UISK: Supporting Model-Driven and Sketch-Driven Paperless Prototyping

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Abstract. Sketches are often used during user interface design and evaluation as both a design support tool and a communication tool. Despite recent efforts, computational support to user interface sketching has not yet reached its full potential. This paper reports a study comparing two evaluation techniques: paper prototyping and a simulation-based evaluation supported by the UISKEI tool.

Keywords: User interface sketching, prototyping, user interface evaluation.

1 Introduction

Most designers create, as part of the design activity, sketches of their alternative design ideas to better communicate them among the design team and to the users, as well as to evaluate them early in the design process [2, 5, 7]. Users, in their turn, prefer to evaluate user interfaces that more closely resemble the final product, but very often find difficulties in going beyond static representations to grasp how the user-system interaction will take place. Through sketches alone, the consequences of certain design choices may go unnoticed, such as restrictions on the configuration of or sequence of actions in order to perform a certain task. There are even users who consider paper sketches a hurried and amateurish representation, despite the success of early evaluation techniques such as paper prototyping [11]. To support designers in the creation of sketch-based prototypes, we have developed a tool called UISKEI (User Interface Sketching and Evaluation Interface), which allows designers to draw and have the tool recognize user interface elements, as well as to associate behavior to these elements in a pseudo-functional prototype. The user can then interact with the prototype as in a simulation of how the application will behave, thus gaining a better understanding of how the interaction will happen, and allowing designers to conduct usability evaluation with users [9] early in the design process.

This paper is organized as follows. The next section presents the tool and the goals it intends to fulfill. The following section describes an early evaluation of how UISKEI compares to paper prototyping, explaining how the test was conducted and the results obtained. Lastly, we present the conclusions of the study.

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2 UISKEI: Instrumenting Sketch-Driven Evaluation

2.1 Designing in UISKEI

UISKEI has been developed to support two design strategies: based on sketches alone, and based on interaction models and sketches. In the first strategy, designers will manually define the behavior of each user interface element to prepare for the simulation. In the second strategy, designers will import the definition of the application behavior from an XML file representing an interaction diagram in MoLIC, a modeling language for interaction as conversation [1]. MoLIC allows designers to represent interaction scenarios [3, 4] in a more structured representation, in which intersections and relations between scenarios are made explicit.

To create the sketch of a presentation unit (window, web page and the like) with the user interface elements contained therein, the user must draw them on the screen, taking advantage of the pen-based interaction supported by the system. There is a predefined language of gestures that allows UISKEI to recognize the corresponding widget (WIMP element), using the algorithms and ideas defined in [6,8,10,12].

Currently, the set of user interface elements recognized by UISK includes the following elements: buttons, labels, radio buttons, toggles, drop-down lists, lists, and textboxes. If an element is not recognized, it remains on the screen as a stroke, allowing the designer to draw any kind of meaningful symbols (for example, simplified images or logos). This possibility of unconstrained drawing grants flexibility to the tool, making it easier for the prototype to better resemble the final interface. In addition, it allows the creation of innovative user interface elements, since every single drawing can be treated as a widget.

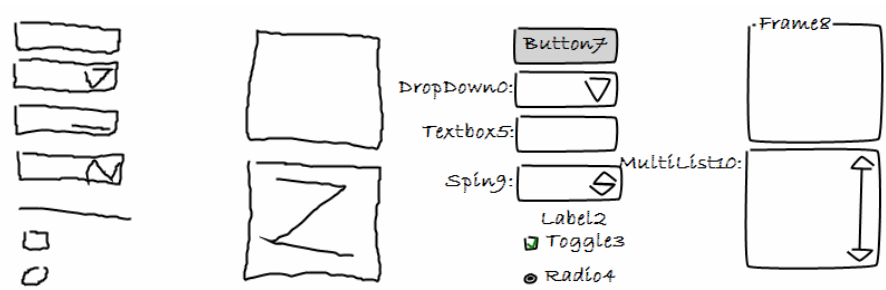

Fig. 1. UISKEI elements

Having drawn the user interface elements, it is possible for the user to define values and behaviors for each element. Values are entered as strings and they can only be added to a specific set of elements, having different interpretations depending of the element. For example, the values of a textbox correspond to the texts that could be "typed" in the prototype while the values of a drop-down list correspond to the items that could be selected in the prototype. Some elements have pre-defined values (e.g. radio buttons have two: checked and unchecked) and others have none (e.g. labels).

The behavior can be conditionally triggered (e.g. depending on the value of another user interface element or several of them) and can result in a series of actions. For example, the click of a command button can result in navigating to different screens according to the state of a toggle button and the click over a toggle button can enable several radio buttons. Behavior can also be added to strokes, widening the possibilities of the tool.

2.2 User Testing through Simulation in UISKEI

After the screens and the corresponding behaviors have been defined, it is possible to launch a simulation to be presented to the final users in order to evaluate the system. The final user interacts with the simulation, and the system performs the behavior assigned to each element, taking into account the context of the interaction. So, without any coding or implementation from the designer's part, it is possible to have a semi-functional sketch-based prototype evaluated with the final user.

3 Paperless Prototyping Evaluation in UISKEI: A Preliminary Study

We have conducted preliminary user testing sessions to evaluate the simulation facility provided by UISKEI and comparing it to the paper prototyping technique.

3.1 Planning the Evaluation

To evaluate UISKEI, we chose a photo web application as the target system, and developed two alternative interactive solutions to it (A and B). Each test participant, acting as a final user, went through both solutions in either paper or UISKEI, giving us insight for further developing the tool and allowing us to make a preliminary comparison between the two prototyping techniques. In order to reduce bias due to the order in which each technique was used, the test participants were divided into four groups, as depicted in Table 1:

Table 1. Test group division

	First paper, then UISKEI	**First UISKEI, then paper**
First A, then B	G1	G2
First B, then A	G3	G4

The tests proceeded according to the following procedure, instantiated here for group G1:

1. Testing using <u>paper prototyping</u>, beginning with <u>solution A</u> and then testing with <u>solution B</u>
2. Interview about the <u>paper prototyping</u> technique
3. Testing using <u>UISKEI simulation</u>, beginning with the <u>solution A</u> and then testing with <u>solution B</u>
4. Interview about the <u>UISKEI simulation</u>, comparing it to <u>paper prototyping</u>

Each user agreed to take part in the evaluation by signing a consent form and all test sessions were recorded (in both audio and screen capture). For this preliminary study, there were two users in each group. Throughout this paper, we call the group G1 participants P1a and P1b, and likewise for the other three groups. All eight users were either undergraduate or graduate students, in their early 20's: five men (four of them with a background in Engineering, one in Communication Studies), and three women (one in Biological Sciences, one in Engineering and one in Communication Studies).

3.2 The Evaluation Scenario

The proposed system was a photo buying web site and all users were presented with the following scenario:

> *You are a recent graduate who wishes to choose certain graduation ceremony photos to buy. In order to do that, you visit the website of the company responsible for the pictures and choose, from among the available photos, the four best shots (¬¬, =P, T_T, ^_^). Next, after looking at the chosen pictures, you decide not to buy one of them (T_T) and then you confirm your request.*

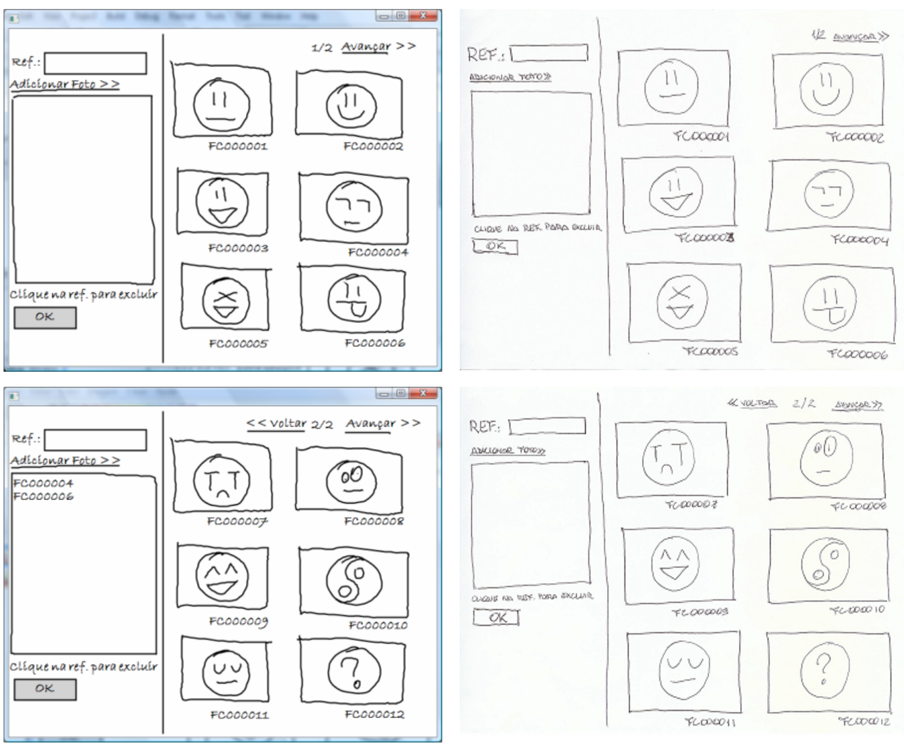

Fig. 2. User interface for solution A

Alternative solution A was inspired by an actual website and had a more textual approach: users must type the reference code in the appropriate textbox and then click “add photo>>” to add it to the list below. To remove, the user must only click on the reference in the list. When the user clicks the OK button, they finish the purchase. All of the screenshots can be seen below: the screenshots drawn in UISKEI on the left, and the corresponding paper version on the right:

Alternative solution B had a more pictorial approach: the user goes through the pages and select the pictures by marking a checkbox below each picture. Also, this solution presents an additional step —a “selected screen”— displaying only the selected pictures side-by-side and allowing the user to compare them and remove those they do not wish to have printed. Again, the screenshots for solution B can be seen below (UISKEI on the left, paper on the right).

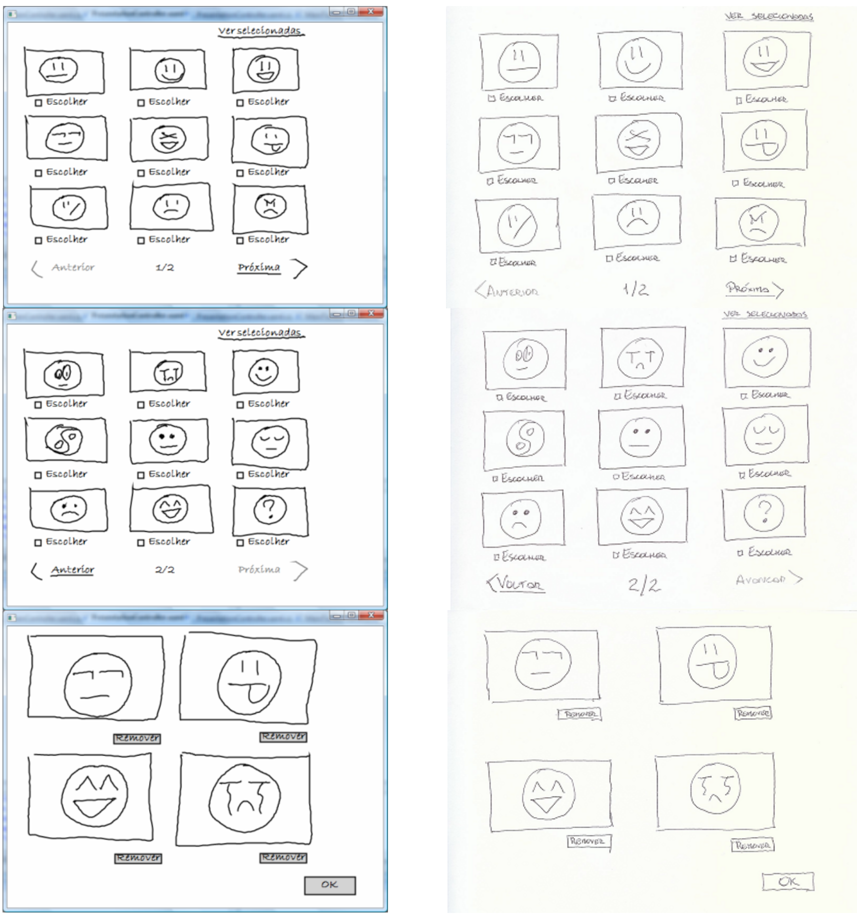

Fig. 3. Solution B “screenshots”

As can be seen, both test materials have a sketchy look, in order to allow us to make a fair comparison and so that the appearance is not a factor of interference with the test results.

3.3 Results

In the interview, besides open questions there were three grading questions, in which the users rated the technique in three aspects:

- Adequacy: how adequate the technique was for testing a user interface prototype. (1 = poor, 5 = adequate)
- Enjoyability: how much the user would like to use the prototyping technique again in the future. (1 = would dislike, 5 = would like very much)
- Comprehensiveness: how much it is possible to understand how the interface works and criticize it. (1 = little comprehensive, 5 = very comprehensive)

Although the test was not significant due to the low number of participants, we already have some interesting indications. The overall results of UISKEI are better: UISKEI ended up with an average of 4.6, while paper prototyping ended up with an average of 3.0. Each UISKEI grade has at least 1.2 points of difference to the corresponding one in paper prototyping. Moreover, UISKEI's strongest point (enjoyability, with a 4.8 average) was the paper's weakest one (with a 2.6 average).

Every user acknowledged and enjoyed the immediate response of UISKEI, saying that the interaction was more visible and dynamic: "*With the computer it is easier, since you click and it appears*" (P4a) and *"it is possible to perceive the basic functionality"* (P2b). Also, another common opinion is that UISKEI prototyping was better because it is already in the same environment as the final solution, being *"close to the real interface"* (P2b).

The results obtained in the rating questions are shown below (Table 2):

Table 2. Results for the rating questions at the interviews

		Paper			UISKEI		
		Adeq.	**Enjoy.**	**Comp.**	**Adeq.**	**Enjoy.**	**Comp.**
G1	**P1a**	4	4	3	4	5	4
	P1b	4	4	5	5	5	5
G2	**P2a**	2	1	1	5	5	5
	P2b	2	1	3	4	4	5
G3	**P3a**	4	3	4	4	5	4
	P3b	5	5	5	5	5	5
G4	**P4a**	2	1	3	5	5	5
	P4b	2	2	2	4	4	3
Average		3.1	2.6	3.3	4.5	4.8	4.5
Std. Dev.		1.2	1.6	1.4	0.5	0.5	0.8

The influence of the test order can be seen by comparing the results of Table 1 grouping certain rows and columns. Comparing the solution order (tables 3 and 4), it is possible to notice that users who were presented with the solution B first (groups

G3 and G4) gave higher grades overall. This can be explained by the users' preference to the more pictorial approach, confirmed in the interview.

Table 3. Results for the rating questions at the interviews of the users presented first with the solution A, than with the solution B

	G1 and G2 (First Row – First A, then B)					
	Paper			UISKEI		
	Adeq.	Enjoy.	Comp.	Adeq.	Enjoy.	Comp.
Average	3.0	2.5	3.0	4.5	4.8	4.8
Std. Dev.	1.2	1.7	1.6	0.6	0.5	0.5

Table 4. Results for the rating questions at the interviews of the users presented first with the solution B, than with the solution A

	G3 and G4 (Second Row – First B, then A)					
	Paper			UISKEI		
	Adeq.	Enjoy.	Comp.	Adeq.	Enjoy.	Comp.
Average	3.3	2.8	3.5	4.5	4.8	4.3
Std. Dev.	1.5	1.7	1.3	0.6	0.5	1.0

Comparing the technique presentation order (tables 5 and 6), it is possible to notice a clear difference between UISKEI and paper prototyping. The paper prototyping technique received higher grades (4.3, 4.0 and 4.3) from users who experimented it first than from users who tested UISKEI (2.0, 1.3 and 2.3). This can also be seen in the standard deviation data: while the tables comparing by technique order (by columns) have standard deviation for paper protoyping below 1.0, the ones comparing by solution order (by row) have the same parameter equal to or above 1.2, showing the influence of the order in which the techniques were presented to participants.

Table 5. Results for the rating questions at the interviews of the users presented first with paper prototyping, than with UISKEI prototyping

	G1 and G3 (First Column – First paper, then UISKEI)					
	Paper			UISKEI		
	Adeq.	Enjoy.	Comp.	Adeq.	Enjoy.	Comp.
Average	4.3	4.0	4.3	4.5	5.0	4.5
Std. Dev.	0.5	0.8	1.0	0.6	0.0	0.6

During the interview, we discovered that paper prototyping was considered unnatural by many of the users. One of them even missed the clicking noise of the mouse: "*[paper] is not much natural, it does not have that feeling, does not have sound, the clicking sound. The experience is different. Cannot say what it has that bugs me, but it is different.*" (P3a). Later, when testing UISKEI, the same user said: "*same thing as in the paper, but presented in a form that was more comfortable to me*" (P3a).

Table 6. Results for the rating questions at the interviews of the users presented first with UISKEI prototyping, than with paper prototyping

	G2 and G4 (Second Column – First paper, then UISKEI)					
	Paper			UISKEI		
	Adeq.	Enjoy.	Comp.	Adeq.	Enjoy.	Comp.
Average	2.0	1.3	2.3	4.5	4.5	4.5
Std. Dev.	0.0	0.5	1.0	0.6	0.6	1.0

One of them (P2b), even called the paper prototyping *"boring and senseless"*, remarking that he felt that it was *"more difficult to understand the dynamics"*, because he felt it was not very efficient nor interactive. By contrast, another user (P3b) said that UISKEI was *"simple and objective"*.

It was also a common idea that the paper has a limitation by its own nature: "*(…) in the paper it is unreal (…) I kind of ignore the idea of having buttons, list and everything.*" (P2a). Many participants felt annoyed by the constant "paper switching", one of them (P4b) even commented that she *"preferred that the computer does the maual job"*. The same user, after testing both techniques, said that *"there are things that you see in the computer and others in paper"*, remarking that she herself had a different behavior while experimenting with the two techniques (in particular, while in the computer, she paid more attention to the screen, noticing the "view results" link in the top right corner, while in the paper she lost her focus more easily).

When asked to compare the techniques, most participants (6 out of 8) preferred UISKEI over paper prototyping. P1a, however, stated that paper is a "*more established thing*", while UISKEI still have its own bugs and some limitations (as, for example, not being able to type in a textbox, being restricted to a set of predefined values). However, his argumentation was: "*UISKEI gave me expectations that were not fulfilled [regarding the aforementioned limitations], opposing to paper, that I would know that I could not type so I would be already resigned*". So, the paper's natural limitations ended up by being a positive aspect to it. The other participant who preferred paper, P1b, said that she felt more comfortable with it, since *"nothing will happen, nothing can be broken"*.

4 Conclusions

This paper presented a study comparing the paper prototyping evaluation technique to an interaction simulation supported by the UISKEI tool. The purpose of the study was to investigate whether the envisioned computational support is promising, and in which directions the development should evolve to take better advantage of the tool for supporting early evaluation of human-computer interaction. The preliminary results showed that UISKEI was generally well accepted by the study participants.

In order to promote UISKEI's adoption by design and development teams, however, some important facilities must be incorporated in the tool.

From the designers' point of view, it is important to have UISKEI import existing dialogue or interaction models to help define the application's behavior and ensure consistency between modeled HCI design decisions and the simulated prototype.

Besides allowing the evaluation of the user interface defined by the widgets and the user-system interaction defined by the behavior (manually or by importing a MoLIC diagram), UISK aims to advance the software specification efforts. Therefore, the UISK team is currently developing a generator for writing the interface and interaction specification in a user interface markup language, together with some UML diagrams. This specification will improve the traceability between the software specification and implementation activities and the earlier design activity. In the future, we intend to make this markup available for graphics designers to improve the user interface using their own special purpose tool.

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