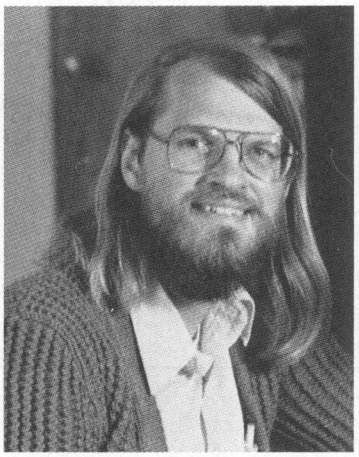
Jim Blinn's Corner



What, Teapots Again?

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Something short this month, since I'm spending so much time preparing for SIGGRAPH 87.

The teapot

A few months ago Frank Crow published an article here that gave the history of Martin Newell's teapot (see January 87 *CG&A*). He also included a database as an unstructured list of Bezier surfaces. There *is* some structure to the teapot though, and it allows a much more compact representation. Here it is.

The body

The body of the teapot is a surface of revolution with an outline consisting of three Bezier curves in the x,y plane. The surface is generated by rotating this outline curve about the *y* axis. The control point coordinates are

point nbr	x	y
1	1.4000	2.25000
2	1.3375	2.38125
3	1.4375	2.38125
4	1.5000	2.25000
5	1.7500	1.72500
6	2.0000	1.20000
7	2.0000	0.75000
8	2.0000	0.30000
9	1.5000	0.07500
10	1.5000	0.00000

The three curves are generated by points (1,2,3,4), (4,5,6,7), and (7,8,9,10). Note that points 3,4,5 are colinear, as are points 6,7,8, to make the segments blend together. A picture of the curve appears in Figure 1.

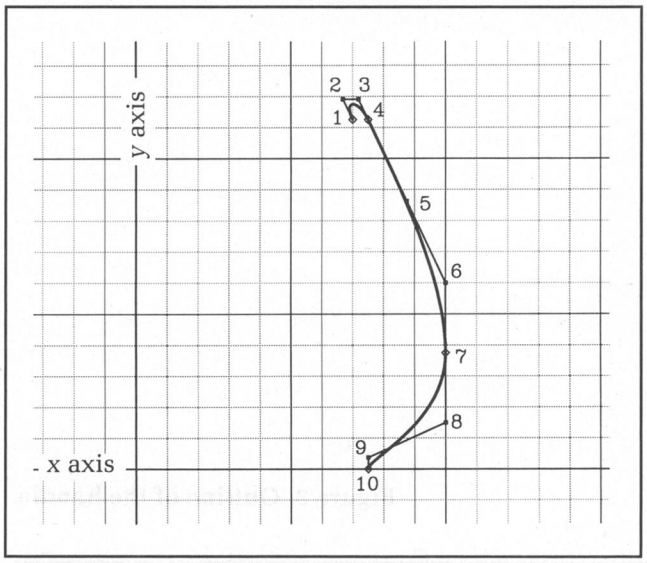

Figure 1. Outline of the body.

The lid

The lid is also a surface of revolution with a geometric construction similar to the body. A picture of the lid outline appears in Figure 2. The control point coordinates are

point nbr	x	y
1	0.0	3.00
2	0.8	3.00
3	0.0	2.70
4	0.2	2.55
5	0.4	2.40
6	1.3	2.40
7	1.3	2.25

0272-1716/87/0900-0061$01.00 1987 IEEE

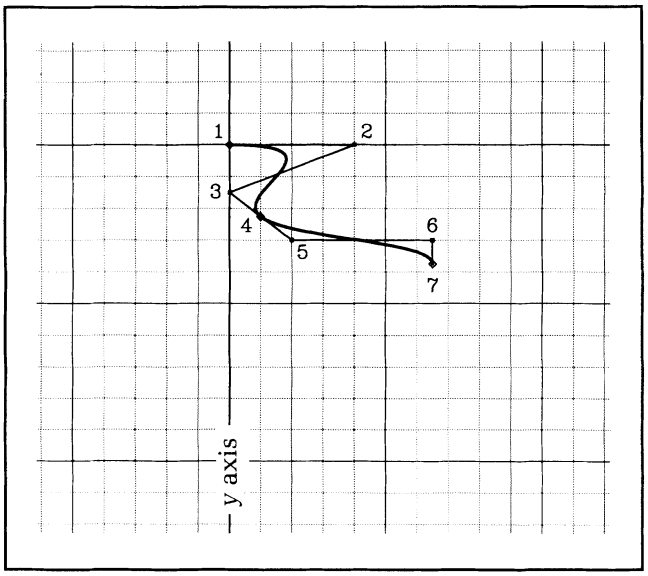

Figure 2. Outline of the lid.

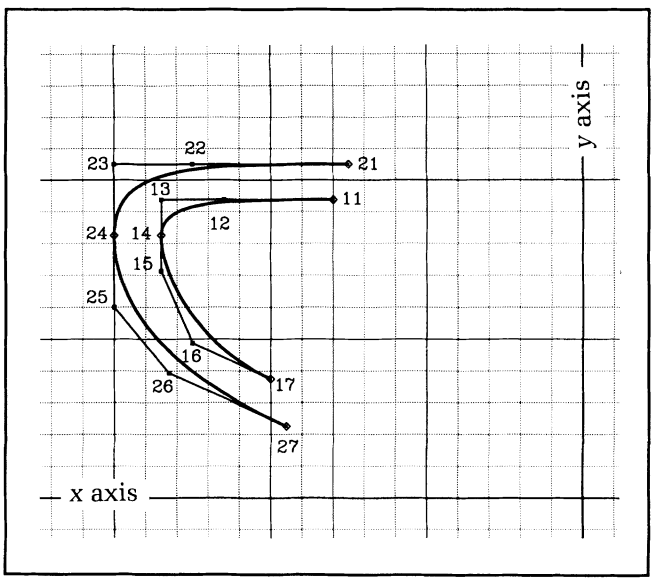

Figure 3. Outline of the handle.

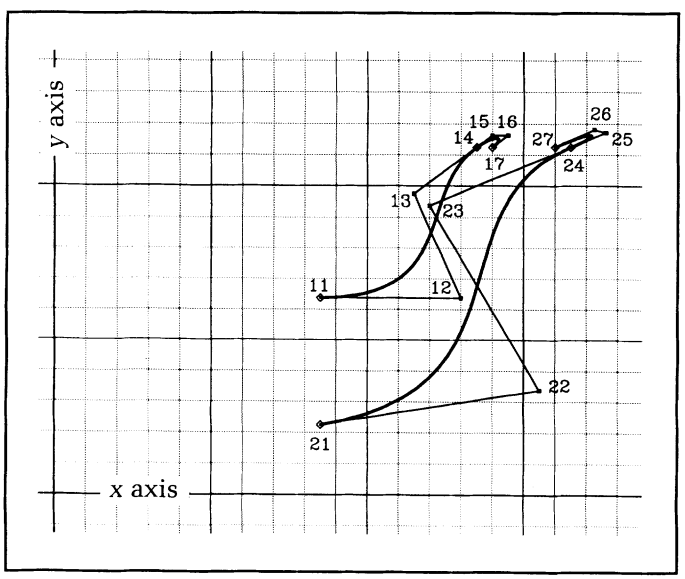

Figure 4. Outline of the spout.

The handle

The handle is symmetrical about the z=0 plane, so I'm only showing half of it—mirror it in z to get the other half. Each half consists of two patches; each patch has two (opposite) edges in the z=0 plane. A picture of these four curves (two per patch) appears in Figure 3. The control point coordinates are

point nbr	*x*	*y*
11	-1.60	1.8750
12	-2.30	1.8750
13	-2.70	1.8750
14	-2.70	1.6500
15	-2.70	1.4250
16	-2.50	0.9750
17	-2.00	0.7500
21	-1.50	2.1000
22	-2.50	2.1000
23	-3.00	2.1000
24	-3.00	1.6500
25	-3.00	1.2000
26	-2.65	0.7875
27	-1.90	0.4500

To generate a whole patch you need four columns of four control points each. The two outer columns come from the above curves. One patch uses points (11,12,13,14) and (21,22,23,24). The other patch uses (14,15,16,17) and (24,25,26,27). To satisfy the smoothness constraint across the mirror plane, the two middle columns must have the same x,y coordinates as their adjacent outer column. The z coordinates, though, are 0.3 instead of 0. To be perfectly explicit, the patch for the top half of the handle has, as its 16 control points, the following coordinates (the notation for each point is p,z, where p is the point number to use for the x,y coordinates):

21,.0	21,.3	11,.3	11,.0
22,.0	22,.3	12,.3	12,.0
23,.0	23,.3	13,.3	13,.0
24,.0	24,.3	14,.3	14,.0

The spout

The spout is similar to the handle except that all the z coordinates of the middle columns don't happen to be the same. A picture of the edge curves appears in Figure 4. The control point coordinates are

point nbr	*x*	*y*
11	1.700	1.27500
12	2.600	1.27500
13	2.300	1.95000
14	2.700	2.25000
15	2.800	2.32500
16	2.900	2.32500
17	2.800	2.25000
21	1.700	0.45000
22	3.100	0.67500
23	2.400	1.87500
24	3.300	2.25000
25	3.525	2.34375
26	3.450	2.36250
27	3.200	2.25000

Again, to satisfy the smoothness constraint, the middle columns of the patch control points must have the same x,y coordinates as their adjacent outer column. For these middle columns the z coordinates are

adjacent point nbr	*z*
11, 21	0.66
12, 22	0.66
13, 23	0.25
14, 24	0.25
15, 25	0.25
16, 26	0.15
17, 27	0.15

Spillage

The original design of the teapot was a bit taller than the one everybody uses today. This is because once, during a demo for ARPA, we scaled the whole object by .75 in the y direction. We thought at the time that they would be so impressed by this capability that they would give us lots more research money. (They didn't.) Anyway, we thought that the low profile teapot looked prettier, so we kept it that way. So, if you scale all the above y coordinates by 1.33333 you will see that the numbers get much rounder.

Leakage

Yes, in the original database the bottom of the teapot is missing. You can add a disk of radius 1.5 in the x,z plane if that is really important to you. And yes, as a matter of fact, the volume of the teapot is almost 42 (but only before it was squashed). ■