User Study Results

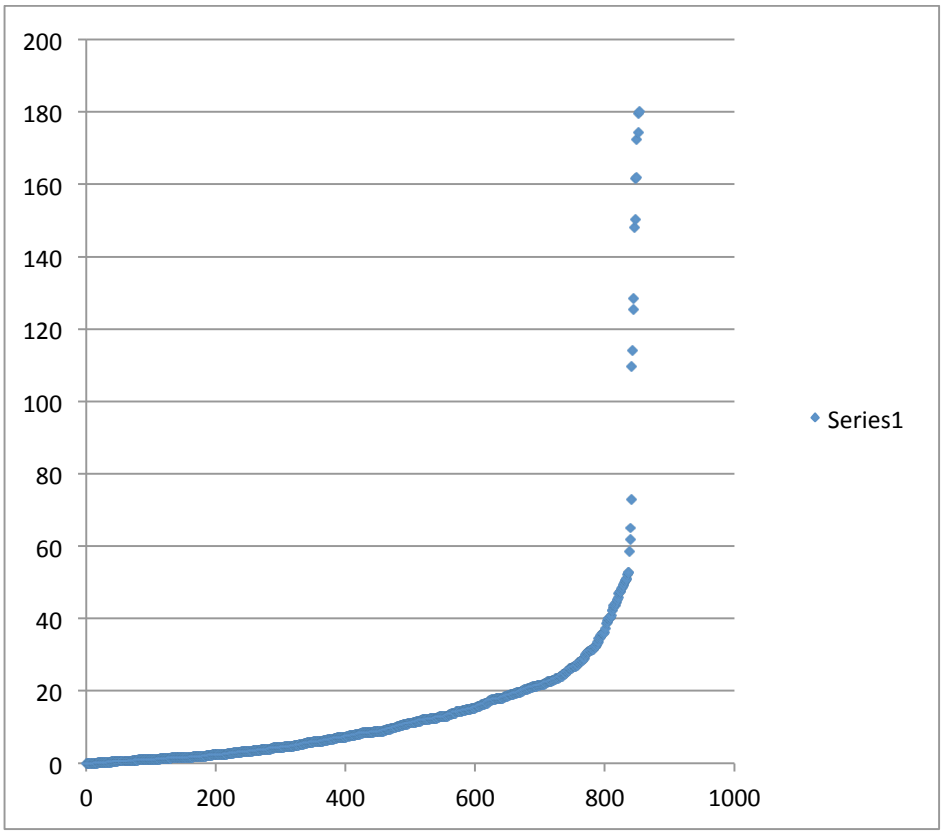
We present here further details and statistics pertaining to our user study on viewer perception of design cross-hairs.

Sketch data-set: Our stimulus captures a variety of shape types, both abstract (ashtray) and recognizable (stapler), from simple (ellipsoid) to more complex (bowl, torus) We employ a mix of 4 designer sketches (e.g. stapler, tube) and 7 actual 3D shapes (e.g. trebol, torus) rendered using silhouettes and cross-sections with orthogonal properties, from an artist specified viewpoint. We present these sketches in three forms to observe the impact of cross-hair composition on shape perception: as complete sketches with cross-sections and silhouettes; as partial cross-sections clipped around cross-hairs at roughly a third of their arc-length; and as isolated crosshairs, randomly translated in the view plane to mitigate any memory bias.

User Interface: Perception of 3D surface normals are typically tested by the interactive orientation of gauges. Our pilot study, however, revealed a user tendency to orient the gauge by attempting to turn the base into an ellipse whose axes align with the cross-hair in the view plane. This base to cross-hair alignment (blue gauge inset) reinforces perceived cross-hair orthogonality (property 2 in Section 3), but affects estimation accuracy, unless we add a third degree of freedom to orient the frame. Instead, since the cross-hair itself perceptually functions as a base, we simply ask users to interactively specify the projected surface normal using a line connected to the cross-hair center, improving ground truth correlation. We can do this since none of our ground-truth cross-hair normals are near perpendicular to the view-plane. We also do not fix the length of the specified normal allowing users to draw freely, so we may observe any systematic use of line length.

User Study Protocol: 25 designers and 30 non-designers were shown, in random order, 50 to 80 sketches on which a single cross-hair normal was queried. Each cross-hair normal was queried twice at different points in the study.

Results:
The paper reports aggregate statistics for our measures of persistence, consistency and accuracy. A plot of the user deviation from ground truth data is shown below clearly indicating viewer accuracy in perceiving ground truth 3D normals:



We also report the significance of our accuracy statistic to be 0.03 for an angle of 15 degrees indicating that with 97% confidence users are accurate to within 15 degrees of the ground truth normals. We do note that our data does not follow a normal distribution but is in fact substantially skewed towards smaller angles (median of 8.3 and mean of 13.7). In this regard, the reported confidence is but a lower bound and our confidence that the viewers perceive ground truth normals accurately is somewhat higher.

We also provide the detailed breakdown of each presentation format and each model:

Number of non-designer participants: 30

Number of designer participants: 25

Complete crosses

	Non-Designers	Designers	Everyone
Average pairwise difference between users	Mean: 16.2 STD: 16.8 Median: 10.4 Samples: 7124 Flipped: 225	Mean: 15.7 STD: 16.1 Median: 10.8 Samples: 5455 Flipped: 93	Mean: 15.7 STD: 16.0 Median: 10.6 Samples: 21126 Flipped: 456
Average difference between users and ground truth	Mean: 14.3 STD: 22.1 Median: 8.4 Samples: 534	Mean: 12.7 STD: 17.0 Median: 7.8 Samples: 322	Mean: 13.7 STD: 20.4 Median: 8.3 Samples: 853
Average difference between users and our results	Mean: 12.6 STD: 12.5 Median: 9.2 Samples: 720 Flipped: 8	Mean: 12.6 STD: 12.7 Median: 8.4 Samples: 603 Flipped: 5	Mean: 12.6 STD: 12.6 Median: 8.7 Samples: 1319 Flipped: 13
Average difference between first and second attempt	Mean: 9.8 STD: 12.1 Median: 5.3 Samples: 358 Flipped: 2	Mean: 10.3 STD: 12.5 Median: 6.0 Samples: 297 Flipped: 5	Mean: 10.1 STD: 12.3 Median: 5.8 Samples: 655 Flipped: 7
Average difference between our result and ground truth	Mean: 2.6 STD: 2.1 Median: 2.3 Samples: 26		

Number of non-designer participants: 30

Number of designer participants: 25

Isolated crosses

	Non-Designers	Designers	Everyone
Average pairwise difference between users	Mean: 13.9 STD: 12.7 Median: 10.7 Samples: 1910 Flipped: 245	Mean: 17.1 STD: 18.2 Median: 11.9 Samples: 2023 Flipped: 466	Mean: 16.0 STD: 16.1 Median: 11.5 Samples: 7805 Flipped: 1482
Average difference between first and second attempt	Mean: 11.5 STD: 11.6 Median: 8.8 Samples: 116 Flipped: 8	Mean: 11.7 STD: 14.8 Median: 6.6 Samples: 119 Flipped: 16	Mean: 11.6 STD: 13.3 Median: 7.5 Samples: 235 Flipped: 24

Number of non-designer participants: 30

Number of designer participants: 25

Partial crosses

	Non-Designers	Designers	Everyone
Average pairwise difference between users	Mean: 16.8 STD: 18.2 Median: 10.9 Samples: 2550 Flipped: 160	Mean: 16.7 STD: 18.6 Median: 10.0 Samples: 5138 Flipped: 587	Mean: 17.4 STD: 19.2 Median: 10.7 Samples: 15149 Flipped: 1451
Average difference between users and ground truth	Mean: 17.2 STD: 27.4 Median: 9.4 Samples: 188	Mean: 18.7 STD: 32.9 Median: 8.3 Samples: 280	Mean: 18.1 STD: 30.9 Median: 8.6 Samples: 467
Average difference between users and our results	Mean: 15.7 STD: 17.3 Median: 10.5 Samples: 388 Flipped: 18	Mean: 13.7 STD: 15.6 Median: 9.3 Samples: 547 Flipped: 36	Mean: 14.5 STD: 16.3 Median: 9.7 Samples: 934 Flipped: 54
Average difference between first and second attempt	Mean: 12.1 STD: 16.4 Median: 6.5 Samples: 194 Flipped: 8	Mean: 12.1 STD: 17.1 Median: 6.8 Samples: 269 Flipped: 20	Mean: 12.1 STD: 16.8 Median: 6.7 Samples: 463 Flipped: 28
Average difference between our result and ground truth	Mean: 2.4 STD: 1.5 Median: 2.7 Samples: 14		

Average statistics by image

Cross	Type	Pairwise difference	Users vs ground truth	Users vs our results	First vs second answer	Us vs ground truth
Car #2	Complete	Mean: 27.8 STD: 19.3 Median: 25.5 Samples: 528		Mean: 26.9 STD: 19.1 Median: 21.5 Samples: 33	Mean: 17.1 STD: 21.7 Median: 10.9 Samples: 16	
Car #3	Complete	Mean: 7.2 STD: 6.4 Median: 5.5 Samples: 496		Mean: 7.0 STD: 3.9 Median: 6.7 Samples: 32	Mean: 5.2 STD: 7.2 Median: 3.0 Samples: 16	
Car #5	Complete	Mean: 35.4 STD: 24.5 Median: 33.6 Samples: 435 Flipped: 36		Mean: 27.5 STD: 19.4 Median: 27.5 Samples: 30	Mean: 22.6 STD: 25.3 Median: 13.8 Samples: 15	
Bump #1	Complete	Mean: 26.2 STD: 20.3 Median: 23.9 Samples: 561		Mean: 20.3 STD: 11.0 Median: 20.0 Samples: 34	Mean: 16.4 STD: 15.5 Median: 13.1 Samples: 17	
Bump #2	Complete	Mean: 9.7 STD: 7.9 Median: 7.5 Samples: 561		Mean: 7.5 STD: 5.0 Median: 7.9 Samples: 34	Mean: 6.3 STD: 5.4 Median: 4.6 Samples: 17	
Bump #3	Complete	Mean: 3.2 STD: 3.5 Median: 2.1 Samples: 561		Mean: 4.9 STD: 2.0 Median: 4.7 Samples: 34	Mean: 3.5 STD: 3.4 Median: 2.2 Samples: 17	

Cone #1	Complete	Mean: 13.2 STD: 9.8 Median: 11.2 Samples: 595	Mean: 9.3 STD: 7.9 Median: 7.7 Samples: 35	Mean: 9.5 STD: 8.2 Median: 8.1 Samples: 35	Mean: 7.7 STD: 8.9 Median: 4.5 Samples: 17	Mean: 0.7 STD: 0.0 Median: 0.7 Samples: 1
Cone #2	Complete	Mean: 12.5 STD: 12.2 Median: 9.7 Samples: 528	Mean: 8.0 STD: 9.2 Median: 2.5 Samples: 33	Mean: 7.8 STD: 9.3 Median: 2.2 Samples: 33	Mean: 10.4 STD: 14.2 Median: 2.8 Samples: 15	Mean: 5.9 STD: 0.0 Median: 5.9 Samples: 1
Cone #3	Complete	Mean: 14.9 STD: 12.3 Median: 11.8 Samples: 630	Mean: 13.3 STD: 12.2 Median: 10.8 Samples: 36	Mean: 13.0 STD: 12.1 Median: 10.3 Samples: 36	Mean: 10.5 STD: 8.8 Median: 10.2 Samples: 18	Mean: 0.6 STD: 0.0 Median: 0.6 Samples: 1
Ellipsoid #1	Complete	Mean: 7.8 STD: 6.4 Median: 5.7 Samples: 561	Mean: 10.8 STD: 7.0 Median: 8.7 Samples: 34	Mean: 15.4 STD: 7.0 Median: 13.3 Samples: 34	Mean: 4.1 STD: 3.8 Median: 2.0 Samples: 17	Mean: 3.8 STD: 0.0 Median: 3.8 Samples: 1
Ellipsoid #3	Complete	Mean: 13.8 STD: 10.4 Median: 11.5 Samples: 561	Mean: 9.8 STD: 7.4 Median: 8.3 Samples: 34	Mean: 9.7 STD: 7.4 Median: 7.9 Samples: 34	Mean: 9.0 STD: 5.8 Median: 8.5 Samples: 17	Mean: 0.4 STD: 0.0 Median: 0.4 Samples: 1
Ellipsoid #8	Complete	Mean: 16.9 STD: 12.0 Median: 14.5 Samples: 496	Mean: 12.6 STD: 9.3 Median: 11.3 Samples: 32	Mean: 12.2 STD: 9.0 Median: 11.7 Samples: 32	Mean: 10.4 STD: 11.9 Median: 6.2 Samples: 16	Mean: 1.0 STD: 0.0 Median: 1.0 Samples: 1
Torus #1	Complete	Mean: 16.5 STD: 13.6 Median: 15.3 Samples:	Mean: 10.8 STD: 10.2 Median: 5.6 Samples:	Mean: 10.5 STD: 10.6 Median: 6.1 Samples:	Mean: 11.1 STD: 11.3 Median: 5.0 Samples: 17	Mean: 1.6 STD: 0.0 Median: 1.6 Samples:

		561	34	34		1
Torus #3	Complete	Mean: 14.5 STD: 13.7 Median: 11.7 Samples: 435	Mean: 9.6 STD: 11.7 Median: 4.3 Samples: 30	Mean: 9.3 STD: 10.9 Median: 5.4 Samples: 30	Mean: 7.5 STD: 6.6 Median: 6.6 Samples: 15	Mean: 3.1 STD: 0.0 Median: 3.1 Samples: 1
Torus #10	Complete	Mean: 22.8 STD: 23.1 Median: 14.2 Samples: 496 Flipped: 83	Mean: 19.3 STD: 32.3 Median: 7.9 Samples: 32	Mean: 14.8 STD: 17.4 Median: 8.6 Samples: 32 Flipped: 3	Mean: 10.5 STD: 11.4 Median: 6.1 Samples: 16 Flipped: 1	Mean: 2.3 STD: 0.0 Median: 2.3 Samples: 1
Torus #11	Complete	Mean: 11.9 STD: 8.7 Median: 9.9 Samples: 528	Mean: 8.1 STD: 6.5 Median: 5.0 Samples: 33	Mean: 9.0 STD: 7.6 Median: 7.8 Samples: 33	Mean: 11.5 STD: 9.9 Median: 11.3 Samples: 16	Mean: 3.3 STD: 0.0 Median: 3.3 Samples: 1
Torus #12	Complete	Mean: 13.0 STD: 10.4 Median: 10.4 Samples: 561	Mean: 10.7 STD: 8.8 Median: 8.8 Samples: 34	Mean: 10.1 STD: 8.6 Median: 8.4 Samples: 34	Mean: 9.7 STD: 9.1 Median: 5.1 Samples: 17	Mean: 2.9 STD: 0.0 Median: 2.9 Samples: 1
Trebol #2	Complete	Mean: 15.8 STD: 11.2 Median: 14.0 Samples: 561	Mean: 12.4 STD: 7.2 Median: 14.4 Samples: 34	Mean: 12.8 STD: 7.2 Median: 13.8 Samples: 34	Mean: 11.6 STD: 11.0 Median: 7.2 Samples: 17	Mean: 2.2 STD: 0.0 Median: 2.2 Samples: 1
Trebol #5	Complete	Mean: 17.8 STD: 13.5 Median: 14.7 Samples: 561	Mean: 13.8 STD: 12.0 Median: 10.0 Samples: 34	Mean: 15.2 STD: 12.9 Median: 11.8 Samples: 34	Mean: 11.9 STD: 13.4 Median: 6.2 Samples: 17	Mean: 3.7 STD: 0.0 Median: 3.7 Samples: 1
Trebol #7	Complete	Mean: 19.6 STD: 18.6 Median:	Mean: 27.1 STD: 14.5 Median:	Mean: 22.8 STD: 14.4 Median:	Mean: 21.6 STD: 16.6 Median:	Mean: 2.7 STD: 0.0 Median:

		15.2 Samples: 561 Flipped: 10	27.8 Samples: 34	22.7 Samples: 34	20.2 Samples: 17 Flipped: 1	2.7 Samples: 1
Stapler #1	Complete	Mean: 7.4 STD: 5.5 Median: 6.3 Samples: 528		Mean: 13.9 STD: 6.4 Median: 13.9 Samples: 33	Mean: 5.9 STD: 4.3 Median: 4.8 Samples: 16	
Stapler #2	Complete	Mean: 12.6 STD: 12.9 Median: 6.7 Samples: 561		Mean: 8.1 STD: 9.7 Median: 4.5 Samples: 34	Mean: 6.9 STD: 8.7 Median: 3.9 Samples: 17	
Stapler #3	Complete	Mean: 12.3 STD: 9.5 Median: 10.2 Samples: 630		Mean: 8.5 STD: 7.0 Median: 8.3 Samples: 36	Mean: 8.5 STD: 5.8 Median: 8.2 Samples: 18	
Stapler #5	Complete	Mean: 6.6 STD: 5.3 Median: 5.4 Samples: 496		Mean: 4.4 STD: 4.1 Median: 3.0 Samples: 32	Mean: 7.2 STD: 7.5 Median: 4.2 Samples: 16	
Tube #1	Complete	Mean: 16.4 STD: 13.7 Median: 13.0 Samples: 561 Flipped: 33		Mean: 12.5 STD: 11.7 Median: 10.2 Samples: 34 Flipped: 1	Mean: 8.3 STD: 7.1 Median: 6.0 Samples: 17 Flipped: 1	
Tube #2	Complete	Mean: 25.2 STD: 17.5 Median: 22.0 Samples: 496		Mean: 19.7 STD: 14.6 Median: 16.6 Samples: 32	Mean: 14.9 STD: 10.4 Median: 14.6 Samples: 16	

Tube #5	Complete	Mean: 20.1 STD: 19.0 Median: 14.7 Samples: 561 Flipped: 16		Mean: 13.7 STD: 15.7 Median: 10.7 Samples: 34	Mean: 10.7 STD: 13.4 Median: 5.3 Samples: 17 Flipped: 1	
Tube #6	Complete	Mean: 21.3 STD: 15.8 Median: 18.4 Samples: 561		Mean: 20.2 STD: 11.7 Median: 22.1 Samples: 34	Mean: 9.8 STD: 6.6 Median: 9.2 Samples: 17	
Ashtray #1	Complete	Mean: 2.1 STD: 2.3 Median: 1.4 Samples: 496	Mean: 1.6 STD: 1.7 Median: 1.1 Samples: 32	Mean: 1.3 STD: 1.8 Median: 0.8 Samples: 32	Mean: 2.3 STD: 2.9 Median: 1.5 Samples: 16	Mean: 0.5 STD: 0.0 Median: 0.5 Samples: 1
Ashtray #2	Complete	Mean: 17.8 STD: 14.0 Median: 14.6 Samples: 561 Flipped: 64	Mean: 18.8 STD: 32.7 Median: 10.2 Samples: 34	Mean: 12.2 STD: 10.0 Median: 9.7 Samples: 34 Flipped: 2	Mean: 11.3 STD: 10.3 Median: 7.4 Samples: 17 Flipped: 2	Mean: 0.7 STD: 0.0 Median: 0.7 Samples: 1
Ashtray #3	Complete	Mean: 8.0 STD: 8.4 Median: 5.8 Samples: 496 Flipped: 60	Mean: 14.8 STD: 37.8 Median: 5.1 Samples: 32	Mean: 5.8 STD: 5.8 Median: 5.3 Samples: 32 Flipped: 2	Mean: 5.0 STD: 9.3 Median: 2.3 Samples: 16	Mean: 0.6 STD: 0.0 Median: 0.6 Samples: 1
Ashtray #4	Complete	Mean: 2.3 STD: 3.4 Median: 1.1 Samples: 496 Flipped: 60	Mean: 13.0 STD: 42.4 Median: 1.5 Samples: 32	Mean: 1.7 STD: 2.6 Median: 1.0 Samples: 32 Flipped: 2	Mean: 1.9 STD: 2.7 Median: 1.0 Samples: 16	Mean: 2.7 STD: 0.0 Median: 2.7 Samples: 1

Bowl #1	Complete	Mean: 28.0 STD: 21.3 Median: 25.3 Samples: 465 Flipped: 1	Mean: 20.2 STD: 16.0 Median: 13.5 Samples: 31	Mean: 20.2 STD: 16.0 Median: 13.5 Samples: 31	Mean: 14.8 STD: 15.2 Median: 7.7 Samples: 15	Mean: 0.0 STD: 0.0 Median: 0.0 Samples: 1
Bowl #2	Complete	Mean: 25.9 STD: 19.2 Median: 23.9 Samples: 496 Flipped: 1	Mean: 21.2 STD: 9.9 Median: 21.6 Samples: 32	Mean: 20.6 STD: 9.6 Median: 19.5 Samples: 32	Mean: 7.8 STD: 7.5 Median: 5.4 Samples: 16	Mean: 1.8 STD: 0.0 Median: 1.8 Samples: 1
Bowl #3	Complete	Mean: 29.2 STD: 20.5 Median: 26.0 Samples: 496 Flipped: 33	Mean: 27.1 STD: 27.3 Median: 23.7 Samples: 32	Mean: 22.8 STD: 15.7 Median: 23.8 Samples: 32 Flipped: 1	Mean: 15.7 STD: 18.7 Median: 11.9 Samples: 16 Flipped: 1	Mean: 1.0 STD: 0.0 Median: 1.0 Samples: 1
Bowl #4	Complete	Mean: 26.4 STD: 19.2 Median: 22.8 Samples: 496 Flipped: 1	Mean: 18.4 STD: 14.5 Median: 14.6 Samples: 32	Mean: 18.4 STD: 14.6 Median: 14.8 Samples: 32	Mean: 21.5 STD: 19.4 Median: 22.6 Samples: 16	Mean: 1.0 STD: 0.0 Median: 1.0 Samples: 1
Cylinder #1	Complete	Mean: 19.8 STD: 19.0 Median: 12.8 Samples: 496	Mean: 13.7 STD: 17.2 Median: 6.3 Samples: 32	Mean: 13.3 STD: 13.9 Median: 8.5 Samples: 32	Mean: 14.1 STD: 11.3 Median: 12.9 Samples: 16	Mean: 7.3 STD: 0.0 Median: 7.3 Samples: 1
Cylinder #2	Complete	Mean: 9.9 STD: 7.9 Median: 7.8 Samples: 496	Mean: 8.0 STD: 6.2 Median: 7.0 Samples: 32	Mean: 7.1 STD: 5.7 Median: 5.5 Samples: 32	Mean: 6.9 STD: 5.0 Median: 7.0 Samples: 16	Mean: 2.9 STD: 0.0 Median: 2.9 Samples: 1

Cylinder #3	Complete	Mean: 15.2 STD: 12.9 Median: 11.7 Samples: 496	Mean: 10.5 STD: 10.4 Median: 7.7 Samples: 32	Mean: 10.4 STD: 9.5 Median: 8.1 Samples: 32	Mean: 9.3 STD: 9.4 Median: 7.4 Samples: 16	Mean: 6.8 STD: 0.0 Median: 6.8 Samples: 1
Cylinder #4	Complete	Mean: 4.5 STD: 9.7 Median: 1.1 Samples: 465 Flipped: 58	Mean: 12.9 STD: 42.1 Median: 0.4 Samples: 31	Mean: 2.5 STD: 7.4 Median: 0.0 Samples: 31 Flipped: 2	Mean: 1.8 STD: 4.5 Median: 0.5 Samples: 15	Mean: 7.3 STD: 0.0 Median: 7.3 Samples: 1
Cone Isolated 3 #3	Isolated	Mean: 11.5 STD: 8.5 Median: 10.0 Samples: 435 Flipped: 29			Mean: 8.8 STD: 8.1 Median: 6.4 Samples: 15 Flipped: 1	
Cylinder Isolated 8 #8	Isolated	Mean: 15.8 STD: 13.4 Median: 12.1 Samples: 496 Flipped: 231			Mean: 11.7 STD: 12.1 Median: 10.2 Samples: 16 Flipped: 5	
Ellipsoid Isolated 8 #8	Isolated	Mean: 15.7 STD: 12.4 Median: 12.8 Samples: 561 Flipped: 145			Mean: 14.2 STD: 12.0 Median: 10.8 Samples: 17 Flipped: 1	
Torus Isolated 3 #3	Isolated	Mean: 43.6 STD: 32.6 Median: 40.0 Samples: 496			Mean: 27.2 STD: 29.3 Median: 13.2 Samples: 16	

		Flipped: 224			Flipped: 3	
Trebol Isolated 5 #5	Isolated	Mean: 16.2 STD: 12.7 Median: 14.4 Samples: 528 Flipped: 90			Mean: 12.6 STD: 11.9 Median: 10.6 Samples: 16 Flipped: 1	
Cone Isolated 1 #1	Isolated	Mean: 11.6 STD: 10.3 Median: 8.8 Samples: 630 Flipped: 203			Mean: 8.9 STD: 12.0 Median: 4.8 Samples: 18 Flipped: 3	
Cylinder Isolated 1 #1	Isolated	Mean: 15.2 STD: 13.2 Median: 11.9 Samples: 595 Flipped: 96			Mean: 8.4 STD: 11.9 Median: 3.3 Samples: 17 Flipped: 1	
Ellipsoid Isolated 2 #2	Isolated	Mean: 19.0 STD: 17.0 Median: 14.9 Samples: 630 Flipped: 37			Mean: 14.7 STD: 12.7 Median: 11.7 Samples: 18 Flipped: 1	
Ellipsoid Isolated 6 #6	Isolated	Mean: 14.9 STD: 14.8 Median: 10.6 Samples: 561 Flipped: 120			Mean: 11.7 STD: 11.0 Median: 7.2 Samples: 17 Flipped: 4	
Torus Isolated 1 #1	Isolated	Mean: 11.3 STD: 9.7			Mean: 9.9 STD: 7.9	

		Median: 8.9 Samples: 595			Median: 8.5 Samples: 17	
Torus Isolated 10 #10	Isolated	Mean: 12.2 STD: 8.9 Median: 10.4 Samples: 561 Flipped: 240			Mean: 8.7 STD: 6.7 Median: 9.8 Samples: 17 Flipped: 2	
Trebol Isolated 6 #6	Isolated	Mean: 11.8 STD: 9.0 Median: 9.8 Samples: 561 Flipped: 33			Mean: 10.8 STD: 6.3 Median: 11.1 Samples: 17 Flipped: 1	
Trebol Isolated 8 #8	Isolated	Mean: 11.4 STD: 8.8 Median: 9.9 Samples: 595 Flipped: 34			Mean: 8.0 STD: 8.6 Median: 5.0 Samples: 17 Flipped: 1	
Trebol Isolated 9 #9	Isolated	Mean: 16.1 STD: 11.7 Median: 14.0 Samples: 561			Mean: 7.2 STD: 7.4 Median: 6.5 Samples: 17	
Car Unbounded #2	Partial	Mean: 42.5 STD: 28.4 Median: 38.4 Samples: 561 Flipped: 178		Mean: 33.8 STD: 26.7 Median: 23.8 Samples: 34 Flipped: 6	Mean: 34.4 STD: 33.8 Median: 18.2 Samples: 17 Flipped: 3	

Car Unbounded #3	Partial	Mean: 12.9 STD: 13.5 Median: 9.3 Samples: 528 Flipped: 182		Mean: 9.2 STD: 9.3 Median: 6.9 Samples: 33 Flipped: 7	Mean: 9.0 STD: 9.8 Median: 6.0 Samples: 16 Flipped: 2	
Car Unbounded #5	Partial	Mean: 30.6 STD: 21.5 Median: 26.2 Samples: 435 Flipped: 33		Mean: 30.1 STD: 18.5 Median: 29.1 Samples: 30 Flipped: 1	Mean: 15.0 STD: 19.0 Median: 5.2 Samples: 15 Flipped: 1	
Flat 1 Unbounded #1	Partial	Mean: 41.9 STD: 25.9 Median: 39.1 Samples: 561 Flipped: 116		Mean: 33.8 STD: 21.5 Median: 26.2 Samples: 34 Flipped: 5	Mean: 33.2 STD: 26.5 Median: 31.5 Samples: 17 Flipped: 1	
Flat 1 Unbounded #2	Partial	Mean: 7.7 STD: 7.1 Median: 4.9 Samples: 561		Mean: 9.4 STD: 3.8 Median: 10.6 Samples: 34	Mean: 5.1 STD: 6.6 Median: 2.4 Samples: 17	
Flat 1 Unbounded #3	Partial	Mean: 3.9 STD: 3.5 Median: 2.9 Samples: 561 Flipped: 33		Mean: 5.4 STD: 2.4 Median: 5.2 Samples: 34 Flipped: 1	Mean: 4.4 STD: 3.9 Median: 2.8 Samples: 17 Flipped: 1	
Cone Ubounded #1	Partial	Mean: 8.4 STD: 5.8 Median: 7.3 Samples: 630	Mean: 11.0 STD: 28.5 Median: 5.8 Samples: 36	Mean: 6.1 STD: 3.9 Median: 5.4 Samples: 36	Mean: 4.7 STD: 2.9 Median: 4.1 Samples: 18 Flipped: 1	Mean: 0.7 STD: 0.0 Median: 0.7 Samples: 1

		Flipped: 35		Flipped: 1		
Cone Ubounded #2	Partial	Mean: 29.6 STD: 22.9 Median: 24.4 Samples: 465 Flipped: 10	Mean: 19.4 STD: 19.2 Median: 11.1 Samples: 31	Mean: 19.3 STD: 19.3 Median: 10.7 Samples: 31	Mean: 21.9 STD: 27.9 Median: 6.6 Samples: 15	Mean: 5.9 STD: 0.0 Median: 5.9 Samples: 1
Cone Ubounded #3	Partial	Mean: 11.5 STD: 9.5 Median: 9.3 Samples: 496 Flipped: 31	Mean: 14.8 STD: 29.7 Median: 7.1 Samples: 32	Mean: 9.4 STD: 8.8 Median: 6.6 Samples: 32 Flipped: 1	Mean: 8.1 STD: 6.6 Median: 6.4 Samples: 16 Flipped: 1	Mean: 0.6 STD: 0.0 Median: 0.6 Samples: 1
Ellipsoid Unbounded #1	Partial	Mean: 7.8 STD: 6.0 Median: 6.2 Samples: 561	Mean: 8.2 STD: 6.6 Median: 6.6 Samples: 34	Mean: 12.6 STD: 6.9 Median: 11.3 Samples: 34	Mean: 4.1 STD: 2.6 Median: 3.4 Samples: 17	Mean: 3.8 STD: 0.0 Median: 3.8 Samples: 1
Ellipsoid Unbounded #3	Partial	Mean: 14.9 STD: 10.7 Median: 12.7 Samples: 630	Mean: 10.5 STD: 7.8 Median: 8.3 Samples: 36	Mean: 10.5 STD: 7.9 Median: 8.0 Samples: 36	Mean: 8.0 STD: 6.7 Median: 7.5 Samples: 18	Mean: 0.4 STD: 0.0 Median: 0.4 Samples: 1
Ellipsoid Unbounded #8	Partial	Mean: 13.9 STD: 12.7 Median: 9.8 Samples: 528 Flipped: 62	Mean: 20.1 STD: 38.4 Median: 7.8 Samples: 33	Mean: 10.2 STD: 9.2 Median: 7.1 Samples: 33 Flipped: 2	Mean: 9.5 STD: 8.8 Median: 7.8 Samples: 16 Flipped: 2	Mean: 1.0 STD: 0.0 Median: 1.0 Samples: 1
Torus Unbounded #1	Partial	Mean: 14.5 STD: 12.0 Median: 11.1 Samples: 630	Mean: 9.9 STD: 8.6 Median: 10.4 Samples: 36	Mean: 9.6 STD: 8.9 Median: 9.2 Samples: 36	Mean: 10.1 STD: 11.0 Median: 8.4 Samples: 18	Mean: 1.6 STD: 0.0 Median: 1.6 Samples: 1

Torus Unbounded #3	Partial	Mean: 13.9 STD: 13.3 Median: 10.0 Samples: 496 Flipped: 87	Mean: 21.3 STD: 44.4 Median: 5.0 Samples: 32	Mean: 8.7 STD: 10.2 Median: 4.5 Samples: 32 Flipped: 3	Mean: 9.4 STD: 17.5 Median: 3.5 Samples: 16 Flipped: 1	Mean: 3.1 STD: 0.0 Median: 3.1 Samples: 1
Torus Unbounded #10	Partial	Mean: 12.2 STD: 13.0 Median: 8.9 Samples: 561 Flipped: 64	Mean: 18.6 STD: 41.0 Median: 7.8 Samples: 34	Mean: 8.4 STD: 9.2 Median: 7.2 Samples: 34 Flipped: 2	Mean: 8.9 STD: 10.3 Median: 4.9 Samples: 17 Flipped: 2	Mean: 2.3 STD: 0.0 Median: 2.3 Samples: 1
Torus Unbounded #11	Partial	Mean: 27.8 STD: 26.9 Median: 16.8 Samples: 465 Flipped: 137	Mean: 42.9 STD: 59.3 Median: 14.5 Samples: 31	Mean: 18.2 STD: 23.9 Median: 10.4 Samples: 31 Flipped: 5	Mean: 16.8 STD: 20.5 Median: 10.1 Samples: 15 Flipped: 2	Mean: 3.3 STD: 0.0 Median: 3.3 Samples: 1
Torus Unbounded #12	Partial	Mean: 13.8 STD: 19.1 Median: 7.8 Samples: 630 Flipped: 18	Mean: 9.8 STD: 14.6 Median: 5.7 Samples: 36	Mean: 9.2 STD: 14.8 Median: 5.7 Samples: 36	Mean: 14.0 STD: 20.2 Median: 7.5 Samples: 18 Flipped: 1	Mean: 2.9 STD: 0.0 Median: 2.9 Samples: 1
Trebol Unbounded #2	Partial	Mean: 16.7 STD: 11.9 Median: 14.7 Samples: 496	Mean: 14.8 STD: 9.8 Median: 14.4 Samples: 32	Mean: 14.1 STD: 9.7 Median: 13.4 Samples: 32	Mean: 10.3 STD: 13.6 Median: 5.8 Samples: 16	Mean: 2.2 STD: 0.0 Median: 2.2 Samples: 1
Trebol Unbounded #5	Partial	Mean: 15.4 STD: 12.5 Median: 12.5 Samples: 528	Mean: 12.3 STD: 11.8 Median: 9.2 Samples: 33	Mean: 13.8 STD: 12.7 Median: 12.0 Samples: 33	Mean: 8.8 STD: 8.0 Median: 8.4 Samples: 16	Mean: 3.7 STD: 0.0 Median: 3.7 Samples: 1

Trebol Unbounded #7	Partial	Mean: 25.8 STD: 22.5 Median: 19.1 Samples: 465 Flipped: 17	Mean: 45.9 STD: 24.7 Median: 38.1 Samples: 31	Mean: 37.7 STD: 17.3 Median: 33.0 Samples: 31 Flipped: 2	Mean: 13.8 STD: 15.0 Median: 10.8 Samples: 15	Mean: 2.7 STD: 0.0 Median: 2.7 Samples: 1
Stapler Unbounded #1	Partial	Mean: 18.8 STD: 24.0 Median: 9.2 Samples: 561 Flipped: 70		Mean: 18.4 STD: 19.0 Median: 12.8 Samples: 34 Flipped: 4	Mean: 8.9 STD: 8.3 Median: 6.8 Samples: 17 Flipped: 2	
Stapler Unbounded #2	Partial	Mean: 15.8 STD: 20.5 Median: 7.7 Samples: 561 Flipped: 44		Mean: 10.6 STD: 16.5 Median: 5.1 Samples: 34 Flipped: 2	Mean: 14.4 STD: 20.4 Median: 6.5 Samples: 17	
Stapler Unbounded #3	Partial	Mean: 11.4 STD: 9.9 Median: 8.5 Samples: 528 Flipped: 216		Mean: 8.7 STD: 7.9 Median: 6.5 Samples: 33 Flipped: 9	Mean: 8.4 STD: 8.2 Median: 8.5 Samples: 16 Flipped: 5	
Stapler Unbounded #5	Partial	Mean: 9.9 STD: 8.7 Median: 8.0 Samples: 528 Flipped: 62		Mean: 7.0 STD: 6.0 Median: 5.2 Samples: 33 Flipped: 2	Mean: 8.2 STD: 6.6 Median: 7.9 Samples: 16 Flipped: 2	
Tube Unbounded #1	Partial	Mean: 12.8 STD: 9.1 Median: 11.0 Samples: 561		Mean: 9.0 STD: 6.3 Median: 8.1 Samples: 34	Mean: 8.6 STD: 8.0 Median: 6.8 Samples: 17	

Tube Unbounded #2	Partial	Mean: 30.0 STD: 26.1 Median: 20.7 Samples: 630 Flipped: 56		Mean: 20.6 STD: 24.1 Median: 12.4 Samples: 36 Flipped: 1	Mean: 20.9 STD: 20.8 Median: 16.0 Samples: 18 Flipped: 1	
Tube Unbounded #5	Partial	Mean: 11.2 STD: 9.9 Median: 8.3 Samples: 496		Mean: 12.7 STD: 6.2 Median: 14.1 Samples: 32	Mean: 7.2 STD: 7.7 Median: 4.8 Samples: 16	
Tube Unbounded #6	Partial	Mean: 16.5 STD: 12.0 Median: 14.6 Samples: 496		Mean: 14.0 STD: 9.2 Median: 14.1 Samples: 32	Mean: 14.1 STD: 8.1 Median: 14.8 Samples: 16	

Numbers shown are average differences across all users, in degrees