User Evaluation

We conducted a user evaluation to assess the usability and effectiveness of our new sketch-based modeling method. In the evaluation, the participants are asked to interactively draw three 3D models to match what are depicted in real images. In addition to checking the result 3D models the participants created, we also ask them to rate the effectiveness and intuitiveness of the new sketch-based modeling method.

Participants

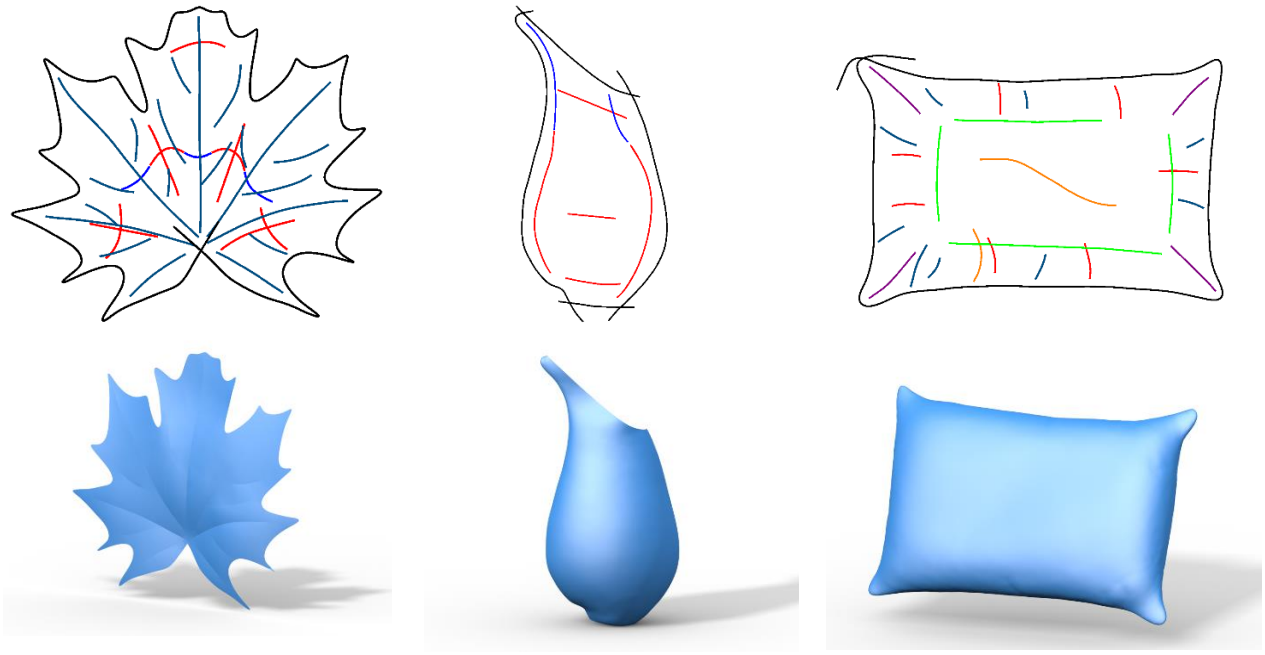
Nine participants (6 males and 3 females) took part in the evaluation. Six of them are computer science graduate students with background in graphics (P1, P2 and P4), vision (P5, P6) and NLP (P7), and one is a graduate student in environment engineering (P3). The rest two are artists (P8, P9). Among all the participants, P1 and P2 have some experiences using 3D modeling software, while the artist P8 works daily with 3D modeling tools of Autodesk 3D Max, Maya, and the artist P9 is well trained with CAD modeling software SolidWorks. Additionally, P1 and P3 have drawing experience. The rest of them have no related prior experiences. Participants performed the sketching tasks on a DELL 21.5’’ touch monitor with a drawing pen.

Procedure

The user evaluation consists of three sessions: training, modeling and final interview. On average, the entire process takes about two hours per participant.

Training session. The training session is designed to make participants learn about the UI and different lines in our tools. One of the authors guided the participants and showed them examples modeled beforehand by the authors. The training examples are shown next, including the reference images, the input strokes and the corresponding 3D models.





Participants practiced what they learned through modeling some of the three examples by drawing strokes themselves. They asked the instructor whenever they feel unsure about the meaning of the sketching lines.

Modeling session. During the modeling session, the participants are asked to model three specific shapes given in the form of three reference images. The instructor accompanied the participants through the session, to answer questions about the UI only. The time used by each participant for each target shape is recorded. The input strokes and final models are also saved. The three target models are arranged in a fixed order: fish, shoe and bird, and participants sketched them one by one. The reference images are shown next.

For every target shape, we have prepared the contour strokes, and these contours were preloaded so that participants only focus on the inner shape variation.

Interview session. In the interview session, we collect feedback from participants by asking them to answer a questionnaire with three questions:

Q1: Do you think the strokes are intuitive?
Q2: When the first try does not match the target well, do you think the modifications easy to conceive?
Q3: Is the overall modeling style intuitive and the tools easy to use?

We asked participants to give a score for each question ranging from 1-5, with 1 being very negative to 5 being very positive.

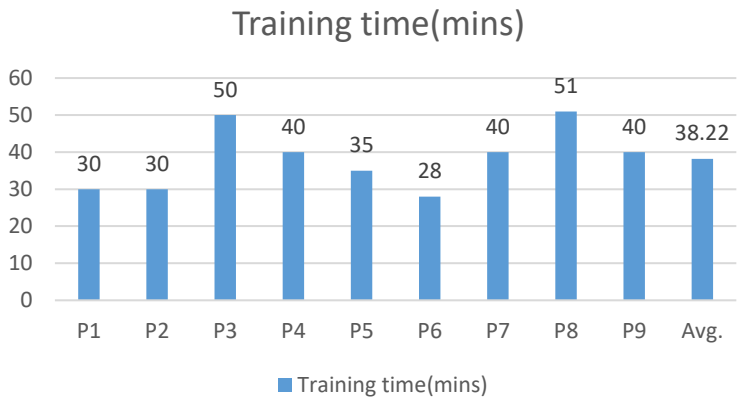
For artists, we ask more questions to compare our approach with their commonly used tools:

Q4: Is the tested approach easier (or not) to use compared with the tools you commonly used for modeling?
Q5: Is the tested approach faster (or not) to compared with the tools you commonly used for modeling?
Q6: Is the new approach capable of generating what you wanted?
Q7: How do you think it fits into the artists’ toolbox for modeling?
Q8: Do you like the new modeling style by drawing 2D strokes?

The scoring criteria is consistent with the Q1-3.

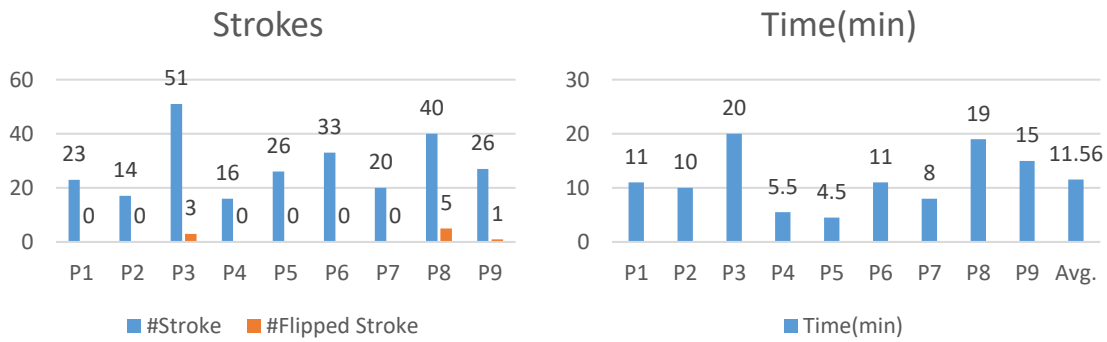
Results

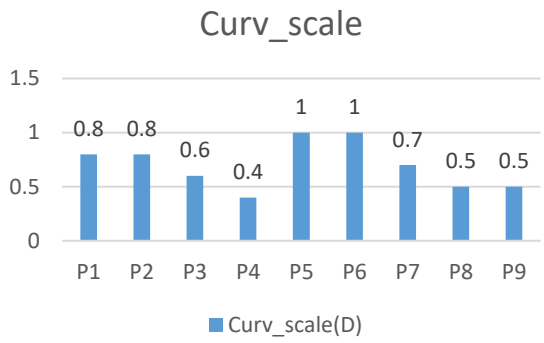
Training session time. The average training time is about 38 minutes. Details for each participant are listed in the chart below. Note that the training was stopped whenever the participant felt confident about using the tool.



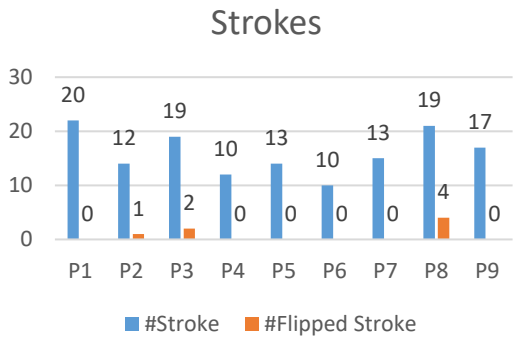
Next we show the number of strokes (with labeling fixations), the total time, and the value of overall curvature scaling for each of three models in charts. Note the number of strokes also counts the boundary strokes which were preloaded.

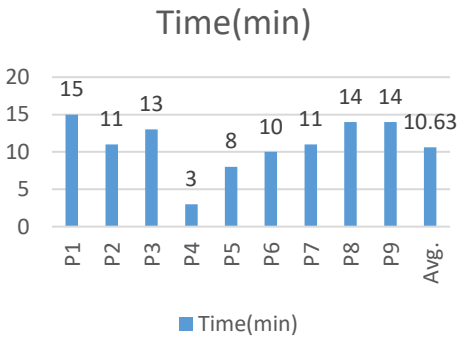
Fish model.

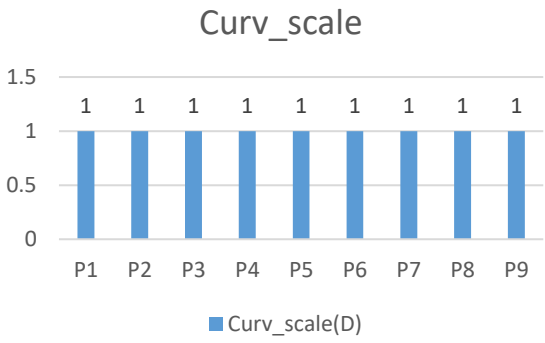




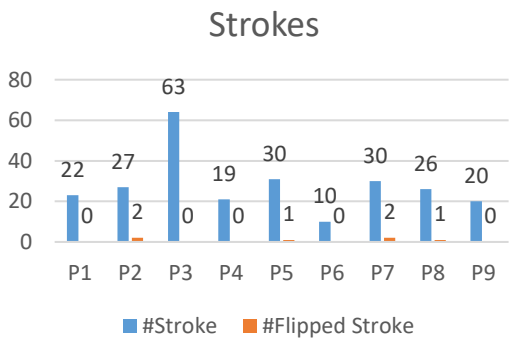
Shoe model.

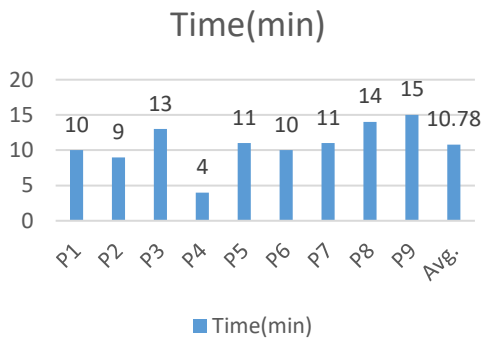


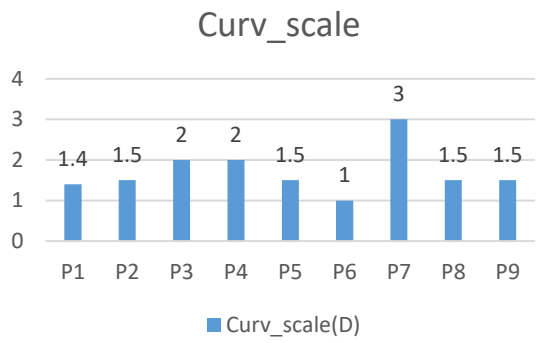




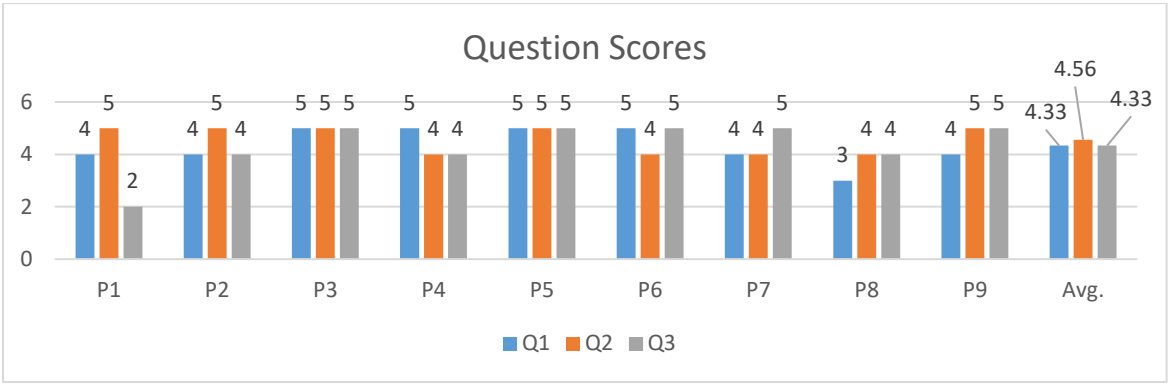
Bird model.



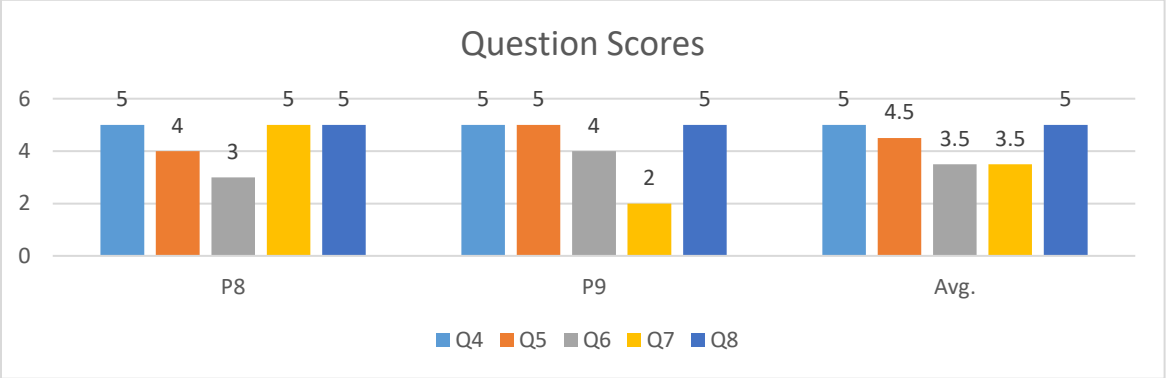




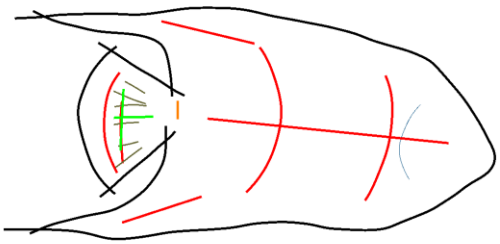
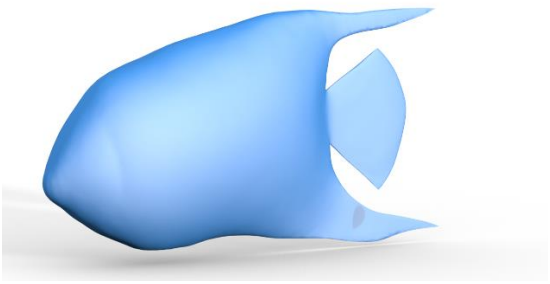
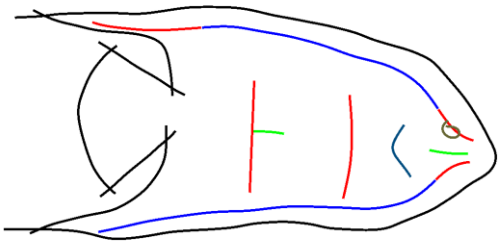
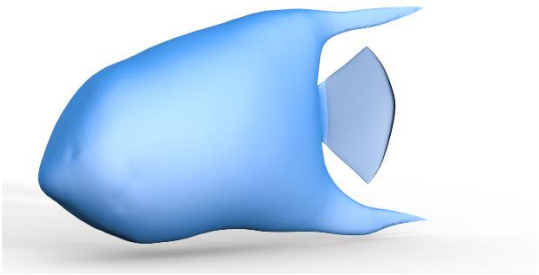
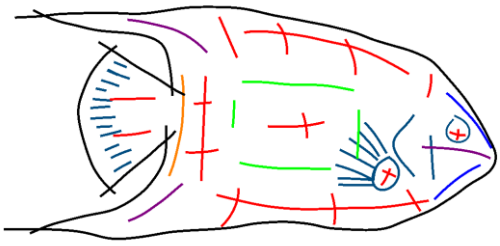
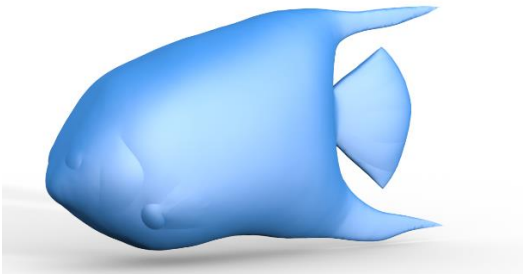
Next, we show the ratings of the three questions by all participants.

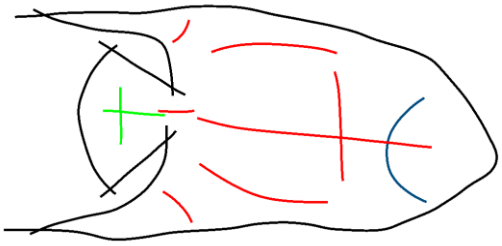
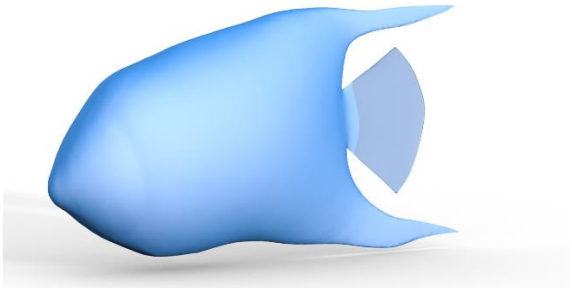
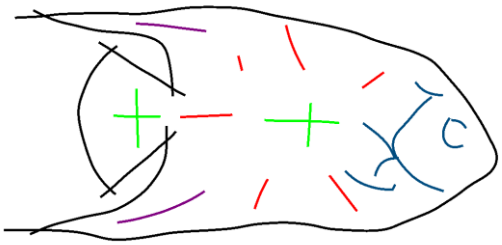
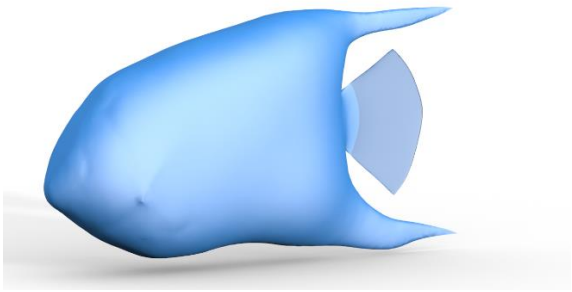
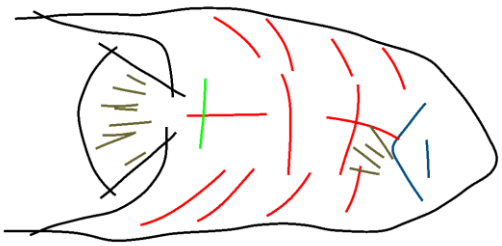
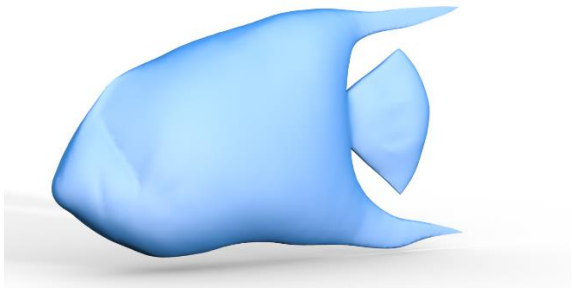
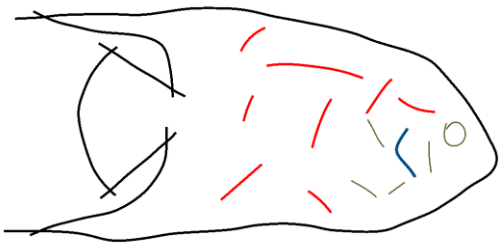
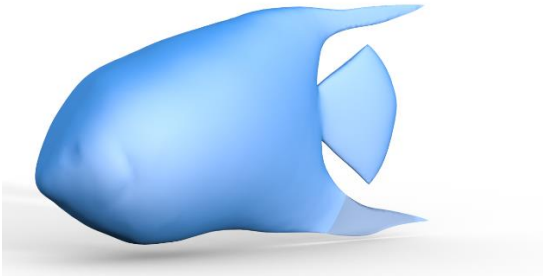
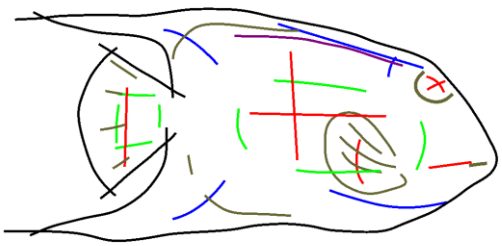
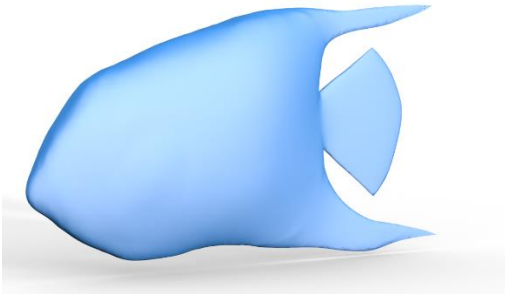


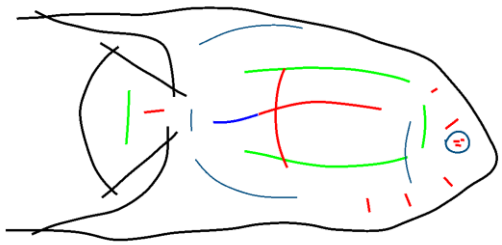
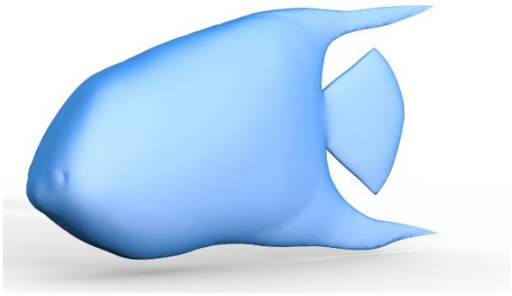
And also the additional questions designed for artists.

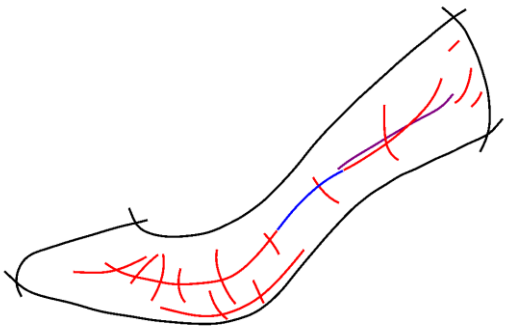
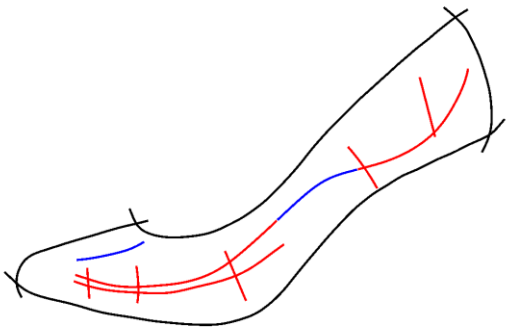
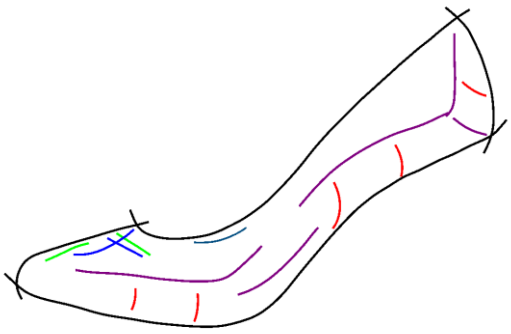


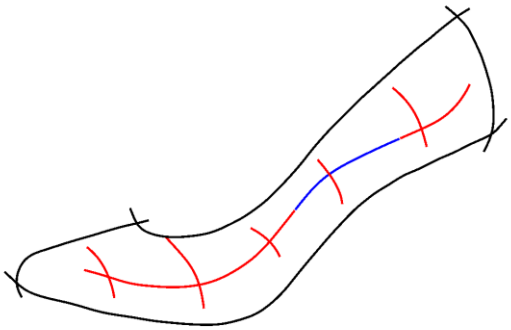
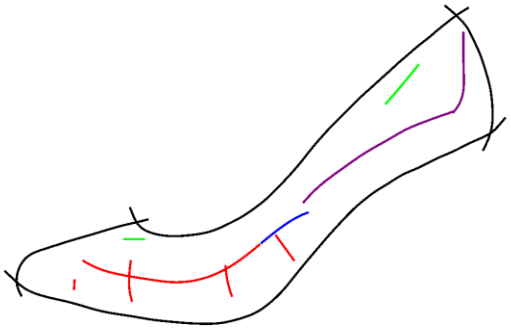
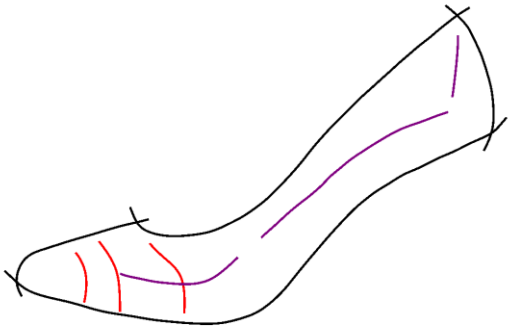
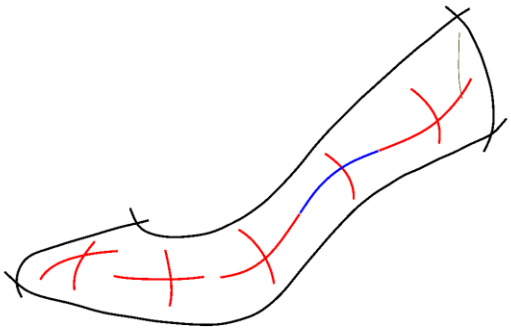
Next we show the sketches and the 3D shapes by each participant for each target shape.

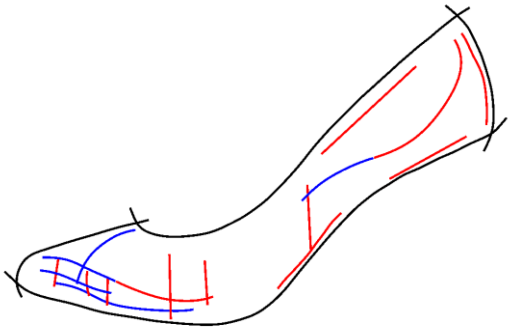
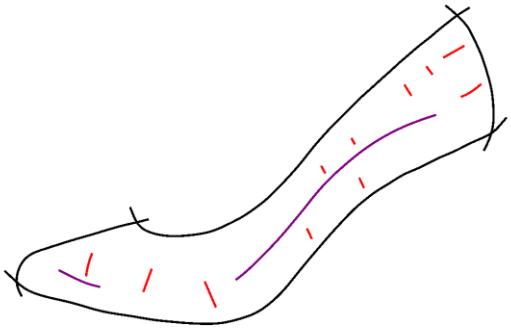
Fish	Sketch	Model
P1		
P2		
P3		

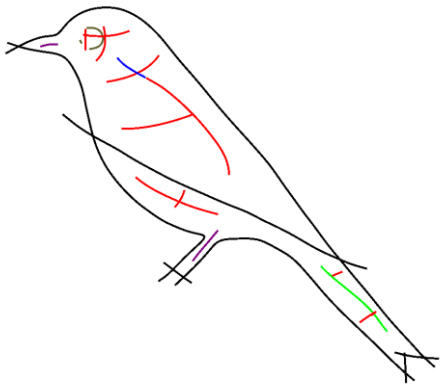
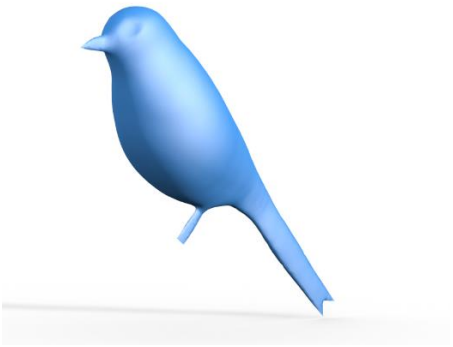
P4		
P5		
P6		
P7		
P8		

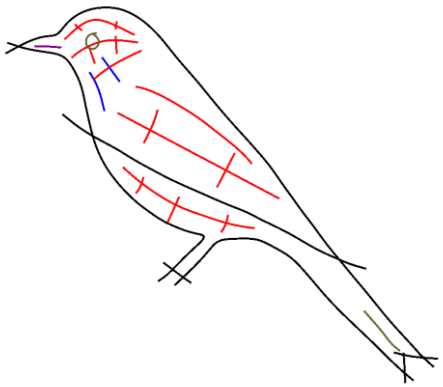
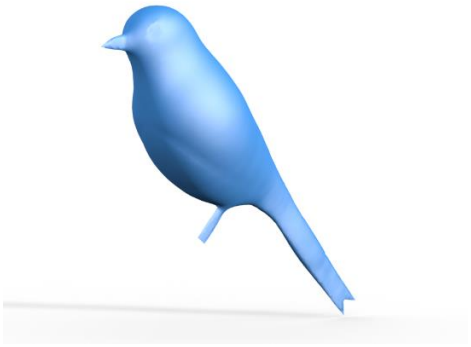
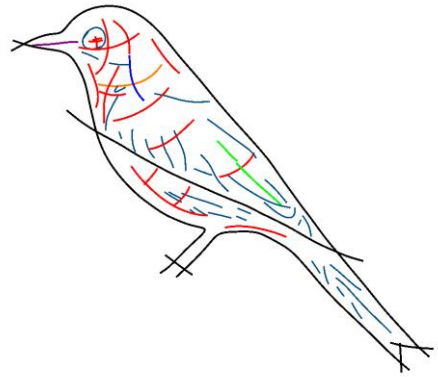
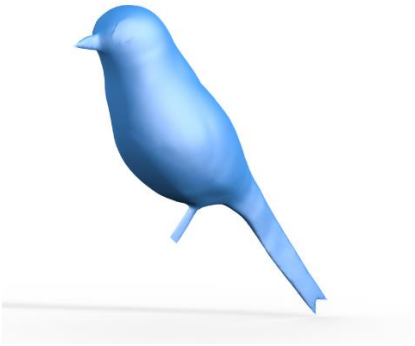
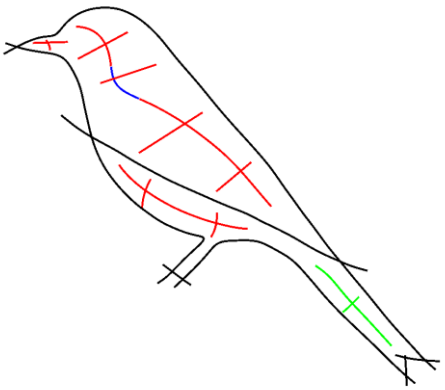
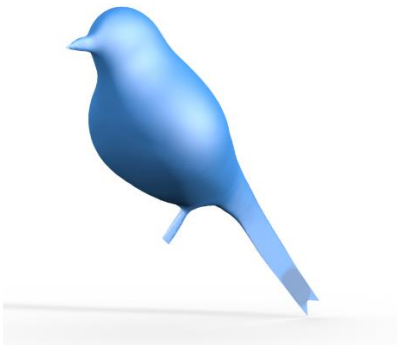
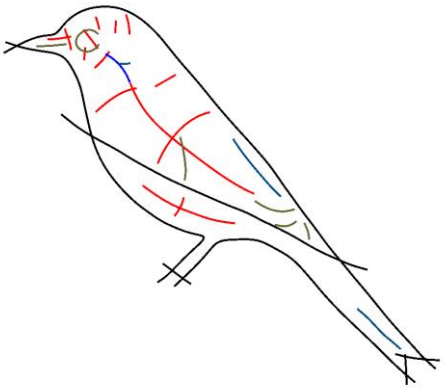
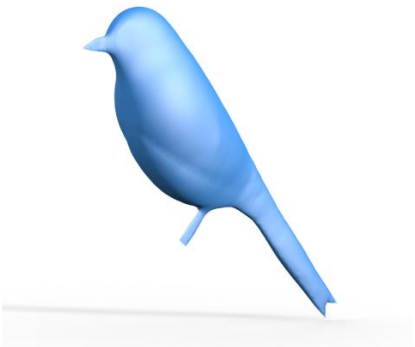
P9		

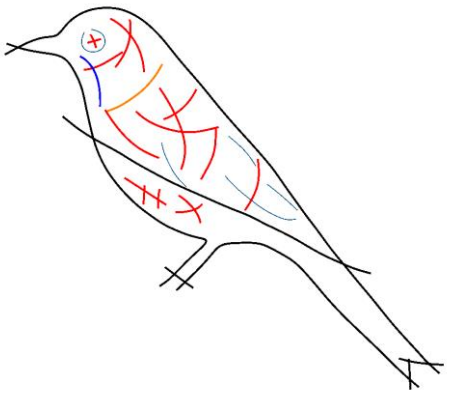
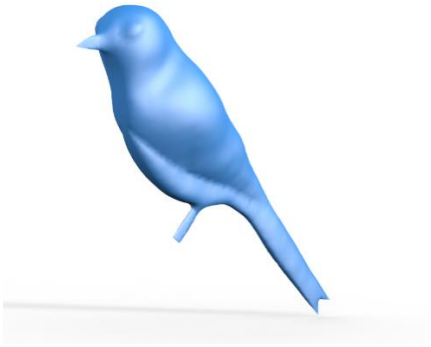
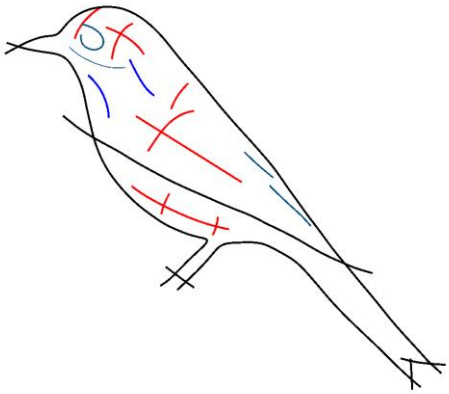
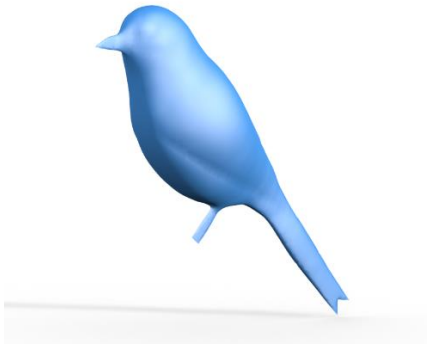
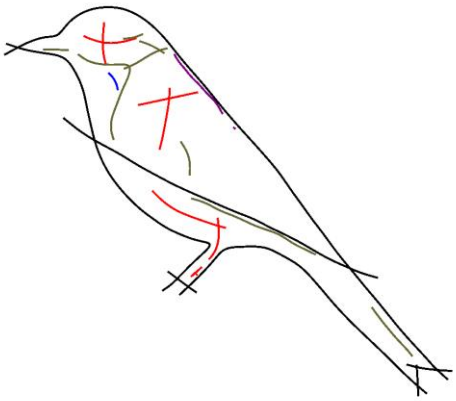
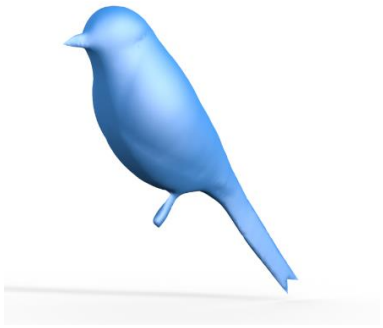
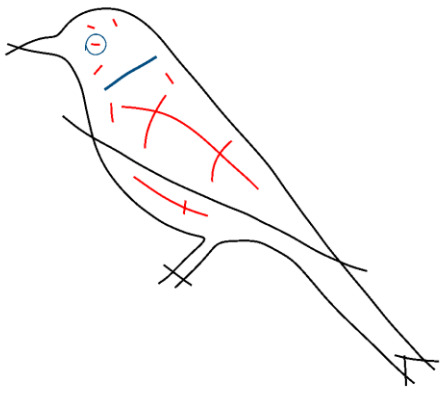
Shoe	Sketch	Model
P1		
P2		
P3		

P4		
P5		
P6		
P7		

P8		
P9		

Bird	Sketch	Model
P1		

P2		
P3		
P4		
P5		

P6		
P7		
P8		
P9		

Summary & Analysis

After analyzing the above data, we see that

(1) regardless of prior modeling or drawing experience, after about 38 minutes training to get familiar with our modeling tool, any participant can sketch each of the testing target shapes in about 10 minutes,

(2) our algorithm is robust in handling different input strokes and delivering similar results, and

(3) the new approach is generally regarded intuitive to use, as the participants can easily realize the 3D shapes in their minds through the strokes drawn.

Specifically, the interview session with artists shows some more interesting points:

(1) the artists believe the new approach can save about 2/3 or 3/4 of time to create models with similar quality compared with their commonly used tools,

(2) the new approach is easy to learn, as compared with the more powerful 3D modeling suites which frequently takes long training period and lots of efforts,

(3) the new approach is useful for drafting 3D shapes quickly. After that, the modelers would like to export the draft designs to other tools for detailed editing and for advanced precision control.

On the other hand, one artist (P8) found the strokes sometimes to be confused with the sculpting strokes from other 3D modeling softwares which the artist uses a lot; the confusion happened more frequently at the beginning of the evaluation but was gradually resolved as the artist used more of our tool.