder

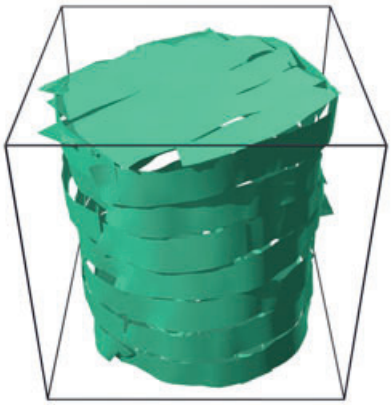
P11 Baseline



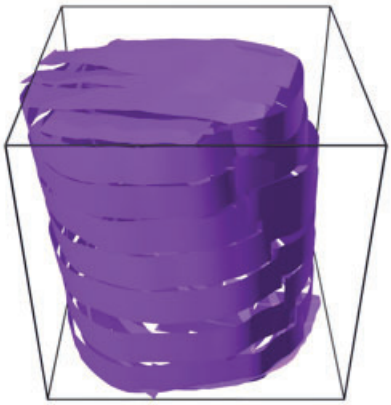
P11 StripBrush



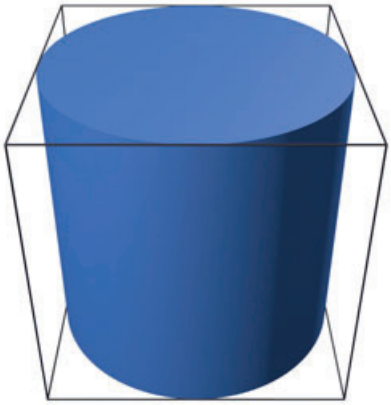
P12 Target Cylinder



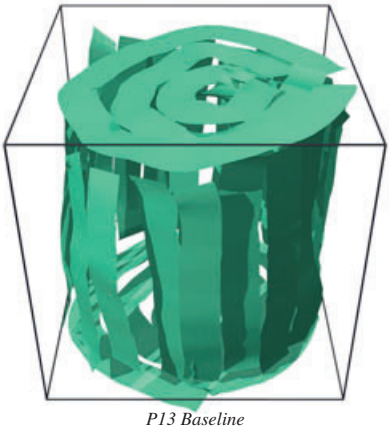
P12 Baseline



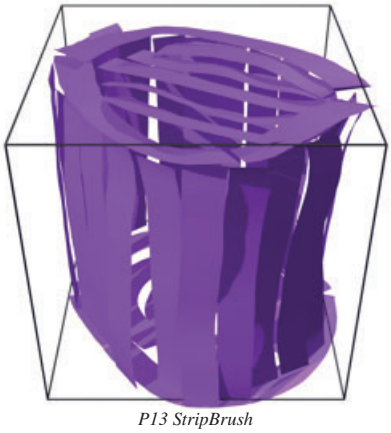
P12 StripBrush



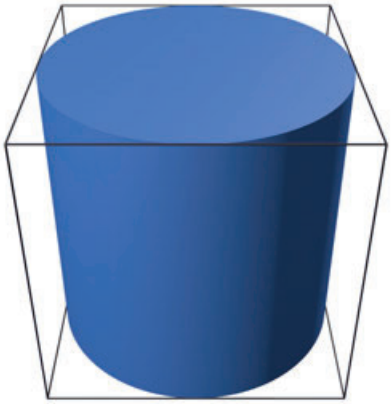
P13 Target Cylinder



P13 Baseline

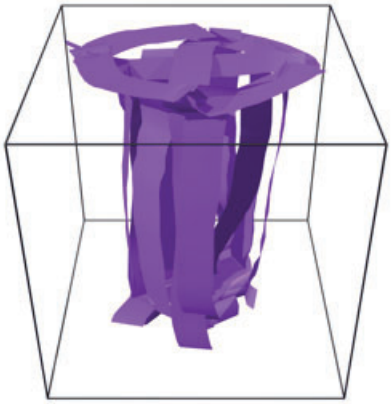


P13 StripBrush

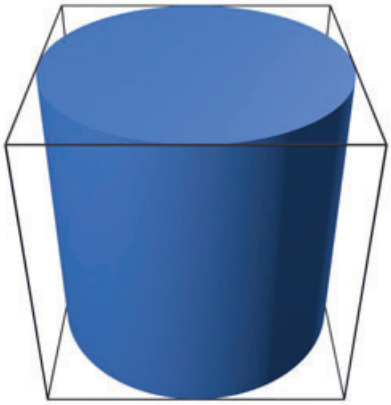


P14 Target Cylinder

P14 Baseline

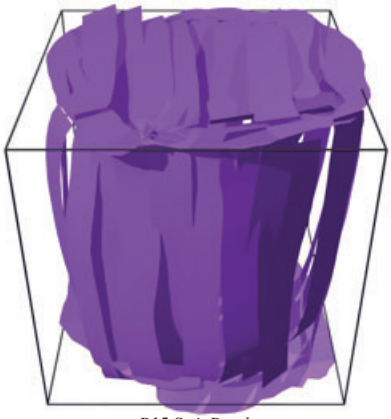


P14 StripBrush

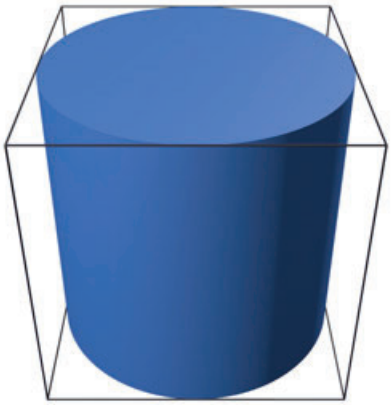


P15 Target Cylinder

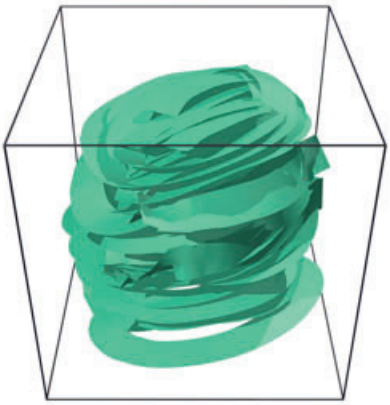
P15 Baseline



P15 StripBrush

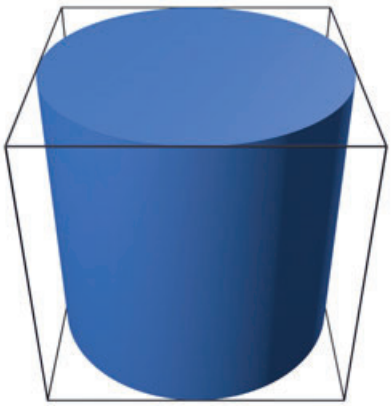


P16 Target Cylinder

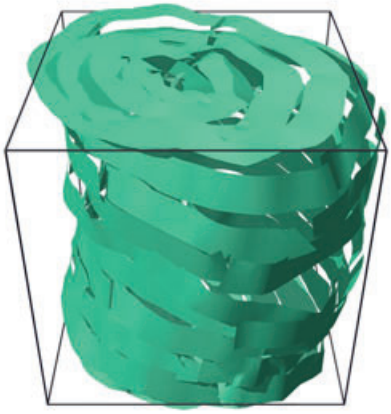


P16 Baseline

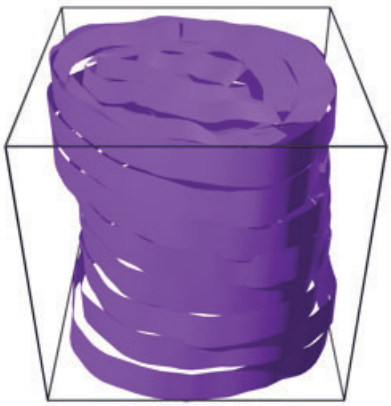
P16 StripBrush



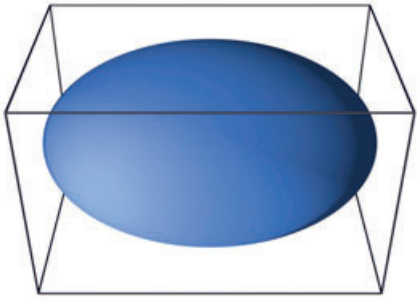
P17 Target Cylinder



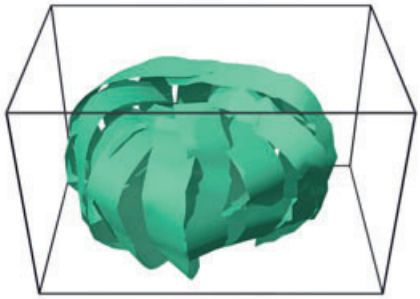
P17 Baseline



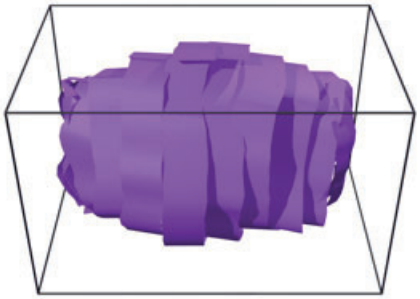
P17 StripBrush



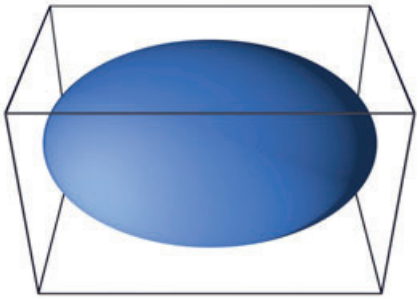
P1 Target Ellipsoid



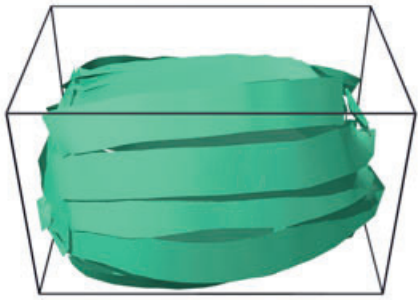
P1 Baseline



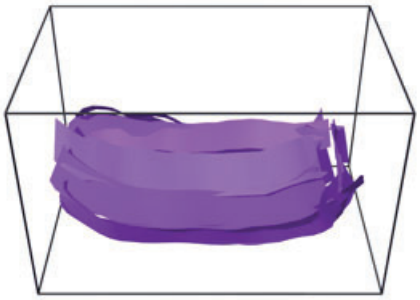
P1 StripBrush



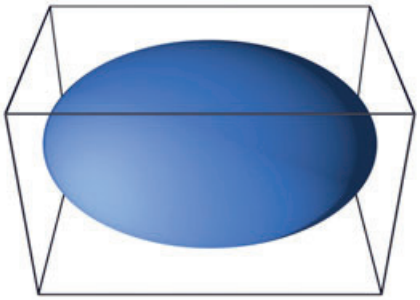
P2 Target Ellipsoid



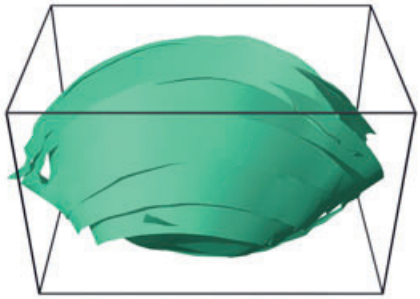
P2 Baseline



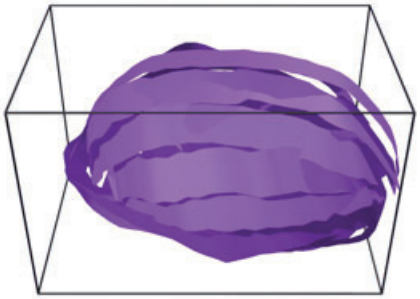
P2 StripBrush



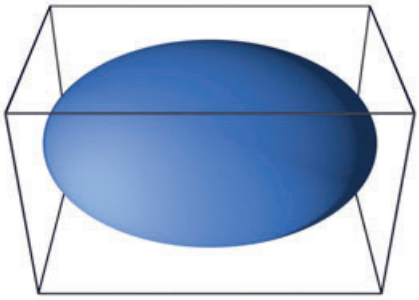
P3 Target Ellipsoid



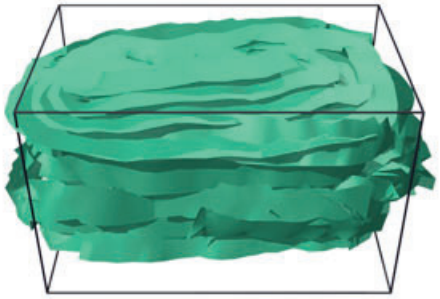
P3 Baseline



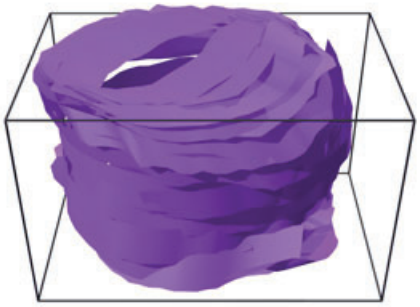
P3 StripBrush



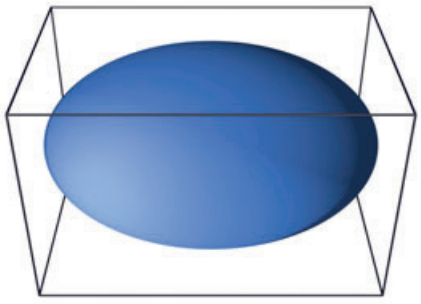
P4 Target Ellipsoid



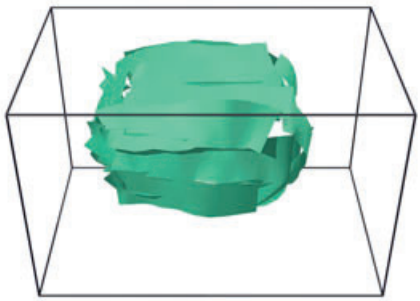
P4 Baseline



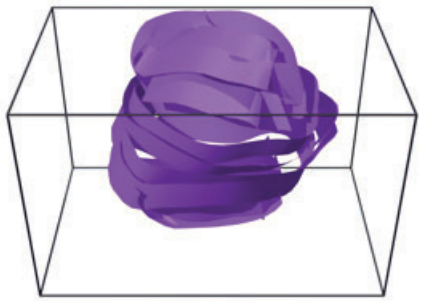
P4 StripBrush



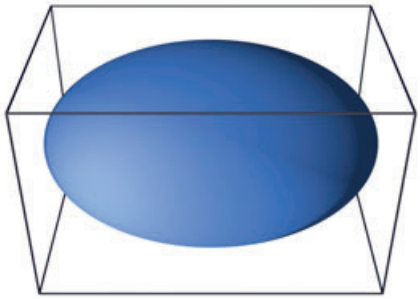
P5 Target Ellipsoid



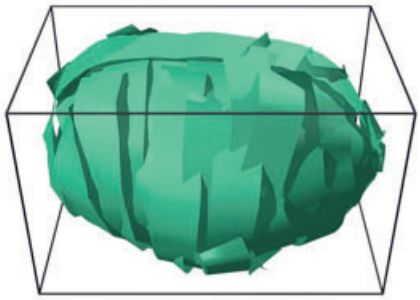
P5 Baseline



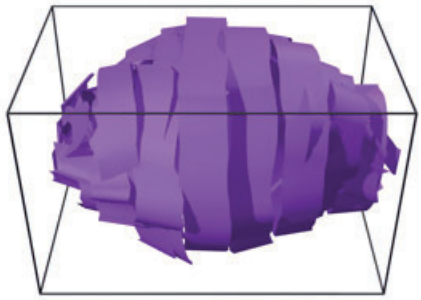
P5 StripBrush



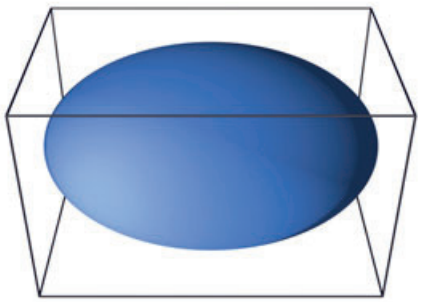
P6 Target Ellipsoid



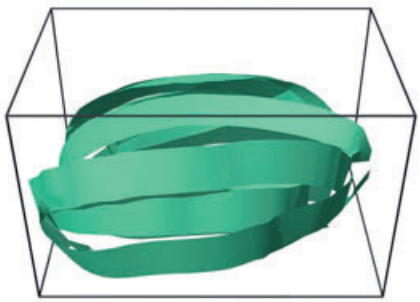
P6 Baseline



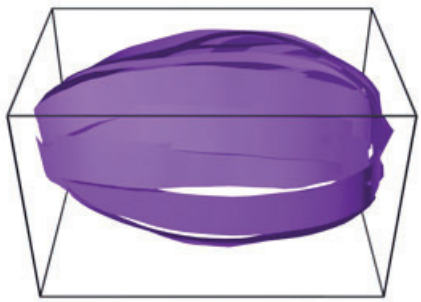
P6 StripBrush



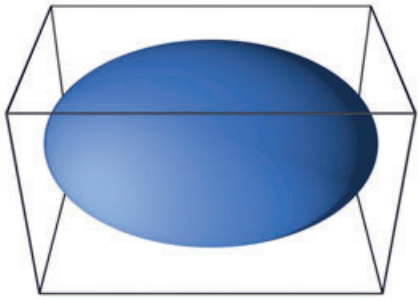
P7 Target Ellipsoid



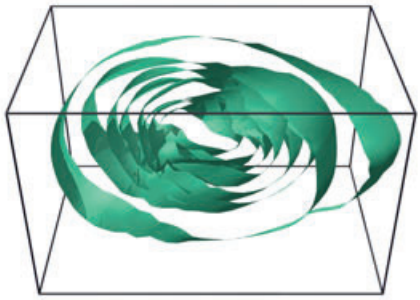
P7 Baseline



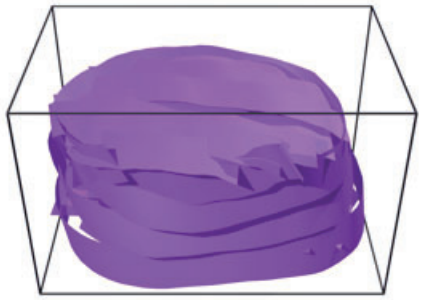
P7 StripBrush



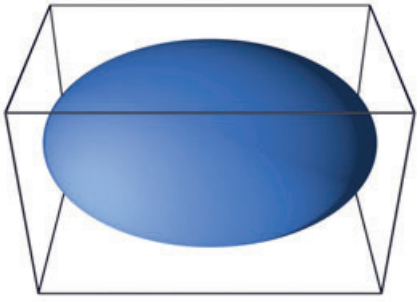
P8 Target Ellipsoid



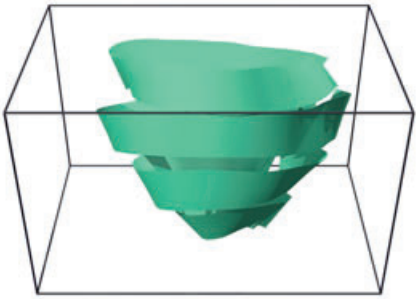
P8 Baseline



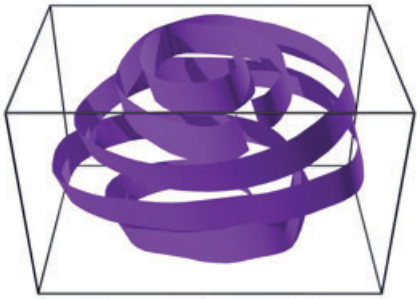
P8 StripBrush



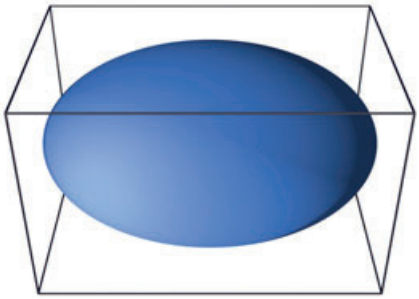
P9 Target Ellipsoid



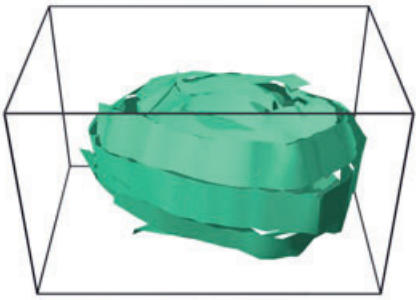
P9 Baseline



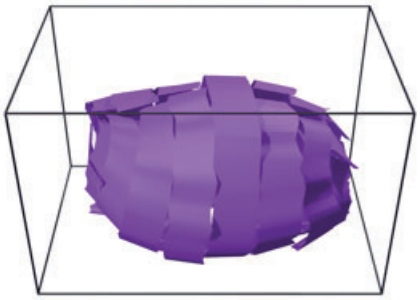
P9 StripBrush



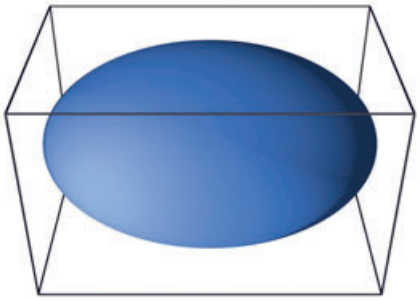
P10 Target Ellipsoid



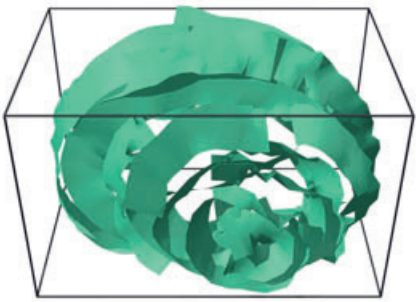
P10 Baseline



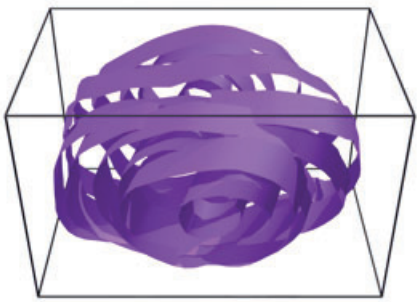
P10 StripBrush



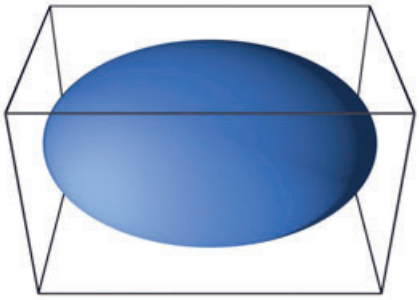
P11 Target Ellipsoid



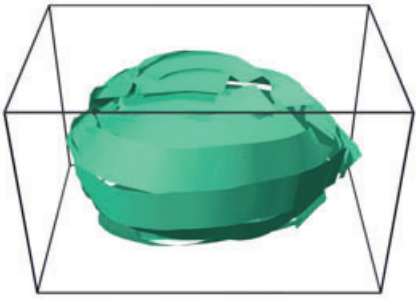
P11 Baseline



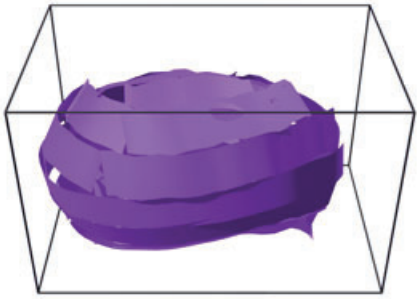
P11 StripBrush



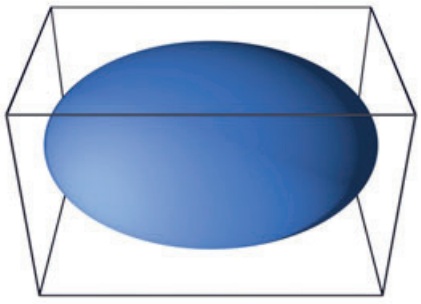
P12 Target Ellipsoid



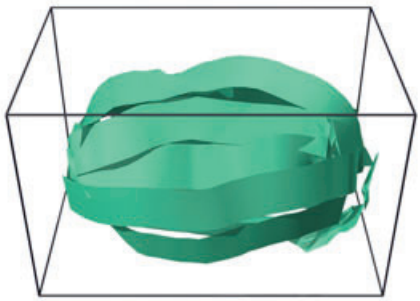
P12 Baseline



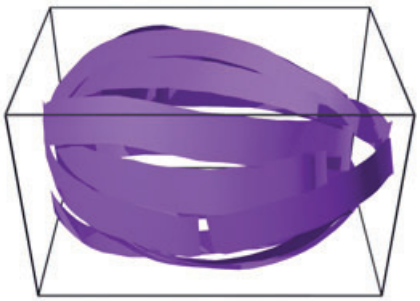
P12 StripBrush



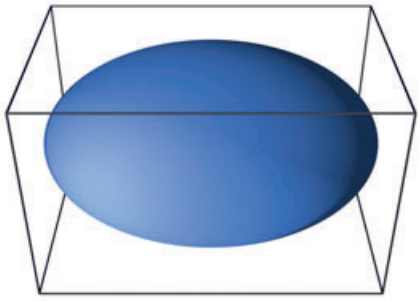
P13 Target Ellipsoid



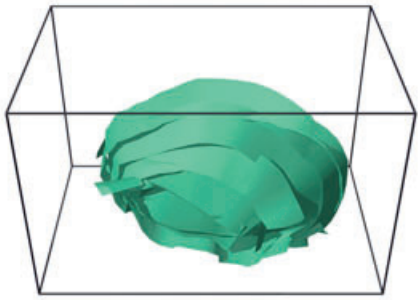
P13 Baseline



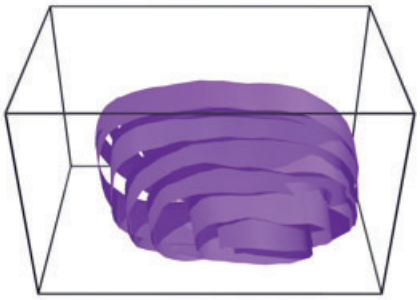
P13 StripBrush



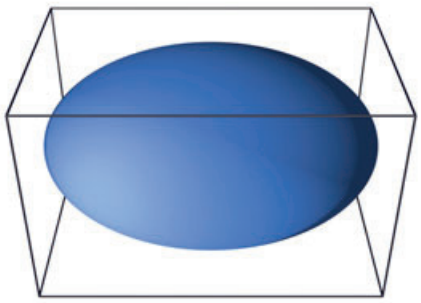
P14 Target Ellipsoid



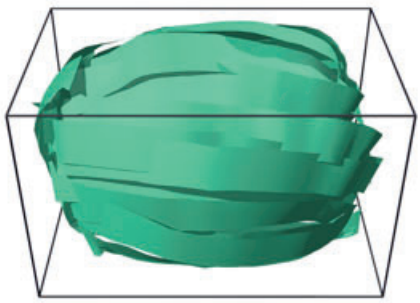
P14 Baseline



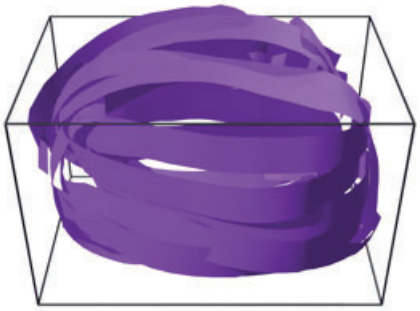
P14 StripBrush



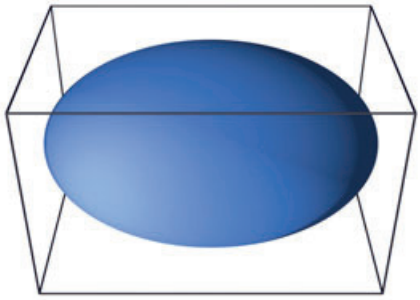
P15 Target Ellipsoid



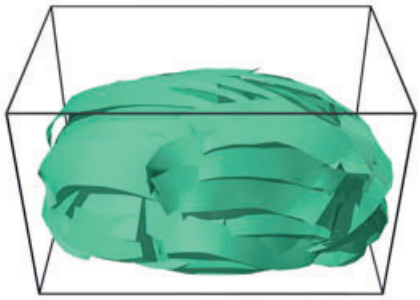
P15 Baseline



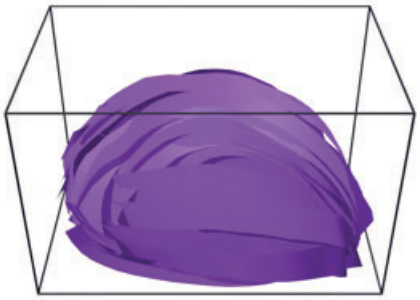
P15 StripBrush



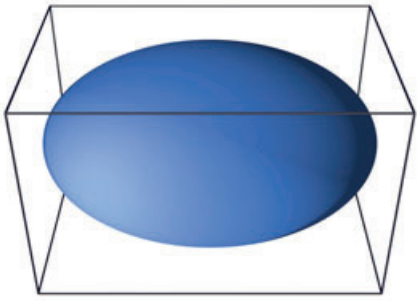
P16 Target Ellipsoid



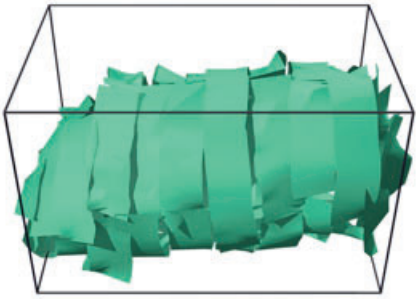
P16 Baseline



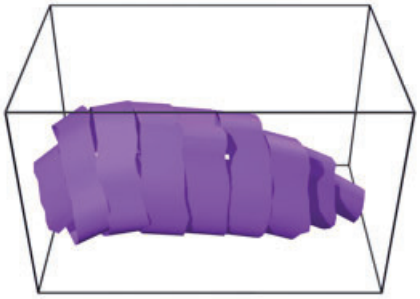
P16 StripBrush



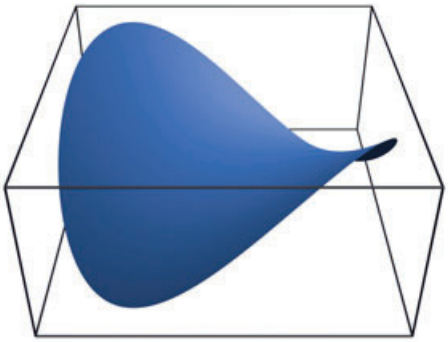
P17 Target Ellipsoid



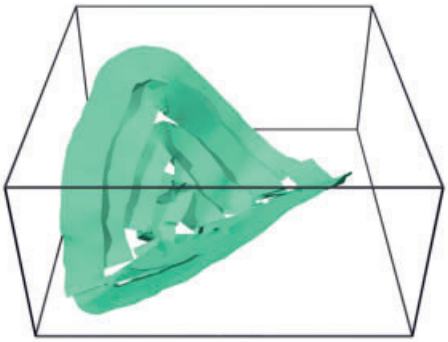
P17 Baseline



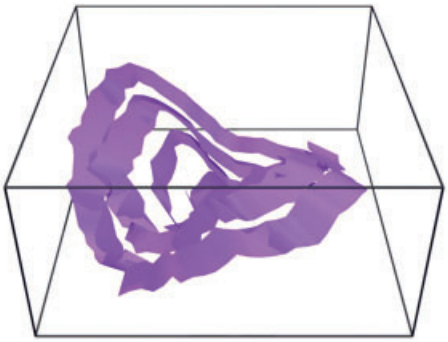
P17 StripBrush



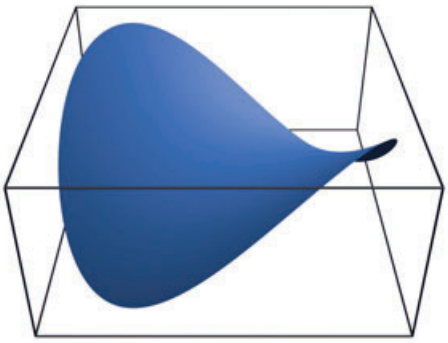
P1 Target Saddle



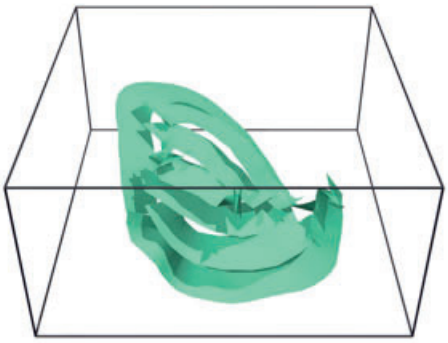
P1 Baseline



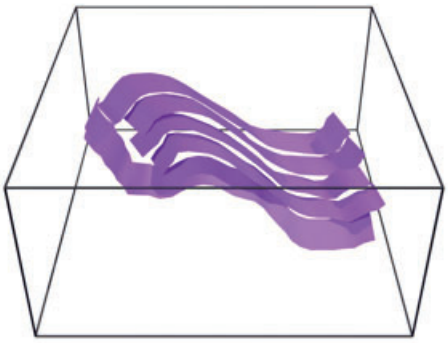
P1 StripBrush



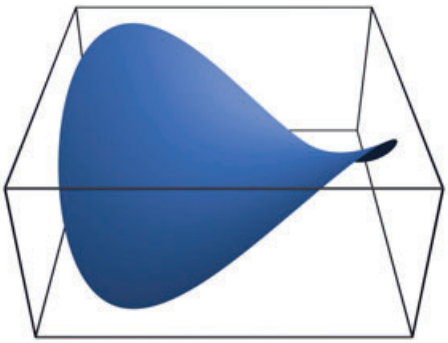
P2 Target Saddle



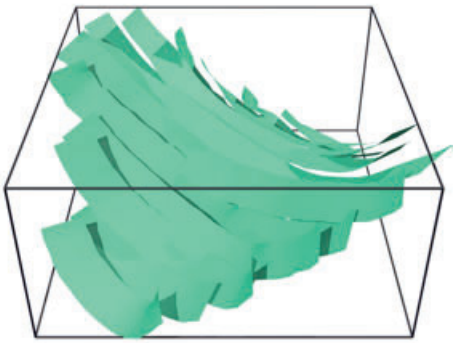
P2 Baseline



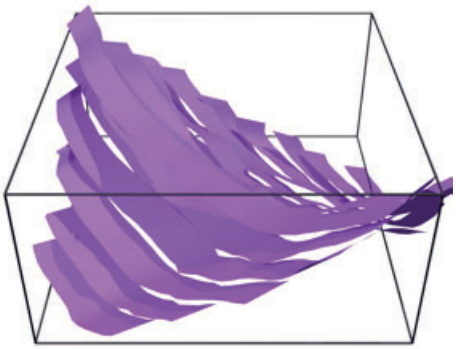
P2 StripBrush



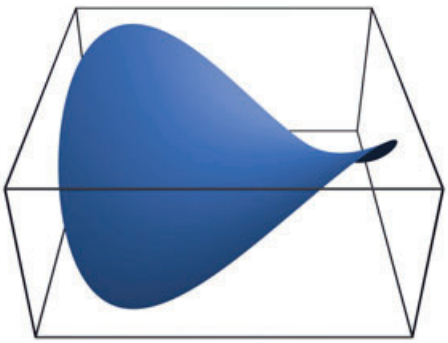
P3 Target Saddle



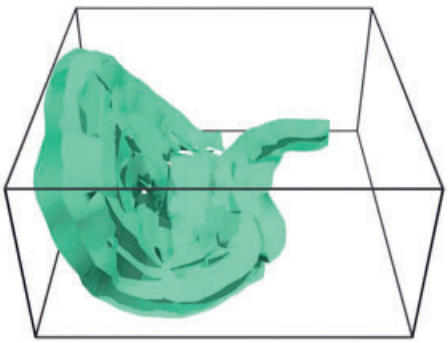
P3 Baseline



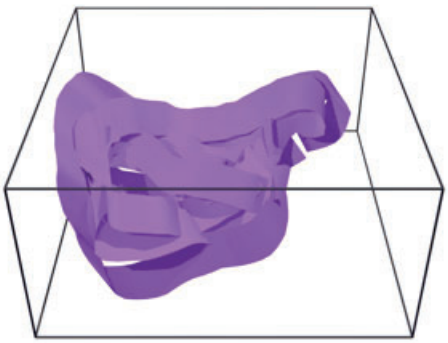
P3 StripBrush



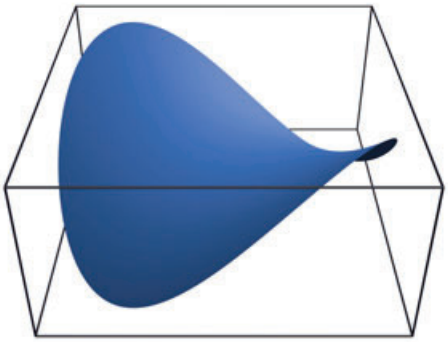
P4 Target Saddle



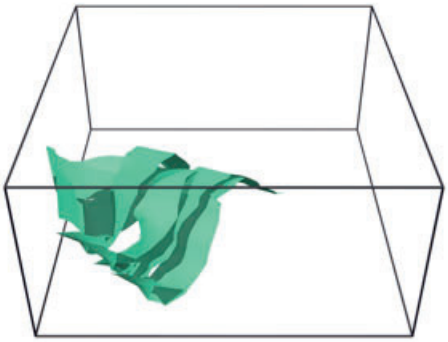
P4 Baseline



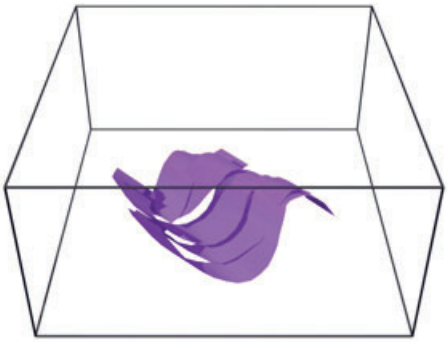
P4 StripBrush



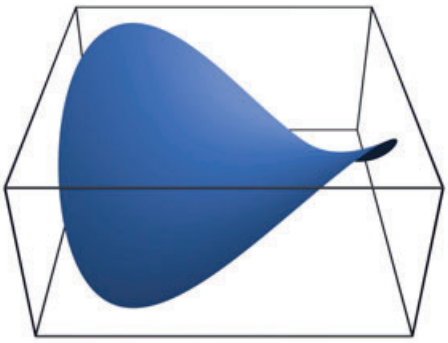
P5 Target Saddle



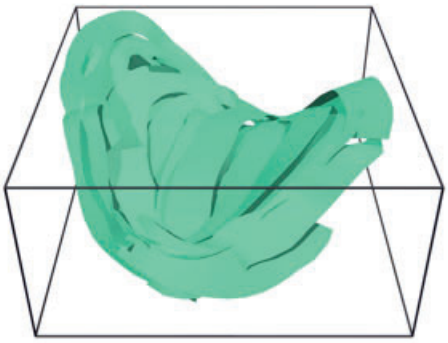
P5 Baseline



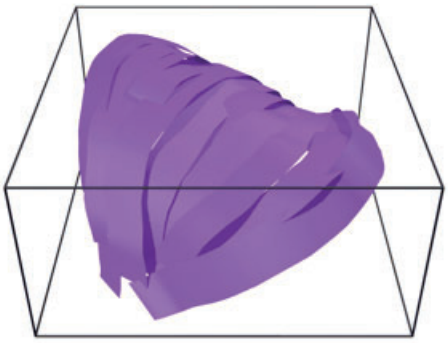
P5 StripBrush



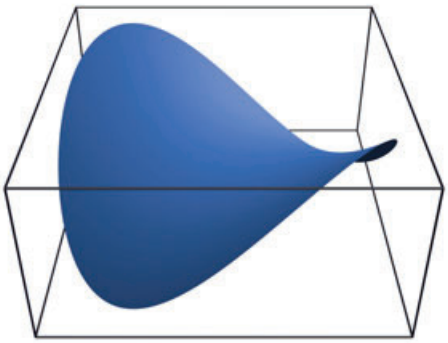
P6 Target Saddle



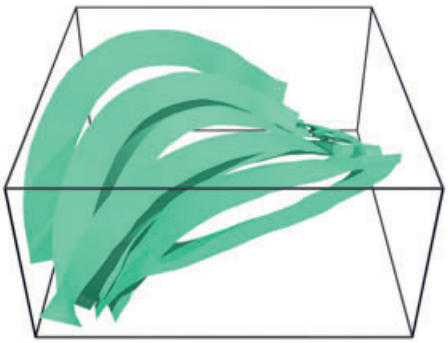
P6 Baseline



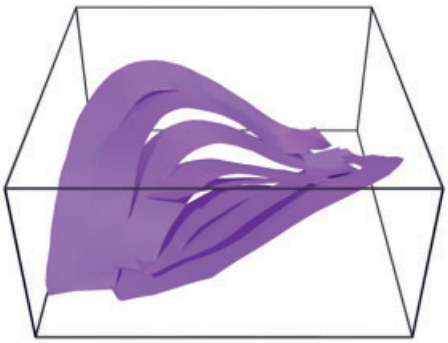
P6 StripBrush



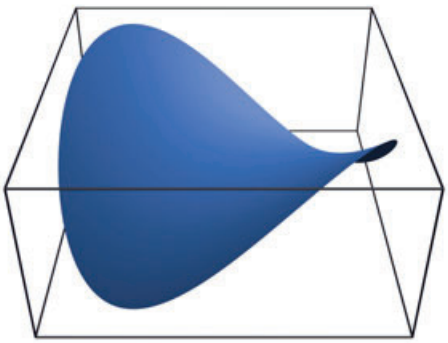
P7 Target Saddle



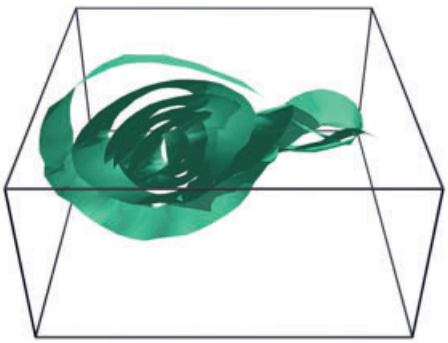
P7 Baseline



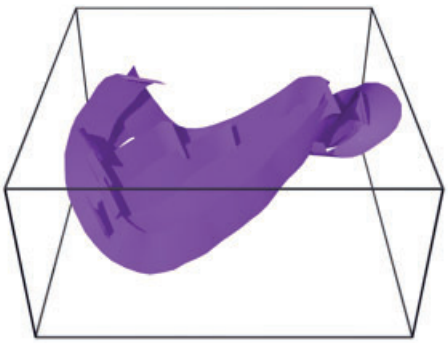
P7 StripBrush



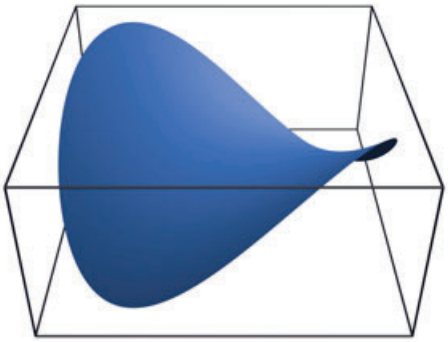
P8 Target Saddle



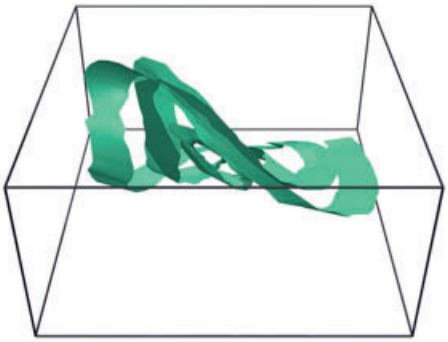
P8 Baseline



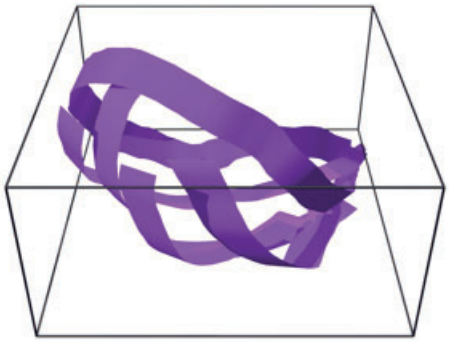
P8 StripBrush



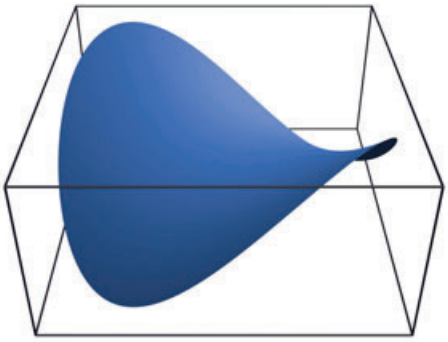
P9 Target Saddle



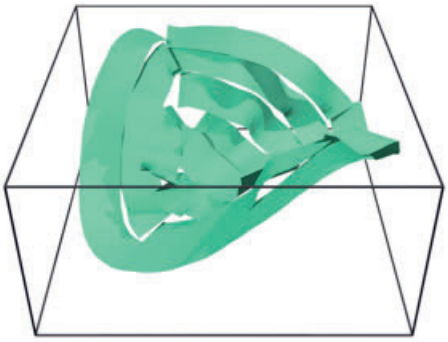
P9 Baseline



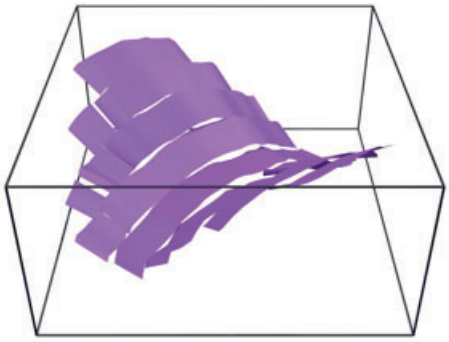
P9 StripBrush



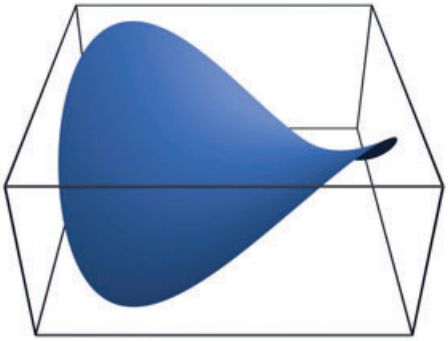
P10 Target Saddle



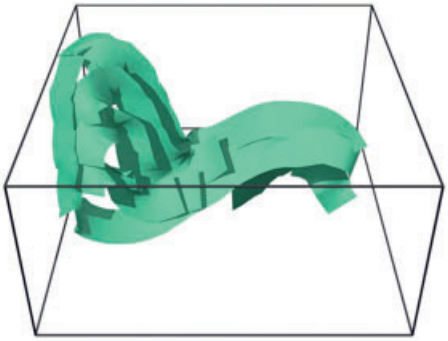
P10 Baseline



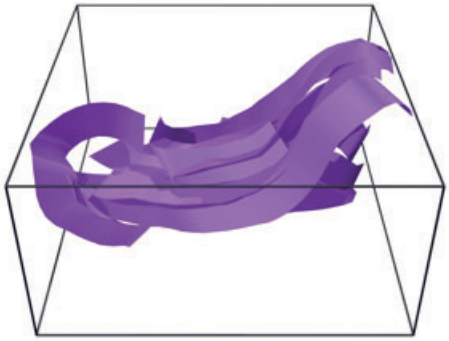
P10 StripBrush



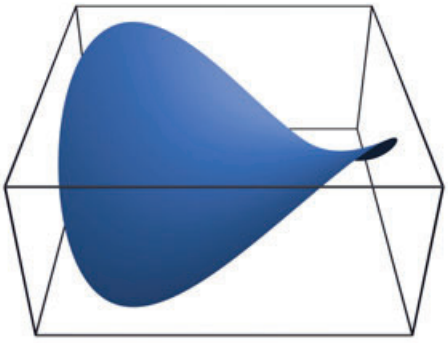
P11 Target Saddle



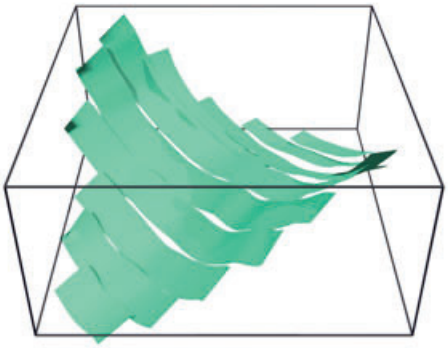
P11 Baseline



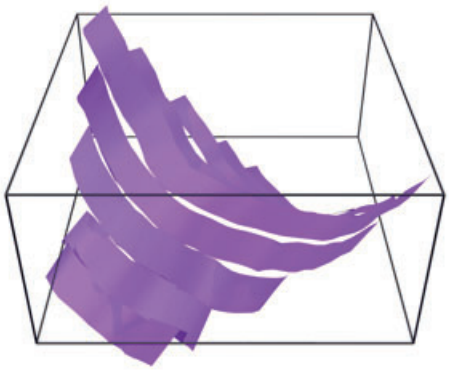
P11 StripBrush



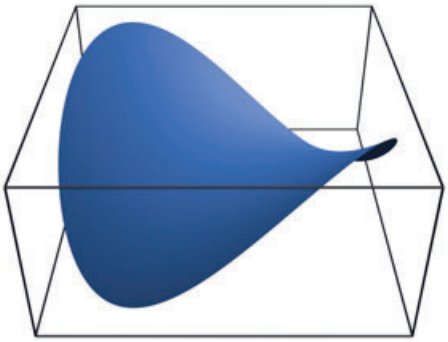
P12 Target Saddle



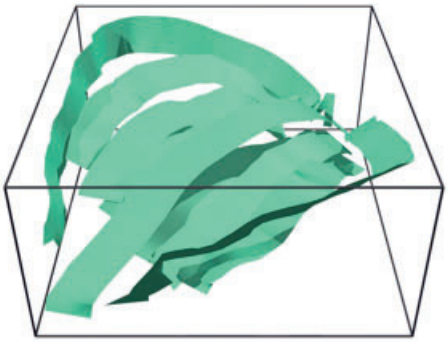
P12 Baseline



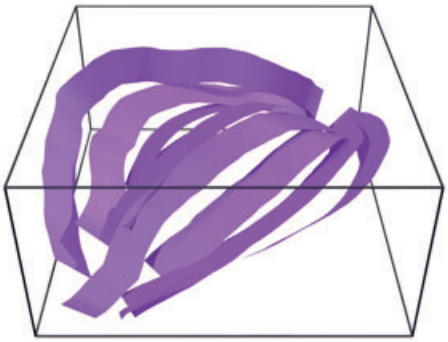
P12 StripBrush



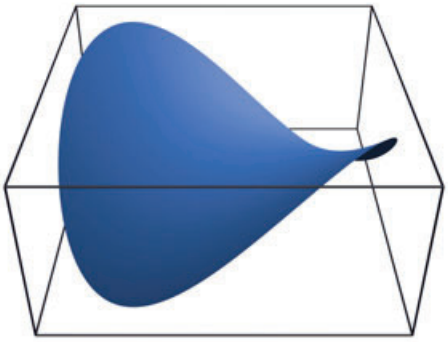
P13 Target Saddle



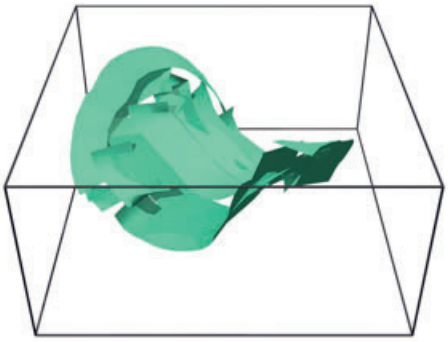
P13 Baseline



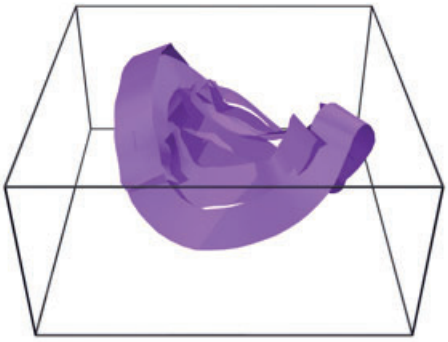
P13 StripBrush



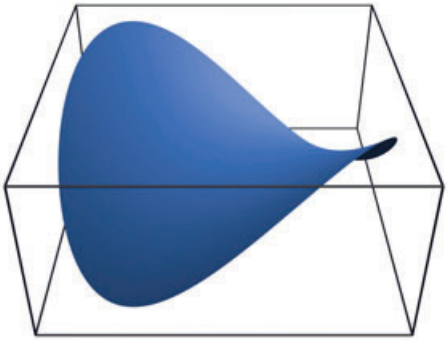
P14 Target Saddle



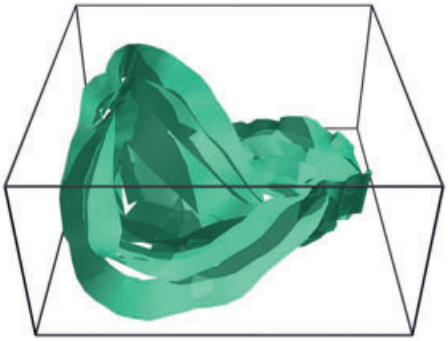
P14 Baseline



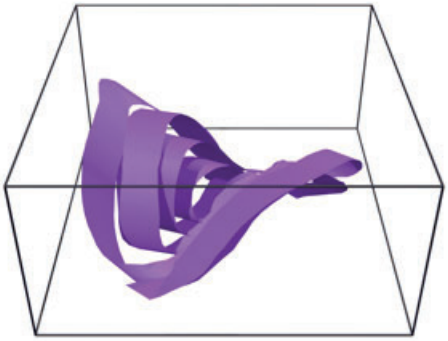
P14 StripBrush



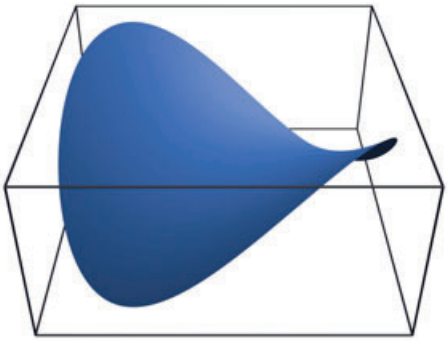
P15 Target Saddle



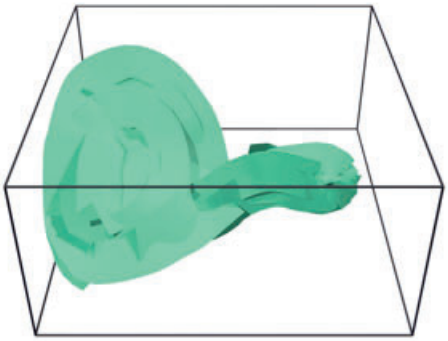
P15 Baseline



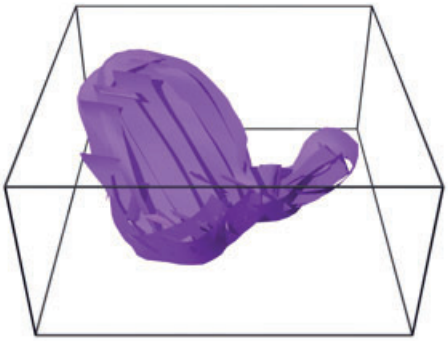
P15 StripBrush



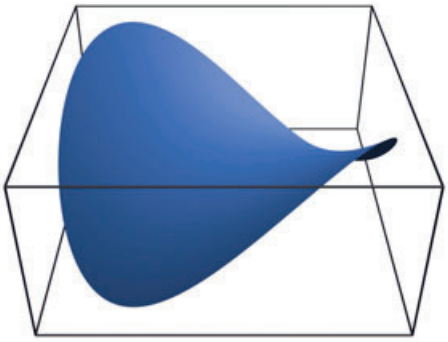
P16 Target Saddle



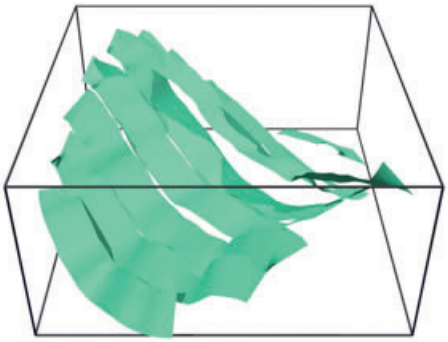
P16 Baseline



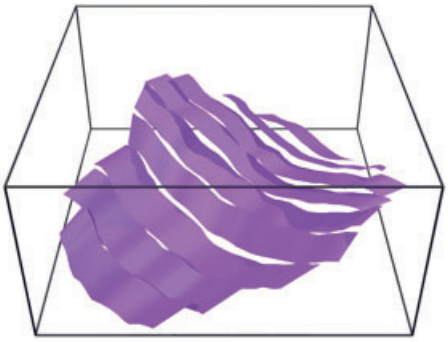
P16 StripBrush



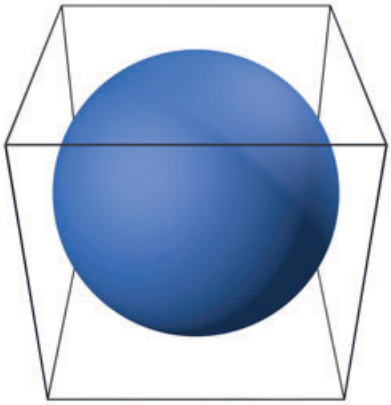
P17 Target Saddle



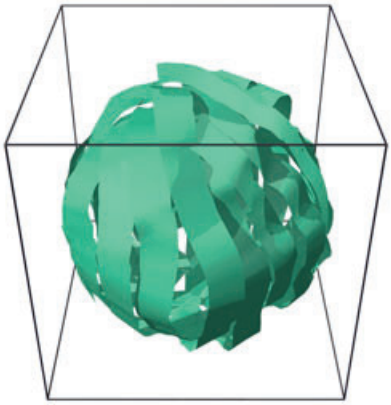
P17 Baseline



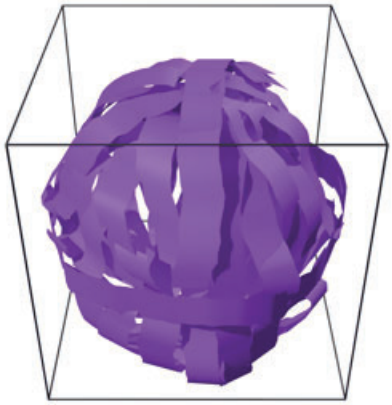
P17 StripBrush



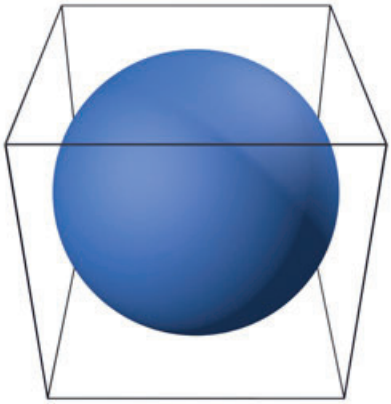
P1 Target Sphere



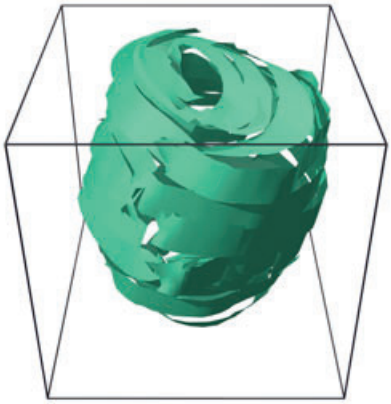
P1 Baseline



P1 StripBrush

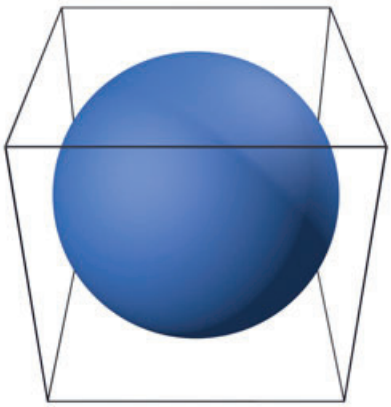


P2 Target Sphere

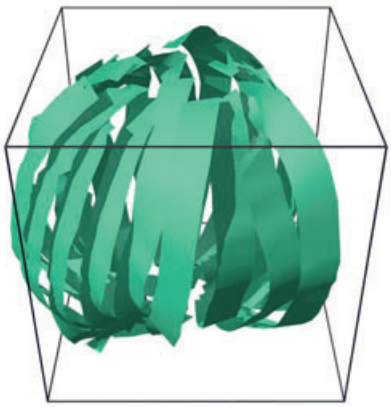


P2 Baseline

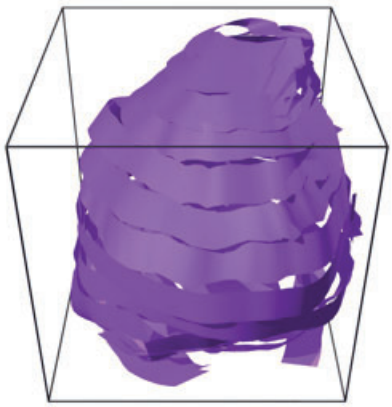
P2 StripBrush



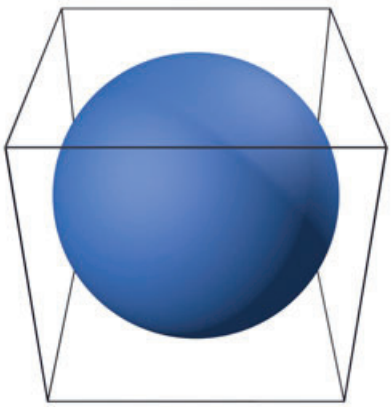
P3 Target Sphere



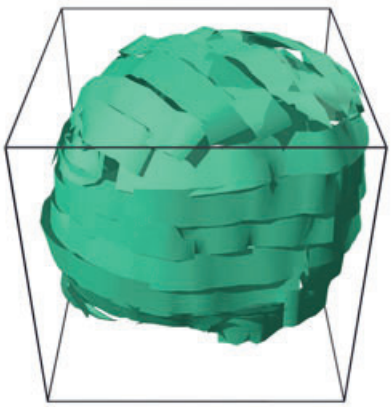
P3 Baseline



P3 StripBrush

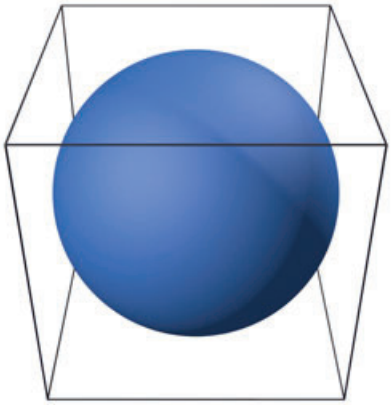


P4 Target Sphere

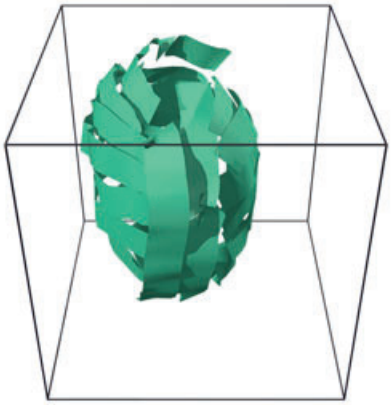


P4 Baseline

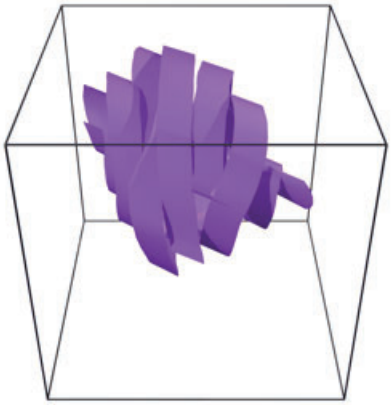
P4 StripBrush



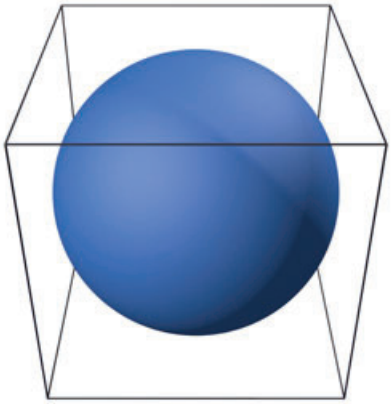
P5 Target Sphere



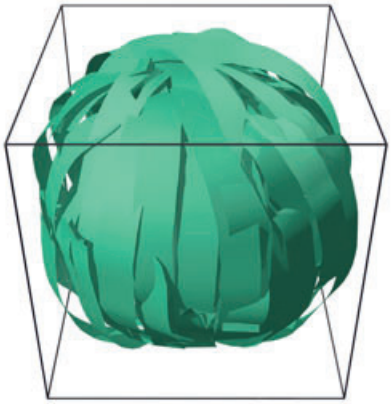
P5 Baseline



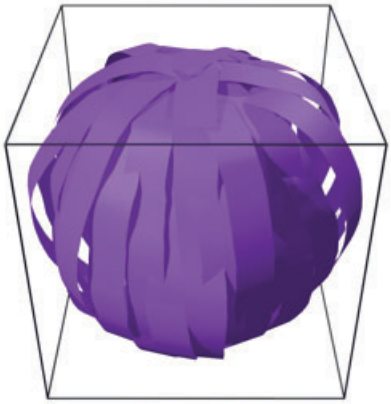
P5 StripBrush



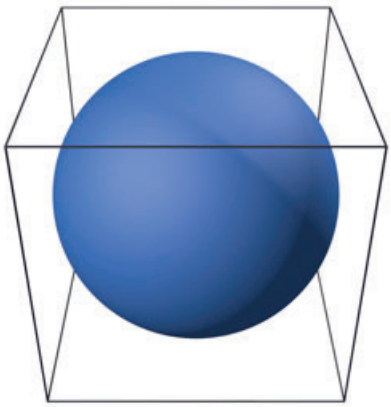
P6 Target Sphere



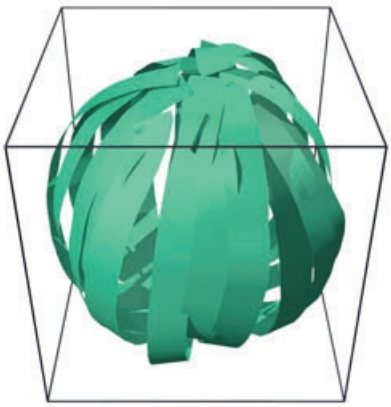
P6 Baseline



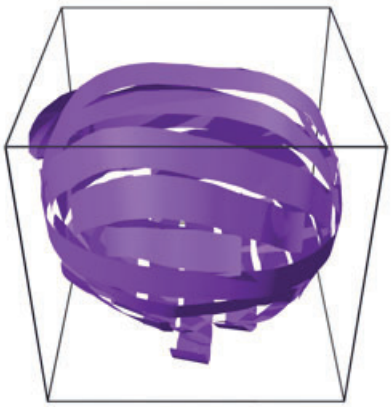
P6 StripBrush



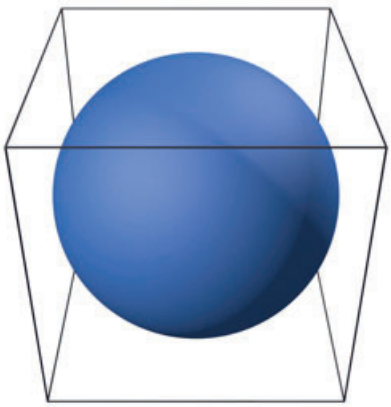
P7 Target Sphere



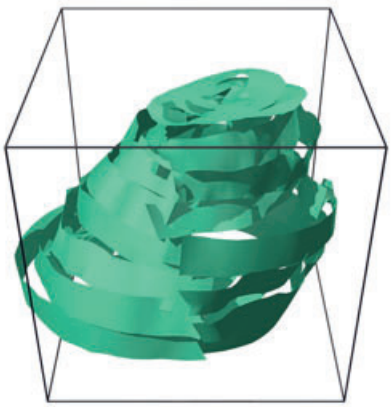
P7 Baseline



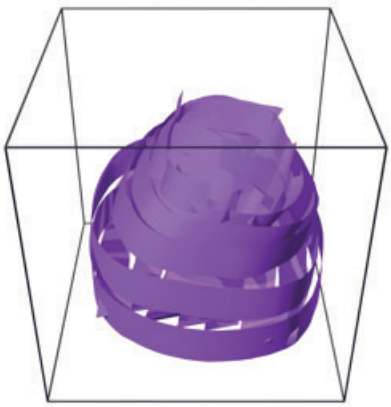
P7 StripBrush



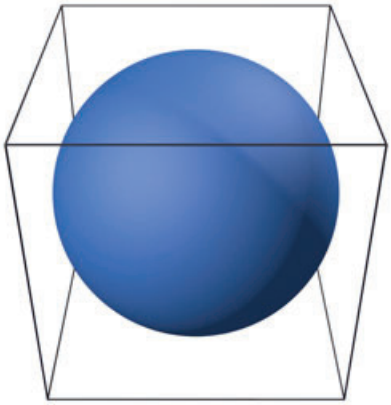
P8 Target Sphere



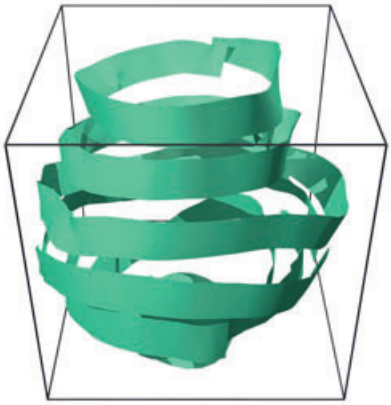
P8 Baseline



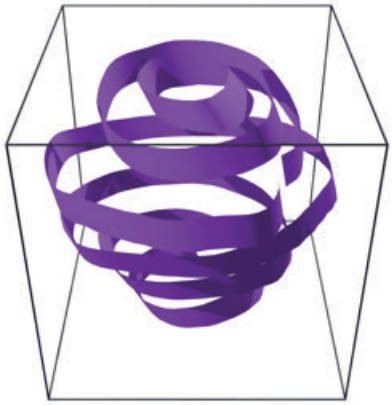
P8 StripBrush



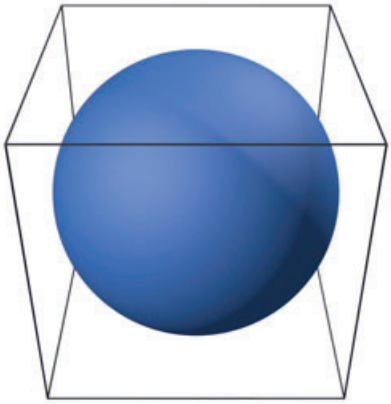
P9 Target Sphere



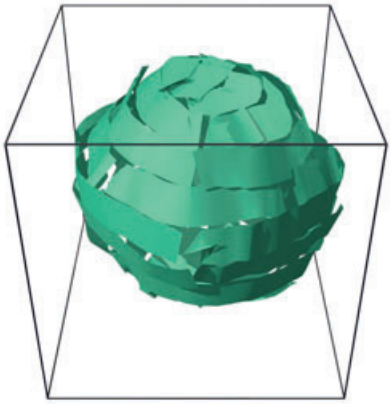
P9 Baseline



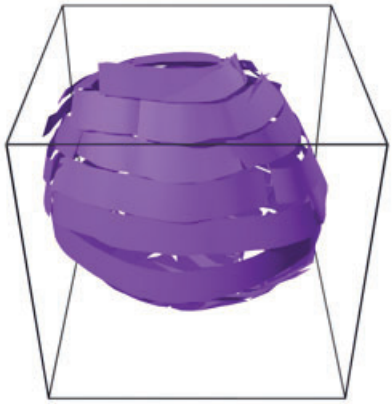
P9 StripBrush



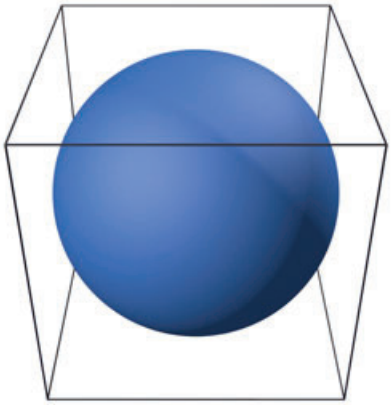
P10 Target Sphere



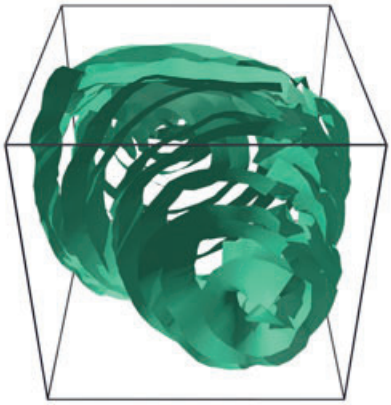
P10 Baseline



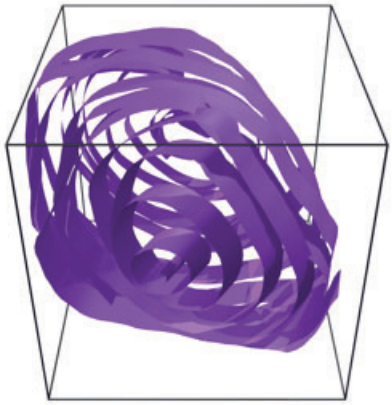
P10 StripBrush



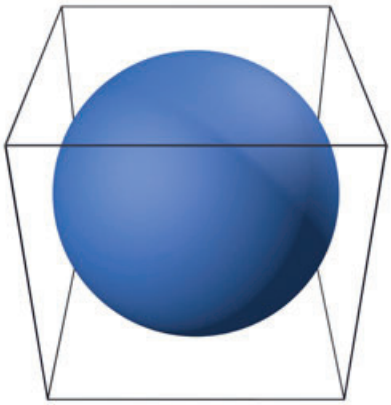
P11 Target Sphere



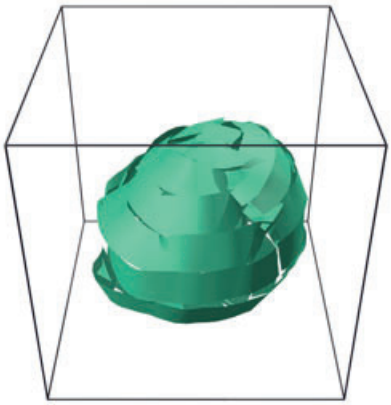
P11 Baseline



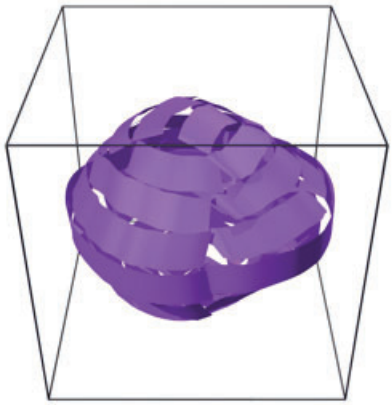
P11 StripBrush



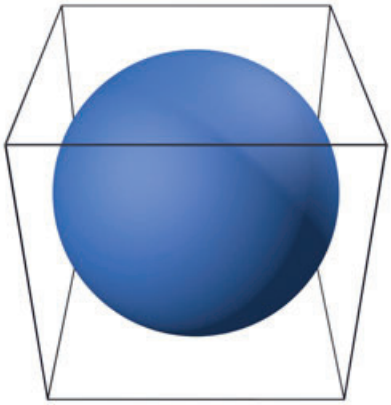
P12 Target Sphere



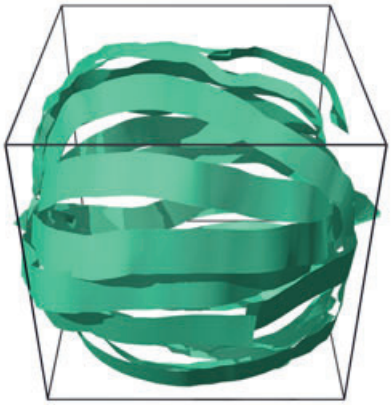
P12 Baseline



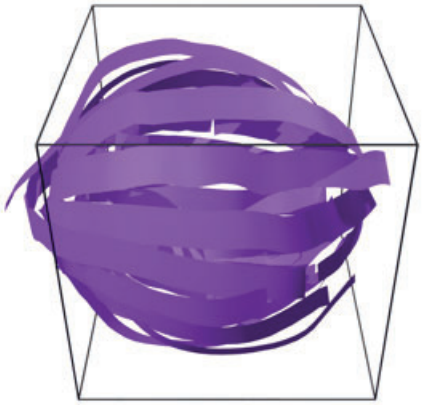
P12 StripBrush



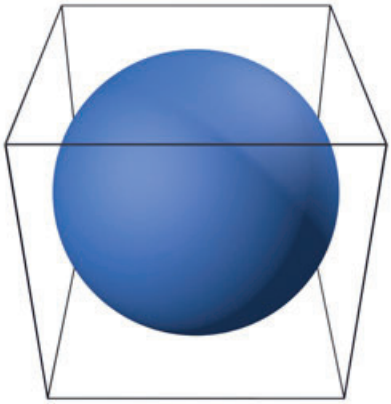
P13 Target Sphere



P13 Baseline

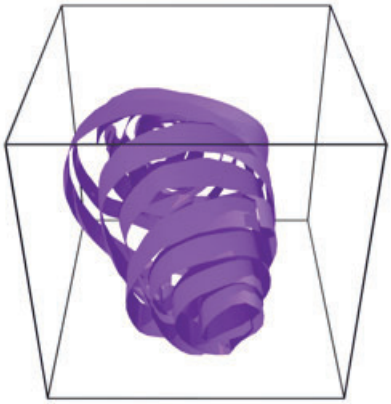


P13 StripBrush

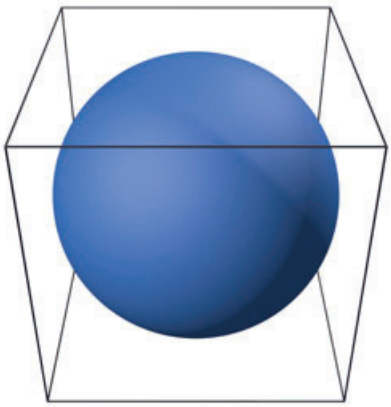


P14 Target Sphere

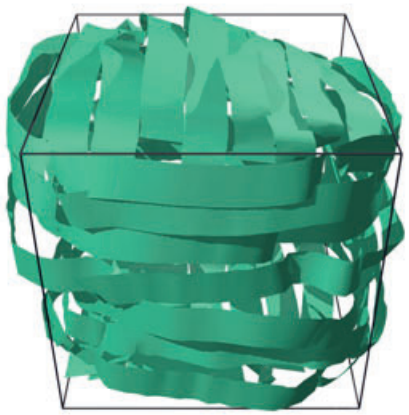
P14 Baseline



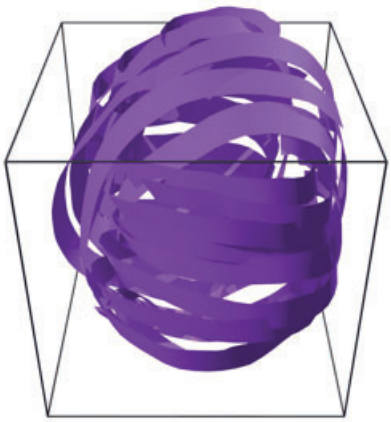
P14 StripBrush



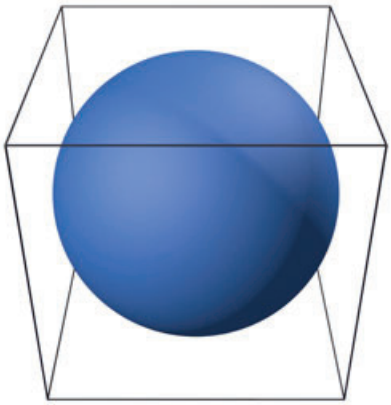
P15 Target Sphere



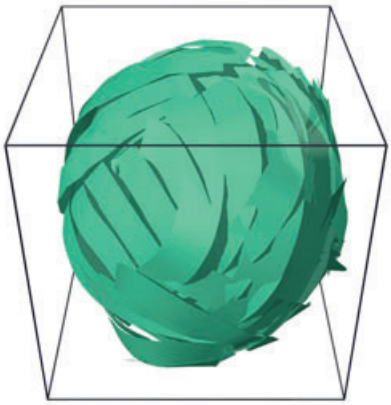
P15 Baseline



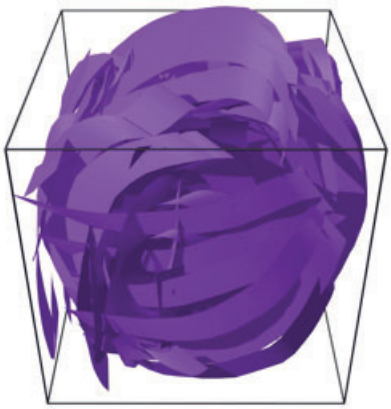
P15 StripBrush



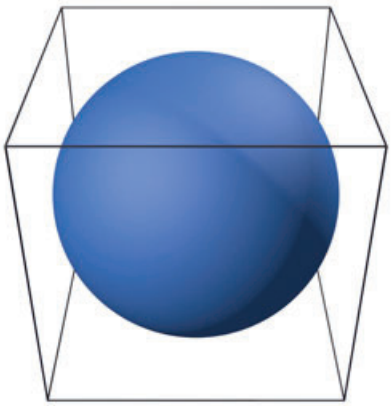
P16 Target Sphere



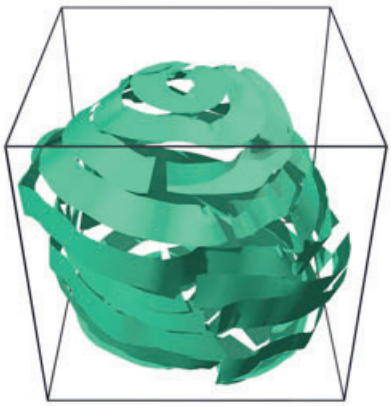
P16 Baseline



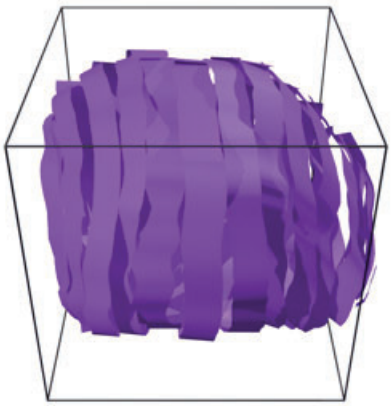
P16 StripBrush



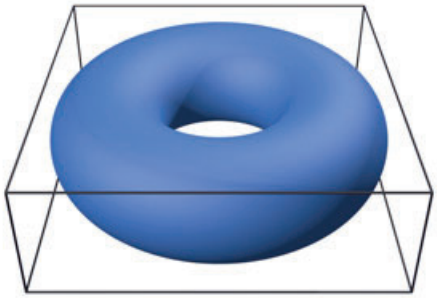
P17 Target Sphere



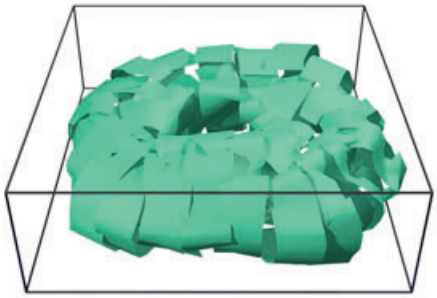
P17 Baseline



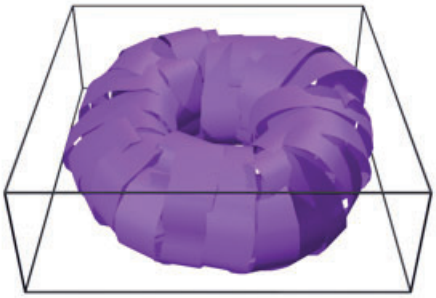
P17 StripBrush



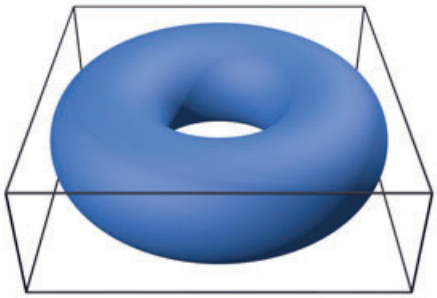
P1 Target Torus



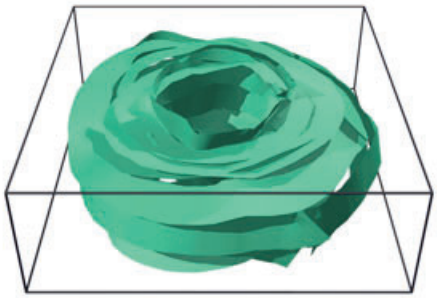
P1 Baseline



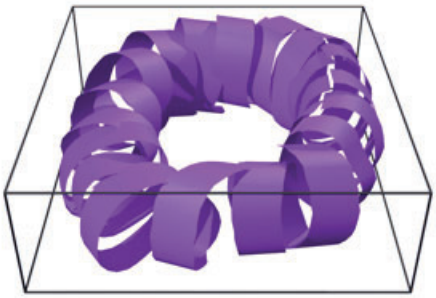
P1 StripBrush



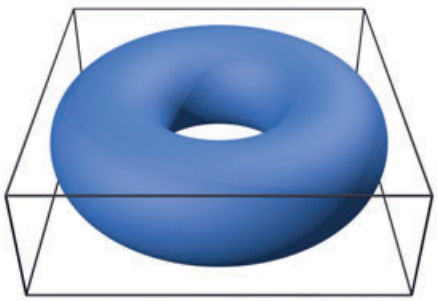
P2 Target Torus



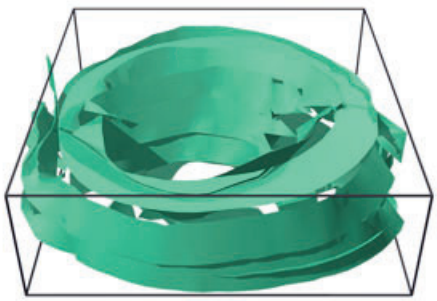
P2 Baseline



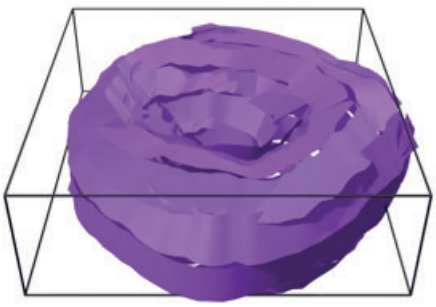
P2 StripBrush



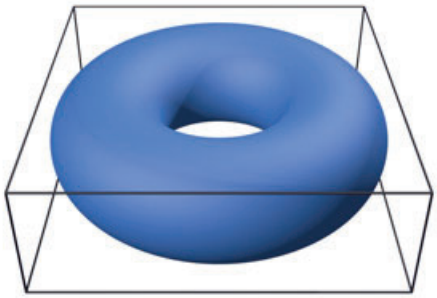
P3 Target Torus



P3 Baseline

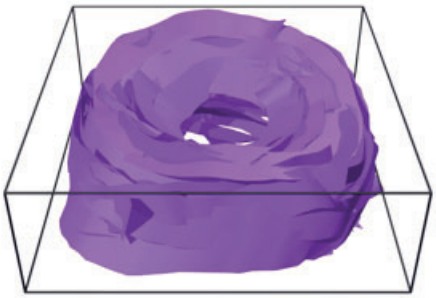


P3 StripBrush

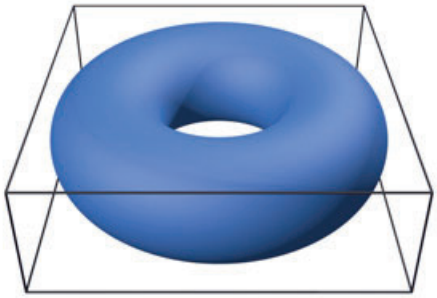


P4 Target Torus

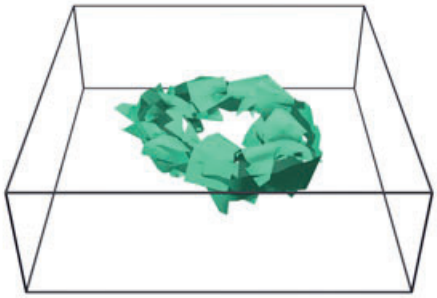
P4 Baseline



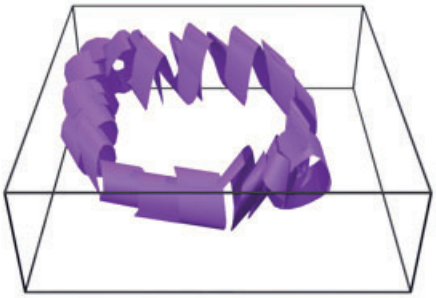
P4 StripBrush



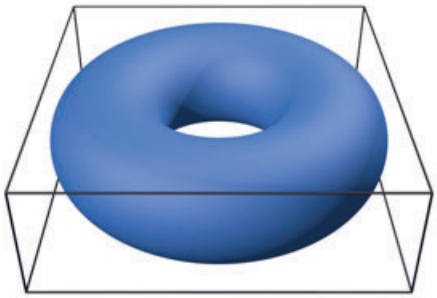
P5 Target Torus



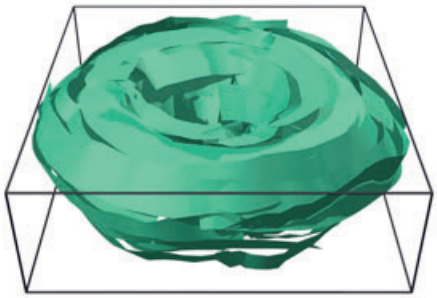
P5 Baseline



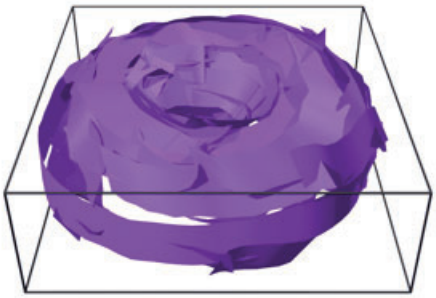
P5 StripBrush



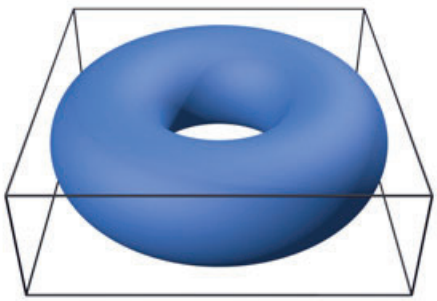
P6 Target Torus



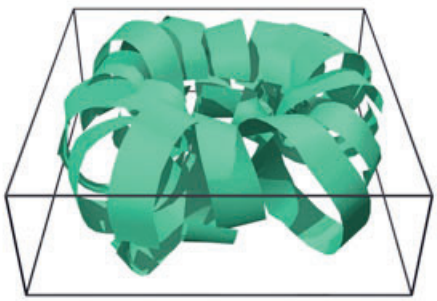
P6 Baseline



P6 StripBrush

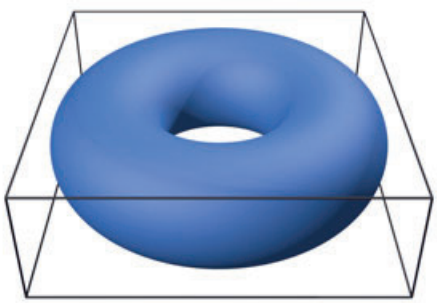


P7 Target Torus

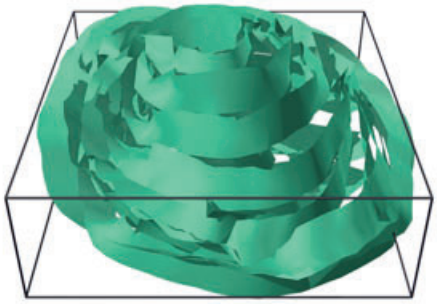


P7 Baseline

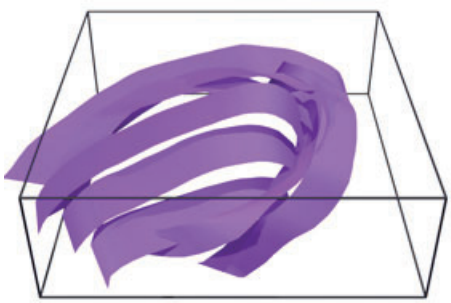
P7 StripBrush



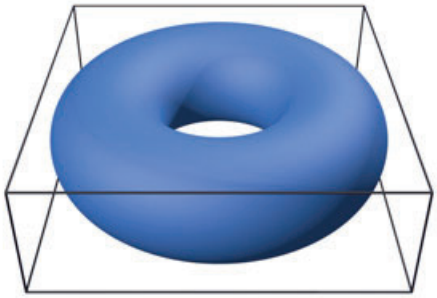
P8 Target Torus



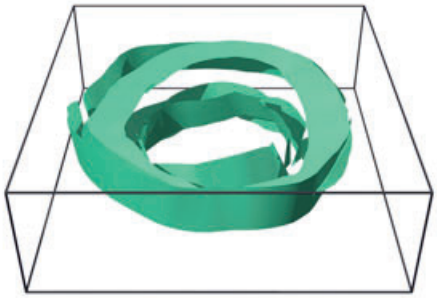
P8 Baseline



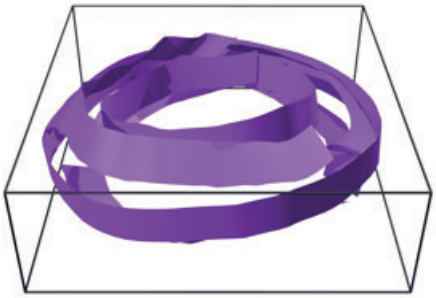
P8 StripBrush



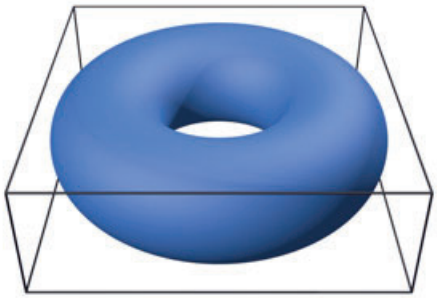
P9 Target Torus



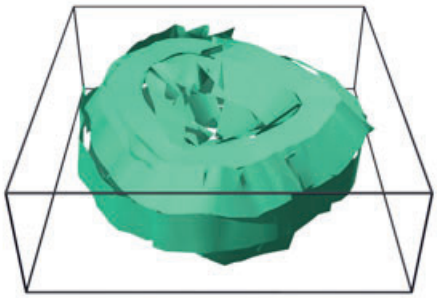
P9 Baseline



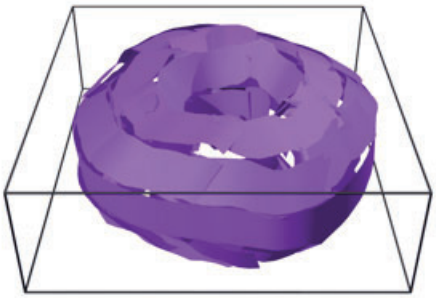
P9 StripBrush



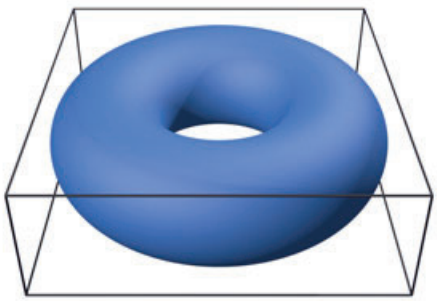
P10 Target Torus



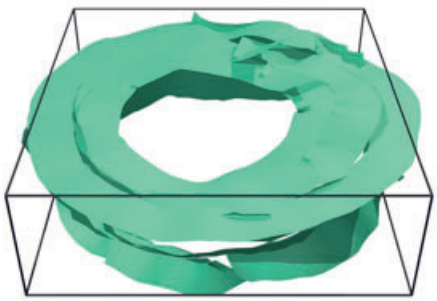
P10 Baseline



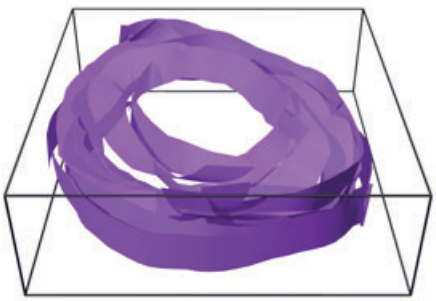
P10 StripBrush



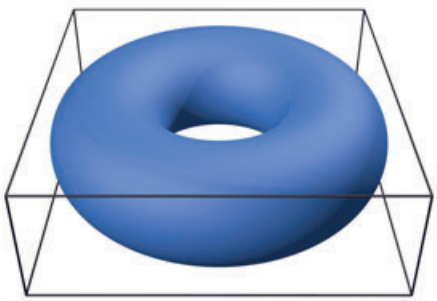
P11 Target Torus



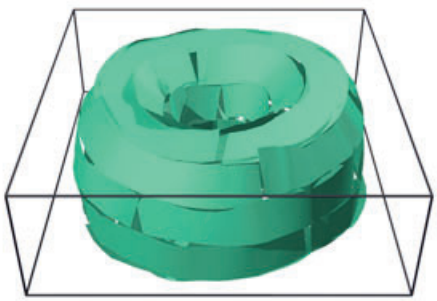
P11 Baseline



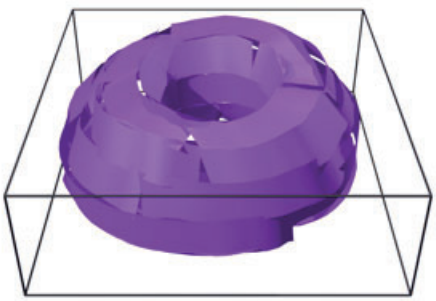
P11 StripBrush



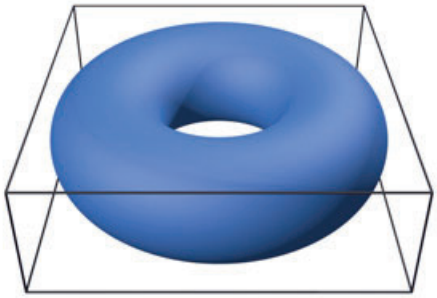
P12 Target Torus



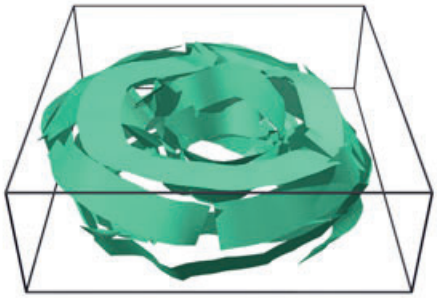
P12 Baseline



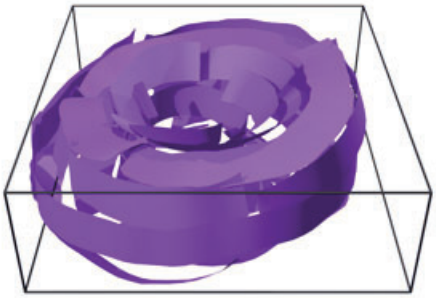
P12 StripBrush



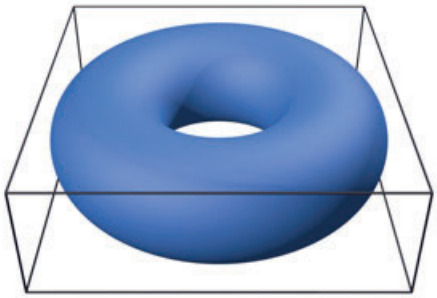
P13 Target Torus



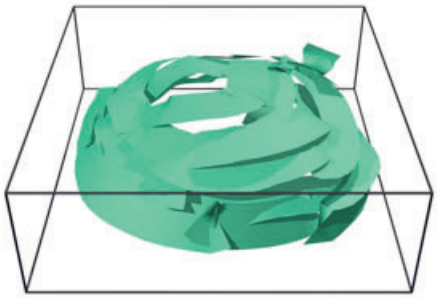
P13 Baseline



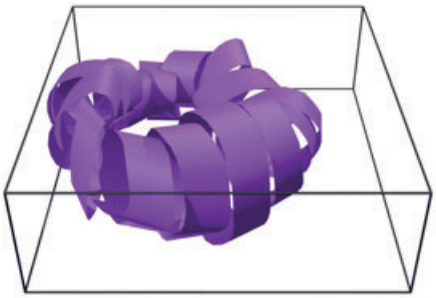
P13 StripBrush



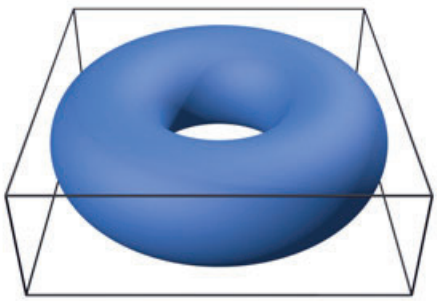
P14 Target Torus



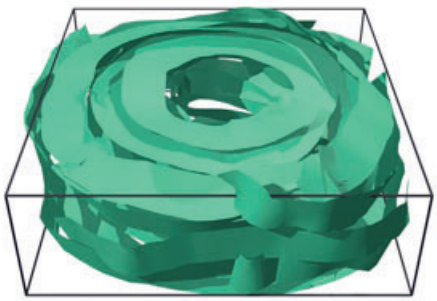
P14 Baseline



P14 StripBrush

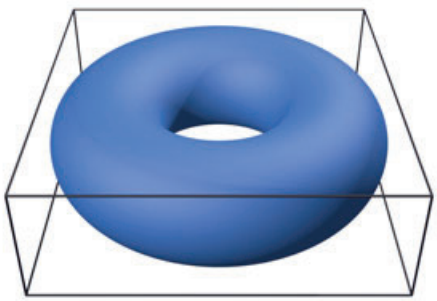


P15 Target Torus

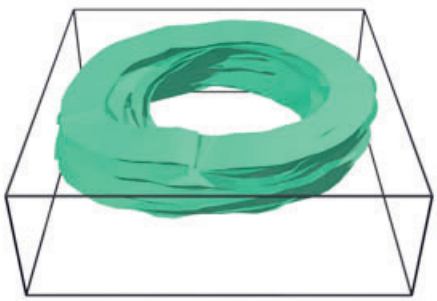


P15 Baseline

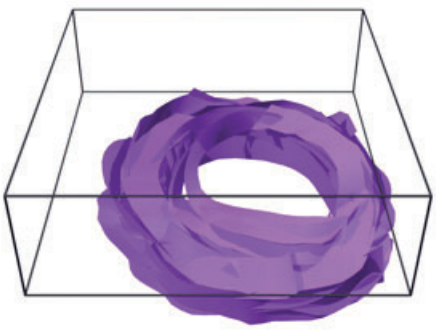
P15 StripBrush



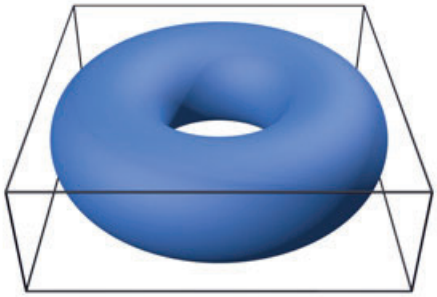
P16 Target Torus



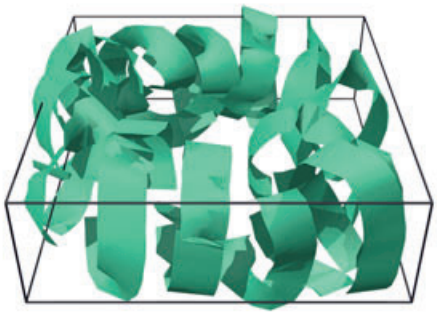
P16 Baseline



P16 StripBrush



P17 Target Torus



P17 Baseline

P17 StripBrush

Table 1: Formative evaluation of Normal-based brush interfaces.

Participant	**Shape**	**Errors**	**Difficulty**
P1	Cube	0	1
P1	Pyramid	0	2
P1	Cone	3	4
P1	Hemisphere	0	4
P1	Torus	1	5
P2	Cube	2	1
P2	Pyramid	1	2
P2	Cone	5	3
P2	Hemisphere	20	4
P2	Torus	59	5
P3	Cube	1	1
P3	Pyramid	0	2
P3	Cone	6	4
P3	Hemisphere	20	5
P3	Torus	2	3
P4	Cube	0	1
P4	Pyramid	7	2
P4	Cone	5	5
P4	Hemisphere	11	4
P4	Torus	9	3
P5	Cube	0	1
P5	Pyramid	0	2
P5	Cone	1	4
P5	Hemisphere	1	3
P5	Torus	1	5
P6	Cube	1	2
P6	Pyramid	6	2
P6	Cone	6	3
P6	Hemisphere	9	4
P6	Torus	25	5
P7	Cube	2	1
P7	Pyramid	3	2
P7	Cone	44	3
P7	Hemisphere	16	4
P7	Torus	62	5
P8	Cube	0	1
P8	Pyramid	4	2
P8	Cone	19	3
P8	Hemisphere	24	4
P8	Torus	9	5

Table 2: Main study results for participants who used StripBrush first and Normal-based brush second.

Participant	Tool	Shape	Ease	Accuracy	Time	Corrections	Ribbons
P1	StripBrush	Square	4	5	2.32	5	9
P1	StripBrush	Circle	3	4	1.887	8	9
P1	StripBrush	Cone	3	4	5.027	27	17
P1	StripBrush	Cylinder	4	4	3.829	13	20
P1	StripBrush	Ellipsoid	2	4	5.291	51	14
P1	StripBrush	Saddle	5	2	1.663	6	7
P1	StripBrush	Sphere	4	4	4.65	29	42
P1	StripBrush	Torus	4	4	5.64	41	24
P1	Normal-based	Square	5	4	2.141	7	8
P1	Normal-based	Circle	5	4	0.682	1	5
P1	Normal-based	Cone	2	2	6.248	50	23
P1	Normal-based	Cylinder	4	2	4.616	37	38
P1	Normal-based	Ellipsoid	4	2	3.36	31	18
P1	Normal-based	Saddle	5	5	1.404	4	10
P1	Normal-based	Sphere	2	4	5.32	45	22
P1	Normal-based	Torus	3	3	7.289	65	36
P2	StripBrush	Square	4	5	5.112	11	7
P2	StripBrush	Circle	3	3	5.848	20	3
P2	StripBrush	Cone	4	4	16.508	63	19
P2	StripBrush	Cylinder	3	2	14.002	52	27
P2	StripBrush	Ellipsoid	4	2	4.306	28	14
P2	StripBrush	Saddle	5	4	2.101	16	5
P2	StripBrush	Sphere	5	4	2.731	8	24
P2	StripBrush	Torus	4	4	2.537	13	13
P2	Normal-based	Square	5	3	1.73	16	8
P2	Normal-based	Circle	5	3	1.985	6	3
P2	Normal-based	Cone	1	1	5.801	37	23
P2	Normal-based	Cylinder	3	5	2.398	5	17
P2	Normal-based	Ellipsoid	4	4	2.423	12	21
P2	Normal-based	Saddle	5	4	1.415	10	7
P2	Normal-based	Sphere	4	2	2.63	12	24
P2	Normal-based	Torus	4	2	2.706	12	17
P3	StripBrush	Square	5	5	1.174	4	12
P3	StripBrush	Circle	4	5	2.337	11	9
P3	StripBrush	Cone	4	4	5.756	19	10
P3	StripBrush	Cylinder	5	5	3.562	10	21
P3	StripBrush	Ellipsoid	4	5	2.946	14	20
P3	StripBrush	Saddle	4	5	3.353	22	14
P3	StripBrush	Sphere	4	4	3.792	10	21
P3	StripBrush	Torus	2	4	4.07	14	16
P3	Normal-based	Square	5	5	0.863	10	11
P3	Normal-based	Circle	5	4	1.214	13	10
P3	Normal-based	Cone	5	2	3.422	31	28
P3	Normal-based	Cylinder	5	5	2.264	9	32
P3	Normal-based	Ellipsoid	4	4	2.826	32	17
P3	Normal-based	Saddle	5	4	1.498	14	12
P3	Normal-based	Sphere	4	3	3.083	47	26
P3	Normal-based	Torus	4	4	2.534	23	22
P4	StripBrush	Square	4	4	1.789	0	10
P4	StripBrush	Circle	2	2	3.018	10	6
P4	StripBrush	Cone	1	4	3.242	3	13
P4	StripBrush	Cylinder	2	2	7.256	4	30
P4	StripBrush	Ellipsoid	1	4	3.686	4	9
P4	StripBrush	Saddle	1	2	4.009	6	6
P4	StripBrush	Sphere	1	4	3.197	1	19
P4	StripBrush	Torus	1	4	3.199	1	32
P4	Normal-based	Square	4	2	1.636	1	11
P4	Normal-based	Circle	2	2	1.569	2	2
P4	Normal-based	Cone	2	2	3.332	3	27
P4	Normal-based	Cylinder	1	2	7.626	11	37

Table 2: Main study results for participants who used StripBrush first and Normal-based brush second.

Participant	Tool	Shape	Ease	Accuracy	Time	Corrections	Ribbons
P4	Normal-based	Ellipsoid	1	2	3.29	1	19
P4	Normal-based	Saddle	2	4	1.442	0	4
P4	Normal-based	Sphere	2	2	4.529	3	45
P4	Normal-based	Torus	2	4	2.798	0	18
P5	StripBrush	Square	5	4	1.2	8	8
P5	StripBrush	Circle	5	3	0.71	2	1
P5	StripBrush	Cone	4	4	0.999	0	10
P5	StripBrush	Cylinder	3	3	2.391	15	7
P5	StripBrush	Ellipsoid	2	2	3.271	9	13
P5	StripBrush	Saddle	2	4	1.647	10	5
P5	StripBrush	Sphere	1	2	3.217	17	2
P5	StripBrush	Torus	3	3	1.177	3	4
P5	Normal-based	Square	3	2	0.822	8	8
P5	Normal-based	Circle	5	4	0.509	2	1
P5	Normal-based	Cone	3	2	2.516	28	20
P5	Normal-based	Cylinder	3	1	1.545	2	22
P5	Normal-based	Ellipsoid	1	4	2.571	8	15
P5	Normal-based	Saddle	1	1	1.664	10	6
P5	Normal-based	Sphere	2	3	2.868	17	22
P5	Normal-based	Torus	1	1	2.85	31	23
P6	StripBrush	Square	5	5	0.852	0	11
P6	StripBrush	Circle	2	4	1.233	6	12
P6	StripBrush	Cone	2	3	2.808	1	39
P6	StripBrush	Cylinder	3	4	2.219	0	32
P6	StripBrush	Ellipsoid	2	2	3.019	3	34
P6	StripBrush	Saddle	2	2	3.365	8	13
P6	StripBrush	Sphere	3	4	3.452	9	32
P6	StripBrush	Torus	1	4	3.334	7	43
P6	Normal-based	Square	4	4	0.95	0	11
P6	Normal-based	Circle	5	5	0.516	0	1
P6	Normal-based	Cone	4	4	2.536	6	32
P6	Normal-based	Cylinder	4	4	1.987	4	36
P6	Normal-based	Ellipsoid	3	4	2.87	6	44
P6	Normal-based	Saddle	4	4	1.435	2	16
P6	Normal-based	Sphere	3	3	2.945	2	45
P6	Normal-based	Torus	3	3	2.883	0	38
P7	StripBrush	Square	5	3	0.983	5	8
P7	StripBrush	Circle	4	3	1.126	11	6
P7	StripBrush	Cone	1	4	3.194	25	25
P7	StripBrush	Cylinder	4	4	2.102	4	36
P7	StripBrush	Ellipsoid	5	5	2.621	13	16
P7	StripBrush	Saddle	2	4	3.013	16	8
P7	StripBrush	Sphere	4	3	3.564	13	21
P7	StripBrush	Torus	2	1	3.882	35	17
P7	Normal-based	Square	5	4	0.94	2	8
P7	Normal-based	Circle	5	4	0.333	1	1
P7	Normal-based	Cone	2	2	2.293	27	20
P7	Normal-based	Cylinder	3	1	2.613	21	15
P7	Normal-based	Ellipsoid	4	2	1.736	8	11
P7	Normal-based	Saddle	4	3	1.148	10	8
P7	Normal-based	Sphere	4	4	3.871	20	20
P7	Normal-based	Torus	1	1	3.178	21	26
P8	StripBrush	Square	5	5	3.858	8	10
P8	StripBrush	Circle	3	4	2.842	3	15
P8	StripBrush	Cone	2	3	3.611	5	35
P8	StripBrush	Cylinder	4	2	2.125	1	20
P8	StripBrush	Ellipsoid	2	1	3.665	2	15
P8	StripBrush	Saddle	2	3	2.637	6	9
P8	StripBrush	Sphere	1	1	4.175	5	13
P8	StripBrush	Torus	3	1	3.626	2	13

Table 2: Main study results for participants who used StripBrush first and Normal-based brush second.

Participant	Tool	Shape	Ease	Accuracy	Time	Corrections	Ribbons
P8	Normal-based	Square	3	3	2.503	1	12
P8	Normal-based	Circle	4	3	1.607	0	8
P8	Normal-based	Cone	3	2	2.83	3	26
P8	Normal-based	Cylinder	3	1	6.259	7	11
P8	Normal-based	Ellipsoid	1	1	3.332	11	1
P8	Normal-based	Saddle	2	1	1.934	12	4
P8	Normal-based	Sphere	2	1	5.791	24	18
P8	Normal-based	Torus	1	1	5.746	26	8

Table 3: Main study results for participants who used Normal-based brush first and StripBrush second.

Participant	Tool	Shape	Ease	Accuracy	Time	Corrections	Ribbons
P9	StripBrush	Square	4	5	1.386	7	8
P9	StripBrush	Circle	4	5	1.386	7	8
P9	StripBrush	Cone	5	5	0.858	2	3
P9	StripBrush	Cylinder	5	3	2.15	5	13
P9	StripBrush	Ellipsoid	5	4	1.217	4	2
P9	StripBrush	Saddle	2	2	4.079	23	5
P9	StripBrush	Sphere	3	3	1.175	3	2
P9	StripBrush	Torus	4	3	2.81	10	6
P9	Normal-based	Square	4	3	0.696	1	8
P9	Normal-based	Circle	3	3	0.76	0	2
P9	Normal-based	Cone	2	4	3.091	14	19
P9	Normal-based	Cylinder	2	3	2.577	11	23
P9	Normal-based	Ellipsoid	2	1	2.914	14	5
P9	Normal-based	Saddle	3	2	1.724	3	1
P9	Normal-based	Sphere	3	4	3.09	8	11
P9	Normal-based	Torus	3	4	2.695	5	7
P10	StripBrush	Square	5	5	1.172	4	9
P10	StripBrush	Circle	1	2	4.155	35	14
P10	StripBrush	Cone	2	3	4.058	29	14
P10	StripBrush	Cylinder	3	3	3.096	14	24
P10	StripBrush	Ellipsoid	3	3	3.16	16	27
P10	StripBrush	Saddle	3	3	2.906	19	13
P10	StripBrush	Sphere	4	2	4.422	19	40
P10	StripBrush	Torus	3	4	4.081	13	45
P10	Normal-based	Square	5	5	1.62	13	8
P10	Normal-based	Circle	2	4	2.826	20	5
P10	Normal-based	Cone	2	2	3.91	26	33
P10	Normal-based	Cylinder	3	3	4.893	24	30
P10	Normal-based	Ellipsoid	2	2	3.841	35	15
P10	Normal-based	Saddle	4	3	2.621	22	12
P10	Normal-based	Sphere	3	3	3.851	16	31
P10	Normal-based	Torus	2	3	4.885	37	24
P11	StripBrush	Square	5	5	0.946	0	10
P11	StripBrush	Circle	5	4	1.04	0	13
P11	StripBrush	Cone	5	4	2.954	0	18
P11	StripBrush	Cylinder	5	5	2.826	1	39
P11	StripBrush	Ellipsoid	3	4	2.411	5	4
P11	StripBrush	Saddle	2	1	2.437	3	11
P11	StripBrush	Sphere	4	4	1.907	1	4
P11	StripBrush	Torus	4	4	1.38	1	11
P11	Normal-based	Square	5	4	1.722	1	10
P11	Normal-based	Circle	5	5	1.594	3	1
P11	Normal-based	Cone	2	2	4.603	5	31
P11	Normal-based	Cylinder	4	3	3.253	1	26
P11	Normal-based	Ellipsoid	5	2	2.688	7	14
P11	Normal-based	Saddle	3	2	2.673	4	9
P11	Normal-based	Sphere	4	3	3.516	3	23

Table 3: Main study results for participants who used Normal-based brush first and StripBrush second.

Participant	Tool	Shape	Ease	Accuracy	Time	Corrections	Ribbons
P11	Normal-based	Torus	4	3	2.747	3	12
P12	StripBrush	Square	5	5	0.895	1	8
P12	StripBrush	Circle	4	3	0.92	4	9
P12	StripBrush	Cone	2	3	4.108	10	31
P12	StripBrush	Cylinder	4	4	7.431	6	25
P12	StripBrush	Ellipsoid	3	2	1.995	3	18
P12	StripBrush	Saddle	5	3	1.314	3	9
P12	StripBrush	Sphere	2	4	2.816	6	28
P12	StripBrush	Torus	3	4	2.886	4	28
P12	Normal-based	Square	3	3	1.43	6	8
P12	Normal-based	Circle	5	5	0.645	1	4
P12	Normal-based	Cone	4	3	2.44	10	31
P12	Normal-based	Cylinder	3	3	3.816	6	34
P12	Normal-based	Ellipsoid	4	3	1.761	2	15
P12	Normal-based	Saddle	5	4	1.535	6	10
P12	Normal-based	Sphere	2	2	2.51	12	25
P12	Normal-based	Torus	2	3	5.07	22	33
P13	StripBrush	Square	5	4	0.767	0	7
P13	StripBrush	Circle	4	3	0.624	0	8
P13	StripBrush	Cone	4	4	1.721	0	22
P13	StripBrush	Cylinder	4	4	2.755	0	40
P13	StripBrush	Ellipsoid	3	3	4.202	8	15
P13	StripBrush	Saddle	4	4	1.315	1	9
P13	StripBrush	Sphere	4	4	2.68	0	24
P13	StripBrush	Torus	2	3	2.724	0	27
P13	Normal-based	Square	4	3	0.846	0	8
P13	Normal-based	Circle	4	3	0.71	1	5
P13	Normal-based	Cone	4	2	2.717	4	24
P13	Normal-based	Cylinder	4	2	3.076	2	28
P13	Normal-based	Ellipsoid	2	2	2.592	0	12
P13	Normal-based	Saddle	1	3	1.524	1	9
P13	Normal-based	Sphere	2	2	3.15	1	23
P13	Normal-based	Torus	1	3	3.677	6	22
P14	StripBrush	Square	5	5	1.298	4	8
P14	StripBrush	Circle	2	5	1.033	1	9
P14	StripBrush	Cone	4	4	1.714	1	19
P14	StripBrush	Cylinder	2	4	1.599	4	24
P14	StripBrush	Ellipsoid	5	3	1.62	3	4
P14	StripBrush	Saddle	5	4	1.637	6	10
P14	StripBrush	Sphere	3	4	2.593	9	14
P14	StripBrush	Torus	4	5	1.796	7	15
P14	Normal-based	Square	4	2	1.769	7	7
P14	Normal-based	Circle	4	1	2.203	11	16
P14	Normal-based	Cone	4	3	1.422	4	19
P14	Normal-based	Cylinder	5	2	2.109	5	31
P14	Normal-based	Ellipsoid	2	2	2.665	13	13
P14	Normal-based	Saddle	1	2	4.886	19	10
P14	Normal-based	Sphere	2	2	3.741	8	23
P14	Normal-based	Torus	1	2	3.066	20	17
P15	StripBrush	Square	5	5	0.675	2	11
P15	StripBrush	Circle	5	5	0.915	4	14
P15	StripBrush	Cone	4	4	2.05	5	41
P15	StripBrush	Cylinder	3	4	2.886	15	51
P15	StripBrush	Ellipsoid	2	4	1.471	6	18
P15	StripBrush	Saddle	3	3	2.181	4	2
P15	StripBrush	Sphere	4	4	1.189	4	26
P15	StripBrush	Torus	2	3	2.987	15	20
P15	Normal-based	Square	4	3	1.234	2	10
P15	Normal-based	Circle	4	3	1.654	5	1
P15	Normal-based	Cone	4	2	1.917	2	27

Table 3: Main study results for participants who used Normal-based brush first and StripBrush second.

Participant	Tool	Shape	Ease	Accuracy	Time	Corrections	Ribbons
P15	Normal-based	Cylinder	4	2	2.289	5	29
P15	Normal-based	Ellipsoid	3	2	1.875	4	19
P15	Normal-based	Saddle	1	2	2.117	1	12
P15	Normal-based	Sphere	1	2	3.937	1	44
P15	Normal-based	Torus	1	2	4.273	6	31
P16	StripBrush	Square	5	5	0.696	0	12
P16	StripBrush	Circle	3	5	1.243	6	21
P16	StripBrush	Cone	4	4	2.166	6	45
P16	StripBrush	Cylinder	2	5	2.045	3	56
P16	StripBrush	Ellipsoid	4	4	1.313	2	28
P16	StripBrush	Saddle	2	2	1.53	16	18
P16	StripBrush	Sphere	2	1	2.019	1	64
P16	StripBrush	Torus	2	3	4.178	14	38
P16	Normal-based	Square	1	2	2.798	12	10
P16	Normal-based	Circle	3	4	1.043	0	11
P16	Normal-based	Cone	4	3	2.954	17	24
P16	Normal-based	Cylinder	4	1	3.149	4	27
P16	Normal-based	Ellipsoid	5	3	2.889	7	54
P16	Normal-based	Saddle	3	2	1.177	0	16
P16	Normal-based	Sphere	4	1	7.172	6	62
P16	Normal-based	Torus	2	4	3.213	6	8
P17	StripBrush	Square	5	4	2.071	3	8
P17	StripBrush	Circle	3	4	2.713	6	15
P17	StripBrush	Cone	4	4	4.705	6	19
P17	StripBrush	Cylinder	4	4	2.339	4	15
P17	StripBrush	Ellipsoid	4	3	1.757	4	8
P17	StripBrush	Saddle	4	4	5.815	8	9
P17	StripBrush	Sphere	3	3	4.637	14	17
P17	StripBrush	Torus	4	3	4.556	3	19
P17	Normal-based	Square	4	2	2.94	12	9
P17	Normal-based	Circle	4	2	1.649	10	5
P17	Normal-based	Cone	2	2	6.108	23	28
P17	Normal-based	Cylinder	4	3	5.589	16	29
P17	Normal-based	Ellipsoid	2	3	5.015	33	31
P17	Normal-based	Saddle	3	3	2.265	5	9
P17	Normal-based	Sphere	3	3	5.462	13	29
P17	Normal-based	Torus	2	1	6.286	30	19

Table 4: Perceived workload assessment performed using the NASA TLX workload survey.

Participant	Tool order*	Tool	Weighted Sum	Mental	Physical	Temporal	Performance	Effort	Frustration
P1	1	StripBrush	59.00	65	25	45	65	65	35
P1	1	Normal-based	69.67	70	85	70	60	65	40
P2	1	StripBrush	97.33	100	100	100	80	100	35
P2	1	Normal-based	85.67	100	90	60	85	95	60
P3	1	StripBrush	42.67	75	5	30	25	60	5
P3	1	Normal-based	39.67	60	5	10	30	60	5
P4	1	StripBrush	86.67	85	70	95	95	75	90
P4	1	Normal-based	87.67	90	85	85	90	90	85
P5	1	StripBrush	80.00	85	70	25	90	85	60
P5	1	Normal-based	99.33	100	100	50	100	100	90
P6	1	StripBrush	74.00	70	85	70	65	70	55
P6	1	Normal-based	36.67	40	35	35	30	45	40
P7	1	StripBrush	79.00	90	80	40	80	80	25
P7	1	Normal-based	87.33	90	100	30	85	80	70
P8	1	StripBrush	73.67	95	5	5	95	85	45
P8	1	Normal-based	76.00	90	60	80	85	80	65
P9	2	StripBrush	43.67	45	35	45	45	45	40
P9	2	Normal-based	76.00	65	80	60	80	80	75
P10	2	StripBrush	66.00	75	60	65	50	65	30
P10	2	Normal-based	67.67	80	65	65	60	60	50
P11	2	StripBrush	65.00	75	70	65	65	55	40
P11	2	Normal-based	68.00	75	65	75	50	90	55
P12	2	StripBrush	58.33	70	55	50	30	70	50
P12	2	Normal-based	69.67	80	75	20	55	70	40
P13	2	StripBrush	40.67	30	40	25	45	50	40
P13	2	Normal-based	48.00	40	55	40	60	35	30
P14	2	StripBrush	93.67	95	90	95	95	95	90
P14	2	Normal-based	97.33	100	90	100	100	95	95
P15	2	StripBrush	53.67	35	35	35	75	75	35
P15	2	Normal-based	62.67	75	85	65	40	65	20
P16	2	StripBrush	88.33	85	90	65	90	85	90
P16	2	Normal-based	74.67	75	65	85	75	70	80
P17	2	StripBrush	55.00	55	45	55	60	55	50
P17	2	Normal-based	62.33	60	50	65	60	65	60

** Order value '1' means participants who used StripBrush first and Normal-based brush second, order value '2' means participants who used Normal-based brush first and StripBrush second.*

Table 5: Tool's usability assessment performed using the System Usability Scale (SUS) survey.

Participant	**Tool order***	**Tool**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Weighted Sum**
P1	1	StripBrush	5	5	4	4	5	3	5	5	4	3	86
P1	1	Normal-based	4	5	4	4	4	4	4	4	3	3	78
P2	1	StripBrush	5	5	2	1	4	2	5	4	2	2	64
P2	1	Normal-based	5	3	4	1	4	2	5	5	3	1	66
P3	1	StripBrush	5	5	5	5	5	5	5	4	4	5	96
P3	1	Normal-based	5	5	5	5	5	5	5	4	5	5	98
P4	1	StripBrush	1	4	1	2	2	4	1	2	1	1	38
P4	1	Normal-based	2	2	2	2	4	4	2	2	1	1	44
P5	1	StripBrush	4	2	2	4	4	4	4	2	3	4	66
P5	1	Normal-based	1	1	2	1	4	2	1	1	1	1	30
P6	1	StripBrush	4	4	4	5	2	5	5	2	4	2	74
P6	1	Normal-based	5	4	4	5	3	2	4	3	5	4	78
P7	1	StripBrush	4	3	4	3	4	5	5	3	2	2	70
P7	1	Normal-based	2	3	3	2	3	3	2	1	2	2	46
P8	1	StripBrush	1	3	1	1	3	2	2	2	1	1	34
P8	1	Normal-based	1	5	1	1	3	1	1	1	1	1	32
P9	2	StripBrush	4	4	4	4	4	4	5	5	4	5	86
P9	2	Normal-based	2	2	1	1	3	3	2	2	2	2	40
P10	2	StripBrush	4	5	4	3	5	4	4	4	3	3	78
P10	2	Normal-based	3	4	3	5	5	4	3	4	3	2	72
P11	2	StripBrush	5	5	4	5	5	5	4	4	5	2	88
P11	2	Normal-based	4	5	4	3	5	5	4	3	4	1	76
P12	2	StripBrush	4	4	5	4	4	4	4	4	3	3	78
P12	2	Normal-based	3	4	4	4	4	2	4	2	3	4	68
P13	2	StripBrush	4	4	4	5	4	4	4	4	3	4	80
P13	2	Normal-based	2	3	3	5	2	3	4	3	3	5	66
P14	2	StripBrush	5	5	4	2	5	3	4	4	4	1	74
P14	2	Normal-based	1	3	1	1	5	3	1	2	1	1	38
P15	2	StripBrush	5	4	4	4	4	3	4	4	4	3	78
P15	2	Normal-based	2	4	1	2	3	3	1	2	2	2	44
P16	2	StripBrush	2	3	2	5	3	2	2	1	2	4	52
P16	2	Normal-based	4	2	3	5	2	2	1	2	2	4	54
P17	2	StripBrush	4	3	4	4	4	5	4	5	4	4	82
P17	2	Normal-based	2	3	2	4	3	4	2	3	2	4	58

Table 1: Statistics of NASA TLX

	Mean StripBrush	Mean Normal-Based	Mean of Differences	Std. Deviation of Differences	95% Confidence Interval Lower	95% Confidence Interval Upper	t	p
Mental	72.350	75.880	-3.529	14.975	-11.229	4.170	-0.972	0.173
Physical	56.470	70.000	-13.529	29.035	-28.458	1.399	-1.921	0.037
Temporal	53.530	58.530	-5.000	28.229	-19.514	9.514	-0.730	0.238
Performance	67.650	67.350	0.294	18.411	-9.172	9.760	0.066	0.474
Effort	71.470	73.240	-1.765	16.196	-10.092	6.563	-0.449	0.330
Frustration	47.940	56.470	-8.529	18.521	-18.052	0.993	-1.899	0.038
Weighted Sum	68.039	71.078	-3.039	14.832	-10.665	4.587	-0.845	0.206

Highlighted rows represent significant improvements for 95% confidence.

Table 2: Statistics of SUS

	Mean StripBrush	Mean Normal-Based	Mean of Differences	Std. Deviation of Differences	95% Confidence Interval Lower	95% Confidence Interval Upper	t	p
Q1	3.880	2.820	1.059	1.600	0.236	1.881	2.729	0.008
Q2	4.000	3.410	0.588	1.064	0.041	1.135	2.279	0.019
Q3	3.410	2.760	0.647	1.455	-0.101	1.395	1.833	0.043
Q4	3.590	3.000	0.588	1.278	-0.069	1.245	1.898	0.038
Q5	3.940	3.650	0.294	0.920	-0.179	0.767	1.319	0.103
Q6	3.760	3.060	0.706	1.047	0.168	1.244	2.781	0.007
Q7	3.940	2.710	1.235	1.348	0.542	1.928	3.779	0.001
Q8	3.470	2.590	0.882	1.219	0.256	1.509	2.985	0.005
Q9	3.120	2.530	0.588	1.661	-0.266	1.442	1.461	0.082
Q10	2.880	2.530	0.353	1.272	-0.301	1.007	1.144	0.135
Overall Score	72.000	58.120	13.882	16.484	5.407	22.358	3.472	0.002

Highlighted rows represent significant improvements for 95% confidence.

Table 3: Statistics of User Feedback

		Mean StripBrush	Mean Normal-Based	Mean of Differences	Std. Deviation of Differences	95% Confidence Interval Lower	95% Confidence Interval Upper	t	p
All	Ease	3.380	3.180	0.206	1.441	-0.038	0.450	1.666	0.049
	Accuracy	3.600	2.760	0.831	1.412	0.591	1.070	6.863	0.000
StripBrush, then Normal-Based	Ease	3.125	3.281	-0.156	1.250	-0.468	0.156	-1.000	0.161
	Accuracy	3.469	2.875	0.594	1.509	0.217	0.971	3.148	0.002
Normal-Based, then StripBrush	Ease	3.611	3.083	0.528	1.529	0.169	0.887	2.929	0.003
	Accuracy	3.708	2.667	1.042	1.294	0.738	1.346	6.831	0.000

Highlighted rows represent significant improvements for 95% confidence.

Table 4: Statistics of Performance Measurements

	Mean StripBrush	Mean Normal-Based	Mean of Differences	Std. Deviation of Differences	95% Confidence Interval Lower	95% Confidence Interval Upper	t	p
Time	2.870	2.800	0.070	1.974	-0.265	0.405	0.414	0.340
Corrections	9.040	11.270	-2.235	11.368	-4.163	-0.307	-2.293	0.012
Ribbons	17.380	18.150	-0.772	10.217	-2.505	0.961	-0.881	0.190

Highlighted rows represent significant improvements for 95% confidence.

Table 5: Statistics of relative shape difficulty

	Mean First Class	Mean Second Class	Mean of Differences	Std. Deviation of Differences	95% Confidence Interval Lower	95% Confidence Interval Upper	t	p
Cube + Pyramid vs Cone	1.560	3.630	-2.062	0.929	-2.557	-1.568	-8.883	0.000
Cone vs Torus + Hemisphere	3.630	4.250	-0.625	1.258	-1.296	0.046	-1.987	0.033

Highlighted rows represent significant improvements for 95% confidence.

StripBrush Comparative Study Interview Notes

The follow-up interview asked participants about the reasons behind their answers to the SUS questions.

Q01 - I think that I would like to use the (LINE/CIRCLE) tool frequently

P1 – [Line] “I would use it if I could, I don't draw too much but if I did, I would use it”
P2 - “I felt more comfortable using it, if I use a drawing system like this I would like to use the line tool”
P3 - “I think the line tool was super straightforward, it was very simple, I knew exactly what I was going to get after pressing the button, the only think it was complicated about it was figuring out how to use the tool to draw the shapes, but the functionality of the tool is super easy. Using the guide at the end of the handle its super simple because you know what the path is going to take and you just follow the path.”
P5 - “Line is simple, there is too much effort for the circle, I needed to keep my hand steady, and the circle makes more noise”
P7 - “Using the circle tool needs more training, the line tool is more simple, and I could jump easily to use it”
P8 - “I liked the first [Line] more than the second [circle]”
P9 - “I didn’t manage to draw with the circle until [having] more practice, the line is very easy to learn, with the circle it’s very easy to get the ribbon wrongly twisted because I need to rotate my wrist”
P9 - “The next time I could draw with a system like this, I would go for the line tool”
P10 - “I would use line, it seems more natural with line”
P10 - “Except for planar curves, for everything else the line tool would be my choice to use”
P11 - “The circle tool when I draw round shapes it is confusing, with the line I know what I will get, the line is straightforward compared with the circle tool”
P13 - “I feel that with the line tool you get a better understanding of the depth, with the circle it is harder to perceive the distance”
P15 - “The line tool is easier to manipulate to draw”
P17 - “The line tool is much more controllable”
P1 - “I also like it [circle tool], it is very interactive so I would like to use it, it is fun”
P4 - “Second [Circle] was more intuitive, I picked the circle tool quicker and it felt quicker”
P10 - “To make a planar curve, the circle is easier, that will be my only preference for that tool”
P16 - “I felt I didn’t like it at first but at the end I think it was more useful than the line”

Q02 - I found the (LINE/CIRCLE) tool unnecessarily complex.

P1 - “I didn't find the circle tool complex, it takes more time than with the first one [line] but at the end you get used to used to it. At the beginning you need some assistance, on how it works, you have to use your wrist a lot, compared with the first one [line]

P3 - “I think the line tool is very similar to what people do when using something like a pencil, you press into the paper, and pull downward and just follow that path and here is the same concept, you don't need to worry about twisting or turning, it feels just like a paint brush. Only in some curved surfaces I had to twist my wrist, but as I went further on the shapes I found it easier, so I attribute this problem to my lack of practice at the beginning and not having experience with it.”
P5 - “3D objects were very hard to create with the circle tool, specifically closed objects”
P5 - “Line was very simple for closed shapes, it is easy to grasp and how to move”
P7 - “Complexity is not the problem it’s a matter of what they demand, line is more systematic and it has a more predictable behaviour, the other one [circle] is less predictable”
P9 - “The circle tool requires more effort, I think with more practice I could handle it”
P12 - “The circle is a bit more complex because the plane. At first, was a bit less intuitive, less than the line.”

Q03 - I thought the (LINE/CIRCLE) tool was easy to use.

P1 - “Sometimes when you move your hand and shakes a bit, the ribbon is not properly done, it is not as accurate when you move your wrist”
P1 - “The line tool is very simple, you just move the line. I think is easy to use, and you get used to the line very quickly.”
P1 - “for the line tool it was kind of easier to use, but this one I think it needs more precision with your hand when you are drawing and I do not have this precision, my hands are shaking sometimes. With the line, I felt like when you drive a new car and it is super easy to turn the wheels and the circle is like an old car in which you need to make more effort to turn the wheel”
P3 - “I you have used any kind of tool like pens, pencils brushes or anything is pretty straightforward”
P3 - “The line tool felt more technically precise when you start and stop, you can do very clean paths”
P5 - “With the circle tool I keep forgetting how the plane was oriented, trying to keep the plane is difficult and is hard to avoid noise and create a smooth ribbon”
P6 - [regarding the cone] “Now I am realized that I should use the same [strategy] with the first tool [circle] it would be easier than with this tool [circle]
P6 - “Both tools have strengths, the circle is a bit more complex, because you need to move the plane, but over all I could give the same rating”
P7 - “The fact that you can create loops with the line tool makes it easier for me”
P8 - “The second [circle] requires me to move more and I could perceive the shape better, but I felt it was more complex and regarding the wrist rotations, I felt like I could get tendinitis, I am not kidding”
P10 - “Initially both are difficult, they are a very different experience, but with the circle the rotation is difficult to decide in which direction I am going, with the proper time maybe the the circle tool could not as hard”
P11 - “Circle has two degrees of freedom, line tool is much easier, most of the images are easier with the line tool except for the planar circle”

P12 - “This [Line] is a lot easier, circle is harder than I expected. But for some shapes is hard to put a flat rating on how easy it is because some parts on the shape are easier than others”
P12 - “In general the shapes are more benefited with the line tool, except for the planar circle. For example, the majority of shapes had vertical elements in which the line tool is superior”
P12 - “Drawing straight lines with circle is hard, the get squiggle, line was easier in that case”
P13 - “You see the line so you can predict the result”
P13 - “Using the circle you need to move your wrist more, with the line you have more degrees of freedom because you can move your wrist”
P13 - “The arm posture that you have to do with the circle, the circle is a good index but is different in the way you usually perceive things.”
P14 - “[circle] It is very hard”
P14 - “Drawing 3D circles is hard with the circle tool. The line tool I could feel it drawing”
P14 - “The circle is harder to put in practice”
P15 - “The line was easier, I can visualize how is going to be in 3D, before I draw I just see myself drawing easier, I felt more comfortable”
P15 - “I had to think too much to use the circle one”
P16 - “Circle has more artifacts, with the line tool I found some other issues but not as much”
P17 - “I realize that circle is way harder than I expected”
P17 - “On this occasion it is easier to handle the tool how it adapts to quicker movements, the circle needs more practice to adapt to the way it works”
P1 - “This one [line] is more easy but if you want to do the [planar] circle it was more difficult with the line tool, and with the circle tool is super easy”
P2 - “With the line tool sometimes I felt that the ribbon was coming from the back [of the cylindrical signifier] and sometimes from my side, and it was a bit confusing, so I had to start, make a small ribbon, erase it and then draw again”
P2 - “When I was doing the [planar] circle I could go with a spiral and it was easier than the line tool, and the line tool was easier for the [planar] square”
P2 - “On the donut I think my result was bad on both, but the circle was easier to go with the circle”
P3 - “At the beginning with the circle tool, I was using my previous knowledge of how the line operated and I was trying to transfer that to the circle tool but as soon I understood how the circle tool works, the best example is the cylinder, how quick you can spin it out the base and the top and then just go up and down it was super easy. I think the circle tool is easy to use, it is just a matter to understand how it works and the limitations of the tool and after that it was super quick and easy to use and very consistent. I feel that I had a little bit more precision with the line tool but I felt so much natural movement especially when drawing the planar shapes”
P4 - “Circle was easier, in the sphere you needed to turn around the surface”
P4 - “The most frustrating aspect is getting the orientation with the controls, the place of the buttons impact the ability to draw, I felt fatigued and uncomfortable. Also the posture, the way I was seated, but I felt this mitigated with the circle tool.”
P11 - “For the planar circle the circle tool is better.”
P16 - “With the line you can get a hook at the end of the ribbons”

P16 - “Different tools are better for certain, the [planar] circle is easier with the circle tool”

Q04 - I think that I would need assistance to be able to use the (LINE/CIRCLE) tool.

P7 - “I imagine myself needing a tutorial on how to use the circle better, I assume it has advantages”

P11 - “In general with both tools I might need assistance on how to draw a specific surface” (the pattern)

Q05 - I found the (LINE/CIRCLE) tool was well integrated with the other functions of the system

P1 - “I didn't have problems to use the other tools, move draw rotate and those functions”

P9 - “I found the entire system very easy to control, there is not a problem with the integration per se”

P9 - “The navigation in 3D is way better than other 3D modeling tools like Blender”

Q06 - I thought there was too much inconsistency in the way the (LINE/CIRCLE) tool works

P1 - “There are a couple of times in which the tool [line] can be inconsistent if you move your wrist, but less than with the other tool [circle]. The circle is a little more tricky with the wrist. Line has less inconsistencies”

P3 - “I think that after use it once [Line tool], I knew what I was going to do everytime I press the button. There was never a time were I wanted to draw something and got something unexpected, it was more to decide the proper way to use the tool for each shape.”

P5 - “The line is consistent”

P6 - “The circle is inconsistent at the end of the line, if you move your hand a bit, it can make an ugly twist, with the line I can end the lines more confident.”

P7 - “The circle requires so much, more moves of my wrist, it requires more effort, when you start or finish a ribbon you can get dirtier, it is difficult to find the right position to begin”

P9 - “Because the twisting, it is hard to keep in mind that the circle needs to be aligned to the surface, with the line there is only one direction that you need to keep in mind”

P9 - “The line is easier to control and the result is more similar to what you were thinking, the circle was more inconsistent and not what I was expecting”

P10 - “The line tool is very fixed, the circle is less clear what will be the result”

P10 - “The fact that you can see the line (with the line tool) you can know what is going to happen”

P11 - “With line you just move your hand and you know what is going to do”

P12 - “For me inconsistency is the difference between what I was expecting to happen and the actual result. The line tool is more predictable, the circle for example has this think of starting the line in the middle of the circle, it is harder.”

P13 - “Line has better dimensionality” [We ask the user to explain the concept] “Dimensionality concept is when you get a better understanding of where you are and the result that you will get”

P13 - “With the line you can see if you are moving in the right direction but with the circle, the direction of drawing is not clear until you move the hand”

P13 - “When I was using the circle I was more prone to make mistakes, sometimes I accidentally rotate my wrist so I get weird results, with the line tool than doesn’t happen, I was not very confident with the circle at moving my hands”
P16 - “With the circle tool there is not a clear understanding of what is doing”

Q07 - I would imagine that most people would learn to use the (LINE/CIRCLE) tool very quickly.

P1 - “Both are easy to learn, the more you use it the better you will be”
P7 - “[drawing] with the circle I needed to even turn the control upside down” (grabbing the control upside down).
P9 - “Line is very easy to learn and handle, I needed to have longer training time for the circle tool”
P9 - “Both tools are very fun to use”
P14 - “Learning could be the same for both”
P16 - “If you start, the line is easier, it is self-explanatory, the circle is harder to understand how to draw”
P17 - “I consider that you need much more practice for the circle tool, and the line I think it is possible to learn it in a short time”
P2 - “Because I felt that the circle has more precision I think it will require more training and more time to get used to. but in general I think my results with the circle were better”

Q08 - I found the (LINE/CIRCLE) tool very cumbersome/awkward to use.

P1 - “[circle] Is not awkward, it is more the accuracy problem, you need to move your hand a lot”
P5 - “[drawing] 3D shapes was very hard, but with the circle was extremely hard even to create straight ribbons”
P6 - “The awkwardness with the circle is mostly with the end of the strokes”
P10 - “I had to take the control on different positions on my hand to use the circle tool, sometimes I had to hold it like vertically and use my middle finger on the trigger”
P13 - “The way we use line is more similar to the conventional way in which we paint in the real world, the circle is not a conventional way of drawing”
P13 - “The only thing that made the circle awkward occasionally was trying to get the right angle from which start the ribbon, If I had a longer session I am sure I would get along better with that.
P6 - “The line tool is awkward to use in sharp edges like the planar circle”

Q09 - I felt very confident using the (LINE/CIRCLE) tool.

P1 - “My drawings are not good, I am not good at drawing, but I felt confident using the line tool. I think with more time I could draw better, it wasn't that bad for the first time.”
P5 - “With the line tool the movement was very smooth”
P5 - “The line tool is still hard, but the circle was at a different level of difficulty, it was extremely hard”
P7 - “I felt more confident with the line, but I see the potential of the other tool [circle] but I feel that I would need a tutorial”
P8 - “With the line I felt like drawing with pencil and paper”

P8 - “Drawing spirals would make draw the shapes much easier, and I know I can do those with the line, but I need more practice”
P13 - “Maybe I was more comfortable with the line because my previous experience with the circle”
P13 - “I made more unnecessary weird shapes with the circle, in general I was more confident with the line tool.”
P14 - “I felt more confident with the line tool, maybe because it was the second.”
P15 - “I felt more confident using the line. Maybe the circle option is better for some parts, if you could mix them in the same draw and I could change between both it would give me a better ability to draw and control”
P17 - “The line is like a painter roller, it is much easier for the person to draw.”
P2 - “It is more about me rather than the tool, because I saw that the images that I did was so awful so I cannot feel confident with my results, if I could practice more and get closer results I would feel better. I have never used VR or a system like this, it was very hard and new for me”
P8 - “The circle tool felt more dynamic, because I had to move my head more, I had more fun, but because it was the second one, and I had more practice”

Q10 - I needed to learn a lot of things before I could get going with the (LINE/CIRCLE) tool.

P1 - “It is easy to learn how to draw, there are just a few functions and it’s like 5 minutes to explain, it is more the fact that you need to practice”

General Comments

P2 - “Sometimes my hand is inside of something that I just draw, that does not happen in real life, and I was wow”
P4 - “it will be better if there were some way to lock the depth so I could draw to a plane”
P4 - “time was not important, I was not seeing the timer”
P4 - “[drawing] felt frustrating, with practice could be different”
P4 - “[drawing] The difficult part are the fine motor skills, and depth was very tricky to get along”
P4 - “I am not as competent in drawing”
P4 - “I felt very embarrassed that people were seeing me”
P5 - “It is very hard not having a surface to touch or to rest on”
P6 - “I would like to rotate this way [pitch, roll] instead of just this [yaw]”
P9 - “I think the pringle [Saddle] is definitely the most difficult one, the torus is the second most difficult, it took a lot of time thinking about how to draw it. The ellipsoid is hard also”
P9 - “For the cylinder, I changed the strategy, I think the first was not the best strategy.”
P9 - “The first time I saw a 3D shape I didn’t know if I needed to draw the surface, of to fill the volume, it took me like three seconds to realize that it was the surface”
P9 - “I think 3D drawing is easier that 3D modeling”
P10 - “[drawing] Being inside the shapes was easier”
P17 - “I would like to rotate in the other way [pitch, roll]”