User Studies for 3-Sweep*

1 User Study

This supplemental file provides detailed statistics of the user study and screenshots of users' modeling results. In this user study, ten subjects were selected. Eight of them are undergraduate students majoring in computer science and electrical engineering while the other two are artists who are experienced in 3D modeling. Seven among the eight students are novices to 3D object modeling while the other one (S8) is interested in geometry processing and has modeling experience. Between the artists, one is professional in 3DMax and the other is professional in Blender. We provided 13 images for them and split the images into three sets. Set I consists of four images in which the objects are very simple shapes and can be represented by single primitives. Set II contains seven photos which are more complex. Objects in these photos have several parts but the constraints are rather simple. Set III has two photos, and several constraints should be added in the modeling process. We let the eight students and the two artists model the shapes in all the three sets. We asked the artists to load the images into the commercial softwares and try to model the objects as close as possible. Each of the students was given a five-minute instruction of our system.

During their modeling process, we recorded the time they used and saved their modeling results. We list the modeling time and modeling results below. Each model was presented to five evaluators (not selected as subjects) and their average scores are used. **The evaluators do not know which model comes from which subject.** We measured the quality of each model by a subjective score ranging from 1 to 5. Scores: 5 = very good, precise; 4 = good, but with slightly noticeable artifacts; 3 = obvious artifacts, but still acceptable; 2 = very obvious artifacts, not quite acceptable; 1 = very bad, unacceptable. We list modeling results and statistics below. For all the modeling results in the figures, the left is the source image; on the right, the first row contains five models from S1-S5; the first three models in the second row are from S6-S8 and the last two are from the artists using 3DMax and Blender respectively. For all the statistics and evaluation scores in the tables, S1-S8 indicate the eight students. A1 is the artist using 3DMax and A2 is the artist using Blender.

The statistics gathered show that using our tool is about 20 times faster than the commercial tools, while achieving a comparable modeling quality. Specifically, for Set I, the average modeling time of the artists is about 32.00 times of the students. The average score of the artists is 4.40, and using our tool is 4.37. For Set II, the respective numbers are 20.93, 4.37 and 4.10. For Set III, the respective numbers are 9.19, 4.60 and 4.36. The modeling speed and score of S8 do not show noticeable differences from other students. For the first two sets, the students usually spent 90% of the time on sketching the 3-sweeps. For the third set, averagely one third of the time were spent on manually providing geo-semantic constraints. The models generated by our tool are more faithful to the details in the images thanks to the edge snapping, but are less smooth, as the reason for most lower scores. This is because although our tool provides the functions to constrain the profile radii smoothness, they are not able to be mastered by the novice users within a short time. A further benefit is that as only our models provide a direct fit to the images, our tool can automatically texture map the model, which done manually may take an artist several hours. (so that we did not ask for texture mapping in this user study).

	Subjects:		S 1	S2	S 3	S4	S5	S 6	S 7	S 8	A1	A2
	model 1	modeling time (sec):	16	15	11	9	12	11	10	10	301	404
	model 1	average score:	4.4	4.2	4.4	4.6	4.4	4.2	4.0	3.8	4.6	4.8
	model 2	modeling time (sec):	7	10	9	6	8	9	7	11	191	250
Sot I	model 2	average score:	4.0	4.8	4.4	4.6	4.6	4.4	4.6	4.6	4.6	4.2
Set1	model 3	modeling time (sec):	6	12	9	6	10	10	9	9	376	477
	model 5	average score:	4.4	4.4	4.6	4.4	4.2	4.4	4.2	4.2	5.0	4.4
	model 4	modeling time (sec):	7	7	10	7	8	10	9	10	155	246
	IIIOuci 4	average score:	3.8	4.8	4.0	4.6	4.6	4.8	4.6	3.8	4.0	3.6
	model 5	modeling time (sec):	27	31	29	23	19	25	22	30	1266	843
	model 5	average score:	4.2	4.0	3.8	3.6	4.0	4.4	4.2	4.4	4.0	4.8
	model 6	modeling time (sec):	25	30	27	27	32	28	34	35	466	337
	model o	average score:	4.4	4.8	4.2	4.4	4.2	5.0	4.0	4.8	4.8	3.4
	model 7	modeling time (sec):	18	24	20	20	19	25	21	21	1090	359
	model /	average score:	4.2	4.4	4.2	4.0	3.8	3.8	3.6	4.0	5.0	2.6
Set II	model 8	modeling time (sec):	38	71	48	62	61	59	72	49	3033	504
Set II	model o	average score:	4.0	4.4	4.2	4.4	3.8	3.8	3.6	3.8	5.0	4.4
	model 0	modeling time (sec):	39	53	46	69	48	50	49	62	720	270
	model 9	average score:	4.8	4.2	3.4	3.6	4.0	4.2	3.8	4.4	4.0	4.0
	model 10	modeling time (sec):	57	99	85	87	75	84	82	78	2190	490
	model 10	average score:	4.2	4.2	3.8	3.6	3.6	3.8	4.2	4.4	4.8	4.6
	model 11	modeling time (sec):	17	25	25	26	18	31	24	20	394	183
	model 11	average score:	4.0	4.0	4.0	4.2	4.0	4.8	4.2	4.0	5.0	4.8
	model 12	modeling time (sec):	103	67	73	125	112	98	94	135	1682	1007
Set III		average score:	4.4	4.6	4.6	4.0	4.0	4.0	4.6	4.0	5.0	4.8
	model 13	modeling time (sec):	189	177	203	214	191	207	231	156	2041	728
		average score:	4.6	4.2	4.2	4.4	4.4	4.6	4.6	4.6	4.6	4.0

Table 1: The modeling time and average scores for models in the user study.



Figure 1: Model 1. Average evaluation scores: 4.4, 4.2, 4.4, 4.6, 4.4, 4.2, 4.0, 3.8, 4.6, 4.8.

	S 1	S2	S 3	S4	S5	S6	S7	S 8	A1	A2
Evaluator 1	4	4	4	5	4	4	3	3	3	4
Evaluator 2	5	4	4	5	4	4	3	4	5	5
Evaluator 3	4	4	4	4	5	4	5	4	5	5
Evaluator 4	4	4	5	4	5	4	4	4	5	5
Evaluator 5	5	5	5	5	4	5	5	4	5	5

Table 2: Evaluation for model 1.



Figure 2: Model 2. Average evaluation scores: 4.0, 4.8, 4.4, 4.6, 4.6, 4.4, 4.6, 4.6, 4.6, 4.2.

	S 1	S2	S3	S4	S5	S6	S 7	S 8	A1	A2
Evaluator 1	5	5	4	5	5	4	5	5	5	4
Evaluator 2	4	5	4	4	4	4	5	4	5	4
Evaluator 3	3	4	5	5	5	4	5	5	5	4
Evaluator 4	4	5	5	4	5	5	4	5	4	5
Evaluator 5	4	5	4	5	4	5	4	4	4	4

Table 3: Evaluation for model 2.



Figure 3: Model 3. Average evaluation scores: 4.4, 4.4, 4.6, 4.4, 4.2, 4.4, 4.2, 4.2, 5.0, 4.4.

	S 1	S2	S 3	S4	S5	S6	S7	S 8	A1	A2
Evaluator 1	4	4	4	5	5	5	5	4	5	5
Evaluator 2	4	5	4	4	4	5	4	4	5	5
Evaluator 3	5	5	5	4	4	4	4	5	5	4
Evaluator 4	4	4	5	4	4	4	4	4	5	4
Evaluator 5	5	4	5	5	4	4	4	4	5	4

Table 4: Evaluation for model 3.



Figure 4: Model 4. Average evaluation scores: 3.8, 4.8, 4.2, 4.6, 4.6, 4.8, 4.6, 4.2, 4.4, 4.0.

	S 1	S2	S 3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	4	5	4	5	5	5	5	4	4	3
Evaluator 2	3	4	4	4	4	4	3	3	4	4
Evaluator 3	4	5	4	4	5	5	5	4	4	3
Evaluator 4	4	5	4	5	5	5	5	4	4	4
Evaluator 5	4	5	4	5	4	5	5	4	4	4

Table 5: Evaluation for model 4.



Figure 5: Model 5. Average evaluation scores: 4.6, 4.4, 4.0, 3.6, 4.0, 4.4, 4.2, 4.2, 4.4, 4.8.

	S 1	S2	S 3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	5	4	4	4	4	5	5	5	4	5
Evaluator 2	4	4	3	4	4	4	4	5	4	5
Evaluator 3	4	4	4	3	4	5	4	4	4	5
Evaluator 4	4	4	4	3	4	4	4	4	4	5
Evaluator 5	4	4	4	4	4	4	4	4	4	4

Table 6: Evaluation for model 5.



	S 1	S2	S3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	5	5	4	5	4	5	4	5	5	3
Evaluator 2	5	5	4	4	4	5	4	4	5	3
Evaluator 3	4	5	4	5	4	5	4	5	5	3
Evaluator 4	4	5	4	4	4	5	4	5	4	4
Evaluator 5	4	4	5	4	5	5	4	5	5	4

Table 7: Evaluation for model 6.



Figure 7: Model 7. Average evaluation scores: 4.2, 4.4, 4.2, 4.0, 4.4, 4.0, 4.0, 4.2, 5.0, 3.4.

	S 1	S2	S 3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	5	5	4	4	4	3	4	4	5	3
Evaluator 2	4	5	5	4	3	4	3	4	5	3
Evaluator 3	4	4	4	4	4	4	3	4	5	2
Evaluator 4	4	4	4	4	4	4	4	4	5	2
Evaluator 5	4	4	4	4	4	4	4	4	5	3

Table 8: Evaluation for model 7.



Figure 8: Model 8. Average evaluation scores: 4.0, 4.4, 4.2, 4.4, 3.8, 3.8, 3.6, 3.8, 5.0, 4.4.

	S 1	S2	S3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	4	5	5	4	4	3	4	4	5	5
Evaluator 2	4	5	4	4	4	4	4	3	5	5
Evaluator 3	4	4	4	5	3	4	3	4	5	4
Evaluator 4	4	4	4	4	4	4	3	4	5	4
Evaluator 5	4	4	4	5	4	4	4	4	5	4

Table 9: Evaluation for model 8.



Figure 9: Model 9. Average evaluation scores: 4.6, 4.2, 3.6, 3.8, 3.6, 4.0, 3.8, 4.4, 4.4, 4.2.

	S 1	S2	S3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	5	4	4	4	4	4	3	5	4	4
Evaluator 2	5	4	3	4	4	4	4	4	4	4
Evaluator 3	5	5	3	4	4	5	4	5	4	4
Evaluator 4	4	4	4	3	4	4	4	4	4	4
Evaluator 5	5	4	3	3	4	4	4	4	4	4

Table 10: Evaluation for model 9.



Figure 10: Model 10. Average evaluation scores: 4.2, 4.2, 3.8, 3.6, 4.0, 4.4, 4.2, 4.6, 4.8, 4.4.

	S 1	S2	S3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	5	5	4	4	4	4	5	5	5	5
Evaluator 2	4	4	3	3	4	3	4	5	5	5
Evaluator 3	4	4	4	3	3	4	4	4	5	5
Evaluator 4	4	4	4	4	3	4	4	4	4	4
Evaluator 5	4	4	4	4	4	4	4	4	5	4

Table 11: Evaluation for model 10.



Figure 11: Model 11. Average evaluation scores: 4.2, 4.4, 4.4, 4.4, 4.2, 4.8, 4.6, 4.6, 4.8, 4.8.

	S 1	S2	S3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	4	4	4	5	4	5	4	4	5	4
Evaluator 2	4	4	4	4	4	5	4	4	5	5
Evaluator 3	4	4	4	4	4	5	5	4	5	5
Evaluator 4	4	4	4	4	4	5	4	4	5	5
Evaluator 5	4	4	4	4	4	4	4	4	5	5

Table 12: Evaluation for model 11.



Figure 12: Model 12. Average evaluation scores: 4.4, 4.6, 4.6, 4.0, 4.0, 4.0, 4.0, 4.0, 5.0, 4.8.

	S 1	S2	S 3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	4	4	4	4	4	4	4	4	5	5
Evaluator 2	5	5	5	4	4	4	5	4	5	5
Evaluator 3	5	5	5	4	4	4	5	4	5	4
Evaluator 4	4	5	5	4	4	4	5	4	5	5
Evaluator 5	4	4	4	4	4	4	4	4	5	5

Table 13: Evaluation for model 12.



Figure 13: Model 13. Average evaluation scores: 4.6, 4.0, 4.6, 4.4, 4.4, 4.6, 4.4, 4.6, 4.6, 4.2.

	S 1	S2	S 3	S4	S5	S 6	S 7	S 8	A1	A2
Evaluator 1	5	4	4	4	4	5	5	5	5	4
Evaluator 2	5	5	5	5	5	5	4	5	5	4
Evaluator 3	4	4	4	4	4	4	5	5	4	4
Evaluator 4	4	4	4	4	4	4	4	4	5	4
Evaluator 5	5	4	4	5	5	5	5	4	4	4

Table 14: Evaluation for model 13.