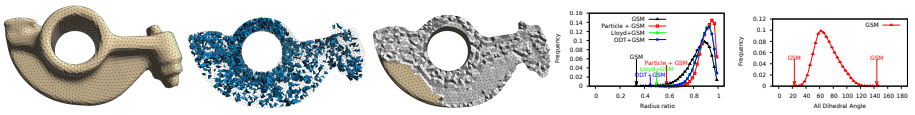
Supplementary Document: More Experiment Results

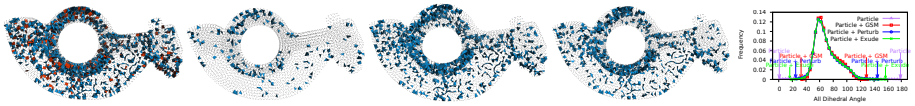
In this document, we list 7 extra models, which are omitted from the paper due to the page limit, to further show the robustness of our GSM method. These are isotropic tetrahedral meshing results. Fig. 1 is an experiment of the Rockarm volume with 10,000 vertices. Fig. 2 is an experiment of the Sphere volume with 5,000 vertices. Fig. 3 is an experiment of the Cube model volume 10,000 vertices. Fig. 4 is an experiment of the Bimba model volume 20,000 vertices. Fig. 5 is an experiment of the Dinosaur volume with 15,000 vertices. Fig. 6 is an experiment of the Fertility volume with 30,000 vertices. Fig. 7 is an experiment on the Elephant volume with 10,000 vertices.

Their corresponding quality statistics are shown in Sec. 2 in the same order as the figures. We use bold font in the tables to point out the best results among all methods. Note that the last two models, i.e., Fertility and Elephant, we only show the results of GSM and Particle+GSM methods. Since Particle+GSM has the best dihedral performance when using GSM as postprocessing. We can see that GSM, either as a standalone optimization method or as postprocessing after some global mesh optimizations, has consistent good performance over all different volumes, which is the same conclusion as mentioned in the paper.

1. Meshing Results



(a) Model (b) GSM (c) Particle+GSM Clipping (d) Radius Ratio (e) Dihedral Angle



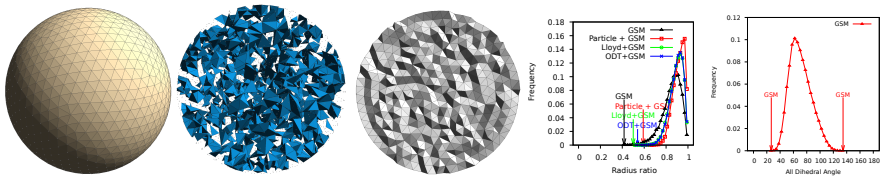
(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exude (j) Dihedral Angle

(k) Lloyd (l) Lloyd+GSM (m) Lloyd+Perturb (n) Lloyd+Exude (o) Dihedral Angle

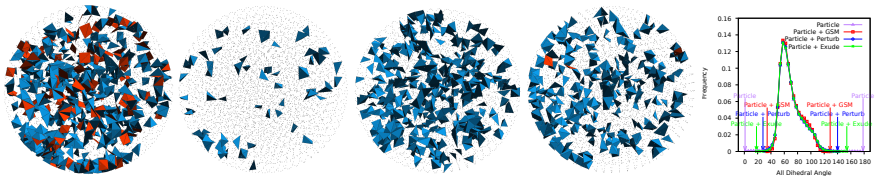
(p) ODT (q) ODT+GSM (r) ODT+Perturb (s) ODT+Exude (t) Dihedral Angle

Figure 1: Rockarm volume meshing with 10,000 vertices. The red ones are tetrahedrons with the smallest dihedral less than 20°, while the blue ones are tetrahedrons with the smallest dihedral less than 40°.

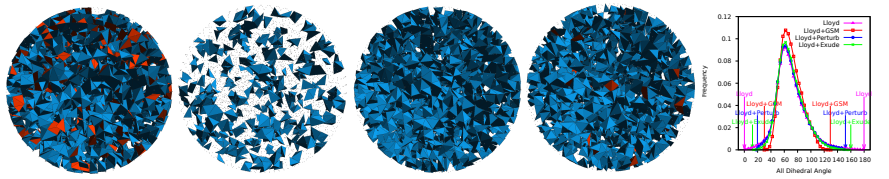
2. Quality Statistics Tables



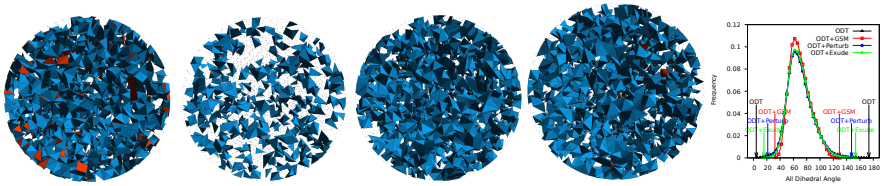
(a) Model (b) GSM (c) Particle+GSM Clipping (d) Radius Ratio (e) Dihedral Angle



(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exude (j) Dihedral Angle

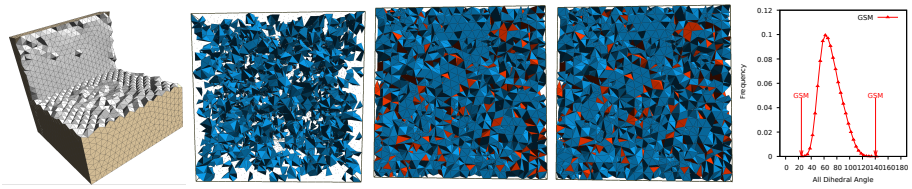


(k) Lloyd (l) Lloyd+GSM (m) Lloyd+Perturb (n) Lloyd+Exude (o) Dihedral Angle

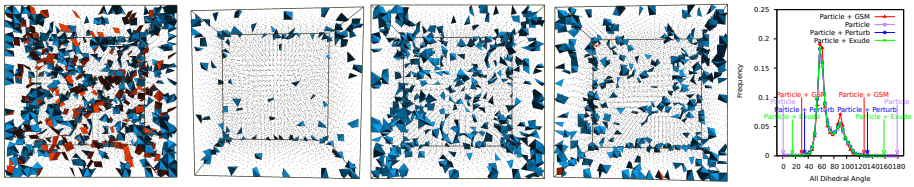


(p) ODT (q) ODT+GSM (r) ODT+Perturb (s) ODT+Exude (t) Dihedral Angle

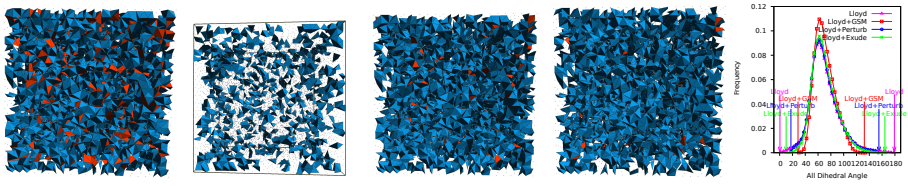
Figure 2: Sphere volume meshing with 5000 vertices. The red ones are tetrahedrons with the smallest dihedral angles less than 20, while the blue ones are tetrahedrons with smallest dihedral angles less than 40.



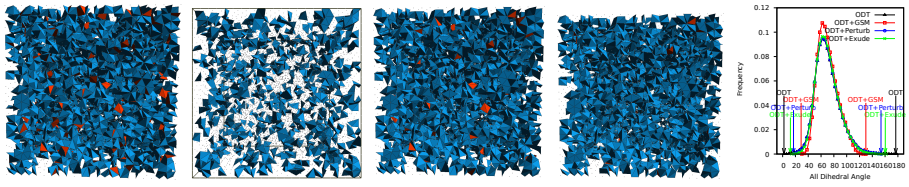
(a) Particle+GSM Clipping (b) GSM (c) Perturb (d) Exude (e) Dihedral Angle



(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exude (j) Dihedral Angle

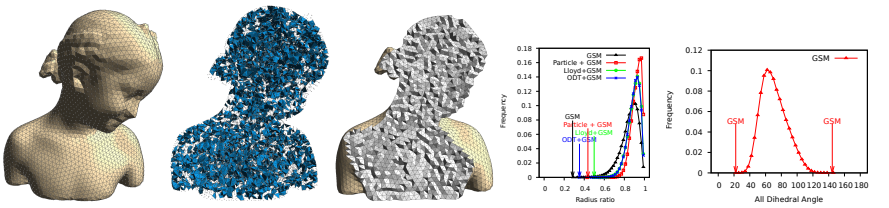


(k) Lloyd (l) Lloyd+GSM (m) Lloyd+Perturb (n) Lloyd+Exude (o) Dihedral Angle

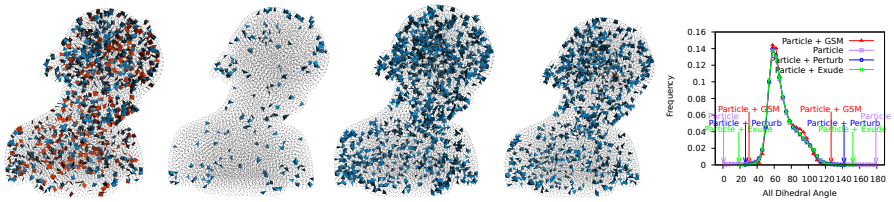


(p) ODT (q) ODT+GSM (r) ODT+Perturb (s) ODT+Exude (t) Dihedral Angle

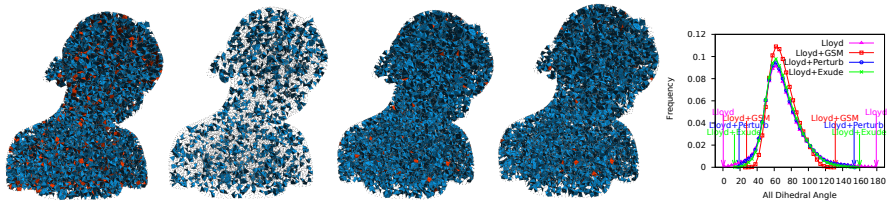
Figure 3: Cube volume meshing with 10,000 vertices. The red ones are tetrahedrons with the smallest dihedral angles less than 20, while the blue ones are tetrahedrons with the smallest dihedral angles less than 40.



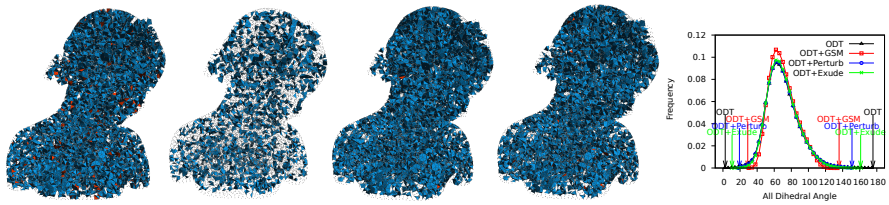
(a) Model (b) GSM (c) Particle+GSM Clipping (d) Radius Ratio (e) Dihedral Angle



(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exude (j) Dihedral Angle



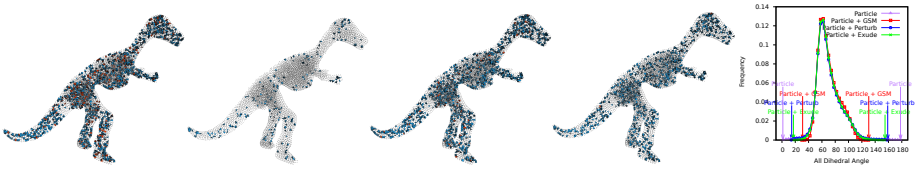
(k) Lloyd (l) Lloyd+GSM (m) Lloyd+Perturb (n) Lloyd+Exude (o) Dihedral Angle



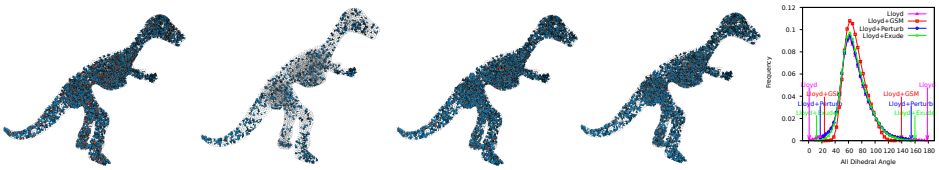
(p) ODT (q) ODT+GSM (r) ODT+Perturb (s) ODT+Exude (t) Dihedral Angle

Figure 4: Bimba volume meshing with 20,000 vertices. The red ones are tetrahedrons with the smallest dihedral less than 20°, while the blue ones are tetrahedrons with the smallest dihedral less than 40°.

(a) Model (b) GSM (c) Particle+GSM Clipping (d) Radius Ratio (e) Dihedral Angle



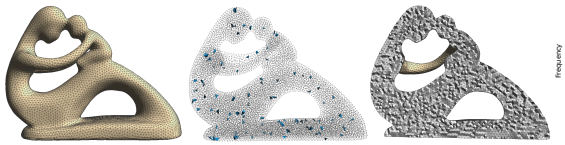
(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exuder (j) Dihedral Angle



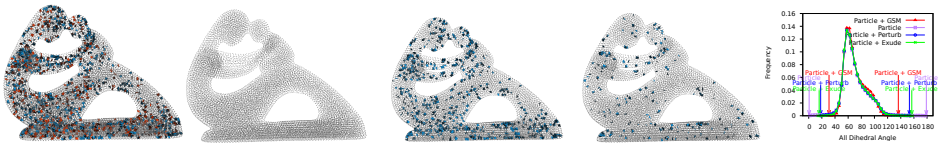
(k) Lloyd (l) Lloyd+GSM (m) Lloyd+Perturb (n) Lloyd+Exude (o) Dihedral Angle

(p) ODT (q) ODT+GSM (r) ODT+Perturb (s) ODT+Exude (t) Dihedral Angle

Figure 5: Dinosaur volume meshing with 15,000 vertices. The red ones are tetrahedrons with the smallest dihedral less than 20°, while the blue ones are tetrahedrons with the smallest dihedral less than 40°.



(a) Model (b) GSM (c) Partilce+GSM Clipping (d) Radius Ratio (e) Dihedral Angle

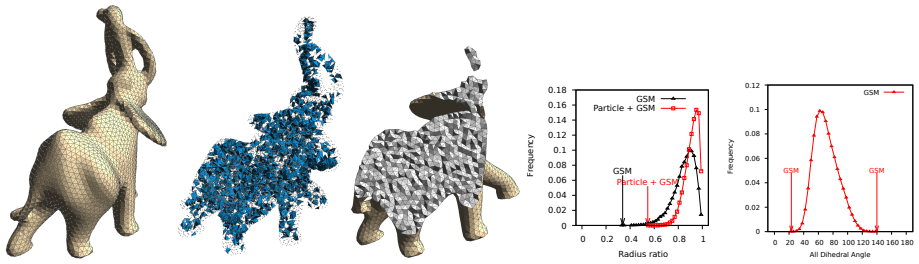


(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exude (j) Dihedral Angle

Figure 6: Fertility volume meshing with 30,000 vertices. The red ones are tetrahedrons with the smallest dihedral angles less than 15, while the blue ones are tetrahedrons with theh smallest dihedral angles less than 30.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10°$	$\# < 20°$	$\# < 30°$	$\# < 40°$	#tet
Init	0.333/179	0.00771/0.609	2801	10,308	20,702	32,029	51,944
GSM	23/144	0.335/0.843	0	0	86	2714	45,287
Particle	0.852/179	0.0163/0.885	168	461	963	2203	47,735
Particle+GSM	**32.8/129**	**0.58/0.909**	0	0	0	**232**	46,723
Particle+Perturb	20/151	0.366/0.896	0	1	269	1304	47,129
Particle+Exude	16.2/157	0.27/0.895	0	4	145	927	47,018
Lloyd	0.73/179	0.0125/0.842	208	984	2496	6443	48,694
Lloyd+GSM	27.4/131	0.5/0.887	0	0	3	1034	46194
Lloyd+Perturb	19.88/151.6	0.3576/0.8555	0	1	1378	5078	47,801
Lloyd+Exude	9.52/163	0.22/0.862	1	68	736	3974	47,304
ODT	4.74/173	0.0918/0.868	39	364	1277	5034	47,792
ODT+GSM	28.2/134	0.448/0.887	0	0	4	1202	46,278
ODT+Perturb	20/151	0.366/0.875	0	1	671	4340	47,336
ODT+Exude	14.2/157	0.281/0.877	0	36	487	3849	47,167

Table 1: Quality statistics of the Rockarm volume meshing with 10,000 vertices.



(a) Model (b) Particle (c) Particle+GSM Clipping (d) Radius Ratio (e) Dihedral Angle

(f) Particle (g) Particle+GSM (h) Particle+Perturb (i) Particle+Exude (j) Dihedral Angle

Figure 7: Elephant volume meshing with 10,000 vertices. The red ones are tetrahedrons with the smallest dihedral less than 20°, which the blue ones are tetrahedrons with the smallest dihedral less than 40°.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10°$	$\# < 20°$	$\# < 30°$	$\# < 40°$	#tet
Init	0.2433/178.9	0.007693/0.5926	1623	6186	12,549	19,124	29,001
GSM	26.71/134.6	0.4161/0.8518	0	0	7	1085	24,932
Particle	1.115/178.4	0.02119/0.8957	82	195	342	813	26,230
Particle+GSM	**34.26/128.9**	**0.591/0.9152**	0	0	0	**64**	25,839
Particle+Perturb	28/140.1	0.4939/0.9039	0	3	28	298	25,940
Particle+Exude	18.3/153.9	0.3119/0.9025	0	3	28	298	25,940
Lloyd	0.1057/179.8	0.002366/0.8444	119	502	1344	3468	26,900
Lloyd+GSM	30.1/129.2	0.5/0.8931	0	0	0	426	25,479
Lloyd+Perturb	19.66/151.9	0.3577/0.8576	0	1	761	2732	26,439
Lloyd+Exude	12.28/159.9	0.2476/0.8642	0	27	370	2100	26,126
ODT	4.193/173.4	0.08287/0.8769	22	162	563	2352	26,308
ODT+GSM	32.17/129.1	0.5398/0.8944	0	0	0	502	25,551
ODT+Perturb	21.43/147.3	0.4035/0.882	0	0	322	2068	26,119
ODT+Exude	15.7/153.5	0.3342/0.8847	0	11	216	1794	26,012

Table 2: Quality statistics of the Sphere volume meshing with 5000 vertices.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10°$	$\# < 20°$	$\# < 30°$	$\# < 40°$	#tet
Init	0.265/178.9	0.0063/0.595	3270	12,373	24,987	38,399	58,432
GSM	24.6/140	0.382/0.85	0	0	31	2298	50,278
Perturb	4.27/172	0.0504/0.586	2613	12,267	26,555	41,862	61,216
Exude	0.743/175	0.0231/0.596	1876	10,690	24,814	40,317	59,983
Particle	0.802/178.81	0.016/0.907	126	306	524	1152	52,808
Particle+GSM	**29.749/127.216**	**0.539/0.923**	0	0	**1**	**126**	52,202
Particle+Perturb	17.77/154.2	0.313/0.91	0	41	256	915	52,521
Particle+Exude	15.048/158.265	0.253/0.913	0	5	58	454	52,369
Lloyd	0.495/179	0.00987/0.844	233	1037	2800	7311	54,221
Lloyd+GSM	28.7/132	0.5/0.893	0	0	5	927	51,324
Lloyd+Perturb	17.66/155	0.3049/0.8558	0	218	1881	6138	53,106
Lloyd+Exude	10.1/164	0.16/0.864	0	68	857	4619	52,656
ODT	2.06/177	0.0395/0.876	35	315	1272	5326	52,975
ODT+GSM	28.8/130	0.473/0.894	0	0	2	1084	51,445
ODT+Perturb	17/154	0.333/0.879	0	86	987	4972	52,756
ODT+Exude	12.1/160	0.254/0.884	0	38	544	4169	52,381

Table 3: Quality statistics of the Cube volume meshing with 10,000 vertices.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10°$	$\# < 20°$	$\# < 30°$	$\# < 40°$	#tet
Init	0.307/179	0.00818/0.584	6878	26,084	52,860	80,286	118,614
GSM	21.1/145	0.284/0.852	0	0	63	4357	101,859
Particle	0.751/179	0.0141/0.901	301	776	1334	2932	106,961
Particle+GSM	**30.6/127**	**0.436/0.921**	0	0	0	**175**	105,377
Particle+Perturb	26.4/142	0.466/0.909	0	0	145	1421	105,895
Particle+Exude	18.7/152	0.353/0.908	0	4	104	1077	105,810
Lloyd	0.541/179	0.0111/0.848	437	1925	5222	13,975	109,592
Lloyd+GSM	27.6/131	0.499/0.895	0	0	4	1692	103924
Lloyd+Perturb	18.87/153.5	0.3261/0.8596	0	249	3305	11,548	108,005
Lloyd+Exude	13.5/160	0.257/0.867	0	92	1533	8650	106,596
ODT	2.69/175	0.0539/0.878	56	543	2244	9757	107,400
ODT+GSM	29.1/142	0.353/0.894	0	0	2	2005	104,237
ODT+Perturb	19.32/151	0.3652/0.8824	0	1	1579	9187	106,723
ODT+Exude	10.67/161.1	0.2311/0.8859	0	74	953	7835	106,155

Table 4: Quality statistics of the Bimba volume meshing with 20,000 vertices.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10°$	$\# < 20°$	$\# < 30°$	$\# < 40°$	#tet
Init	0.2815/178.9	0.006723/0.5998	4616	17,010	33,628	50,900	80,433
GSM	18.85/141.7	0.3523/0.8498	0	1	95	3647	69,686
Particle	1.322/178.1	0.02519/0.8924	221	681	1333	3115	73,200
Particle+GSM	**31.04/130.4**	**0.5397/0.9152**	0	0	0	**247**	71,682
Particle+Perturb	14.57/158.9	0.2574/0.8976	0	231	876	2532	72,754
Particle+Exude	17.18/154.9	0.3119/0.9031	0	8	157	1461	72,157
Lloyd	0.9108/178.5	0.01882/0.8451	332	1367	3706	9730	74,785
Lloyd+GSM	23.87/139.5	0.4361/0.891	0	0	20	1460	70,867
Lloyd+Perturb	17.57/154.2	0.3121/0.8566	0	279	2424	8091	73,370
Lloyd+Exude	11.98/159.8	0.2061/0.8644	0	88	1048	6210	72,747
ODT	1.668/176	0.04018/0.8732	67	497	1815	7361	73,277
ODT+GSM	22.45/133	0.4748/0.8907	0	0	8	1694	70,619
ODT+Perturb	20.71/149.3	0.3748/0.8789	0	0	1117	6466	72,407
ODT+Exude	12.69/158.5	0.2768/0.8811	0	54	712	5863	72,455

Table 5: Quality statistics for the Dinosaur volume meshing with 15,000 verties.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10^\circ$	$\# < 20^\circ$	$\# < 30^\circ$	$\# < 40^\circ$	#tet
Init	0.245/179	0.00645/0.6	9593	35,604	71,653	110,689	170,393
GSM	22.3/140	0.299/0.85	0	0	132	6989	146,705
Particle	0.698/179	0.0143/0.896	491	1250	2347	5175	154,262
Particle+GSM	**30.8/134**	**0.499/0.918**	0	0	0	**364**	151,677
Particle+Perturb	18.2/153	0.343/0.903	0	88	1148	3577	153,116
Particle+Exude	15.9/157	0.241/0.904	0	11	285	1981	152,380

Table 6: Quality statistics of the Fertility volume meshing with 30,000 vertices.

Method	$\theta_{min}/\theta_{max}$	$\gamma_{min}/\gamma_{mean}$	$\# < 10^\circ$	$\# < 20^\circ$	$\# < 30^\circ$	$\# < 40^\circ$	#tet
Init	0.329/179	0.000214/0.608	2933	10,699	21,528	33,644	53,105
GSM	22.8/145	0.338/0.849	0	0	53	2295	45,918
Particle	0.715/179	0.0139/0.882	156	559	1292	3169	49,084
Particle+GSM	**31.7/127**	**0.547/0.912**	0	0	0	**345**	47,626
Particle+Perturb	24.5/146	0.405/0.894	0	0	407	2022	48,345
Particle+Exude	11.9/160	0.228/0.894	0	12	207	1530	48,184

Table 7: Quality statistics for the Elephant volume meshing with 10,000 vertices