# **State of the Research:**

# **Drawing Style Adaption User Study**

Alexa Keizur and Kiley Sobel

Summer 2011

## **Research Question:**

Our goal for this user study was to determine if users would alter their drawing styles to increase recognition rates. We wanted to explore if changes would occur with no feedback from the system and/or with ghost gate feedback from the system. Ghost gates are gate-shaped outlines that appear behind strokes that have been labeled as gates.

We hypothesized that users in both cases would adapt their drawing styles but that users who drew with ghost gate feedback would make more significant changes that would increase correct recognition rates.

## **User Study Findings:**

### **Conditions**

Condition 1: Ghost gates appear behind all gates right after the circuit is recognized, on any effected gates after regrouping or relabeling, and on any gate which the pen is over. All ghost gates present disappear upon a pen-down. The type of the gate is also shown in the “Label” hover icon, and strokes are colored according to their type.

Condition 2: Text labels appear next to all stroke groups after recognition, indicating what the group was recognized as. The type of the gate is also shown in the “Label” hover icon, and strokes are colored according to their type.

### **Procedure**

First the user was welcomed to the study and told that we were gathering data on how users draw with LogiSketch. They were shown a short video tutorial of the system and given a chance to practice selection. They were then given time to review digital logic circuits.

For the warm-up portion of the study, the user was asked to draw two of each logic gate without wires or inputs. After drawing each gate, the user pressed a “Next” button and was given the name of the next gate. The order of these gates was constant across users. After drawing each of the seven logic gates twice, the warm-up portion was over.

For the main portion of the study, the user was asked to draw each of seven circuits twice. The user was given an equation for each circuit of the form “c = a AND b” (where the output *c* is the result of the input *a* and the input *b* combined by an AND gate). Once the user had drawn the circuit, he or she pressed the button labeled “Recognize,” prompting the system to run its recognition processes. The recognition feedback was then displayed in accordance with the specified condition. The user then corrected any recognition errors using any of the following processes: erasing and redrawing, relabeling, and regrouping. Once the circuit was correctly recognized (or the user wanted to move on) the user pressed the “Next” button to move on to the next circuit. The user was done once he or she had drawn each of the seven circuits twice.

Lastly, the user was asked a few questions about his or her demographic (including gender, handedness, and tablet experience) and his or her experience with the system (including how frustrated he or she was, how much he or she thought his or her drawing style had changed, and his or her overall satisfaction with the system).

This procedure took approximately an hour for each user, and users were given candy, cookies, and a 1 in 5 chance to win a $50 Amazon gift card as compensation.

### **Analysis**

In order to analyze the users’ drawing data, we first went through the completely recognized sketches and ensured that all of the shapes were labeled correctly. If they were not, we manually labeled the incorrect shapes, but we did not redraw any parts of the drawings.

Next, the recognition team ran the fully labeled sketches (14 for each user) through a script that calculated the total number of each type of gate and the number of these gates that were correctly recognized by the system. From this data, we also extracted the correct recognition rate, which equaled the total correctly recognized gates over the total number of gates for every sketch.

The next task was to investigate how correct recognition rate changed over time. First, we tracked each user’s recognition rate from the first to the fourteenth trial, and then computed the correlation and the line of best fit between recognition rate and time for each user. Next, we tracked each condition’s recognition rate from the first to the fourteenth trial by combining the data for each trial of all the users in each condition. We then computed the correlation and the line of best fit between recognition rate and time for each condition, and also ran paired, one-tailed t-tests between the conditions’ correct recognition rates for each trial.

Finally, we ran independent, one-tailed t-tests on the interview data by comparing the scale answers of the users in Condition 1 with corresponding answers of the users in Condition 2.

### **Results**

None of the correlations between correct recognition rate and time were significant. This also indicates that data was not linear and the lines of best fit did not accurately model the data.

Additionally, there were no significant differences between the recognition rates of users in Condition 1 and the recognition rates of users in Condition 2 for each trial.

For the interview data, there was a significant difference between Condition 1’s answers and Condition 2’s answers for how helpful the system was at showing recognition errors. The users in Condition 1 felt that the system was more helpful at showing recognition errors than the users in Condition 2 did. This implies that users like ghost gates as system feedback better than text labels on the sketch.

## **Ideas for the Future:**

We believe that this study could have significant results if certain changes are made. We recommend that the study be carried out in the future with the following modifications:

* More users
* More equations/a longer task, split over two or more days
* Use the adaptive image recognizer
* Use the practice window in another condition
* Let ghost gates scale in two dimensions, make sure that this reflects recognition

## **How to Carry Out the Study Yourself:**

All documentation on how to run the study and TestRig analysis (plus the data from our study) is in the folder **…\Data\DrawingStyleStudyData\**. Read the document **README.txt** in this folder for full information.