Electronic Sketching on a Multi-platform Context: A Pilot Study with Developers

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Abstract

During the past 45 years there has been a recurrence of interest on supporting sketching at electronic devices and interactive surfaces, and despite sketching *recognition* to be fairly well addressed on the literature, the adoption of electronic sketching as a *design tool* is still a challenge.

The current popularization of touch screen devices allows designers to sketch using their device of preference, while the current multi-platform capabilities made possible by HTML5 allows sketching systems to run on many devices at the same time. Those two factors combined might pose new opportunities for researchers to explore how designers use sketching on flexible setups by combining heterogeneous sketching devices for design sessions.

This may arise new possibilities in the field of prototyping user interfaces since, by using such multi-platform systems, designers would now be able of designing interfaces for multiple devices by producing and testing them on the device itself.

This paper reports a pilot experiment conducted with 6 developers, grouped into pairs on design sessions using Gambit – a multi-platform sketching system that provides a lightweight approach for prototyping user interfaces for many devices at once. We performed a discourse analysis of the professionals based on recorded videos of interviews conducted during and after design sessions with the system and aggregated the data in order to investigte the main requirements for multi-platform sketching systems.

Keywords: Sketching, Multi-platform, User Interface Design, Discourse Evaluation.

1. Introduction

Sketching is an important – perhaps necessary – tool for design, since it function not as a mere fixation of finished solutions but as an external part of the mental process itself (Sachse et al., 2004). For over 45 years since the first sketch-based computer systems were proposed (Ivan, 1963; Ellis et al., 1969) there has been recurring interest in supporting sketching with computation (i.e. sketching at electronic devices and interactive surfaces).

Despite sketching *recognition* to be fairly well addressed on the literature, the adoption of electronic sketching as a *design tool* is still a challenge (Johnson et al., 2008).

The current popularization of touch screen devices and the multi-platform capabilities made possible by HTML5 might pose new opportunities for developers to build distributed interactive systems with minimum effort on adapting the system for each platform. Systems to support design activities such as sketching are also included on this set of new opportunities, also giving room for researchers to investigate how designers use sketching to prototype interfaces on the current multi-platform scenario.

We then define *multi-platform sketching* as the activity of drawing with an electronic stylus at different devices while having the same system running on those different devices (Sangiorgi et al., 2012).

When designing, people draw things in different ways, which allows them to also perceive the problem in new ways. People engage in a sort of *conversation* with their sketches in a tight cycle of drawing, understanding, and interpreting (Schon & Wiggins, 1992). However, nowadays there are many devices available for designers to sketch upon (MacLean et al., 2011), with different characteristics such as screen sizes, weight and processing capabilities; this is a fact to be addressed into contemporary sketching research.

Therefore, the fundamental question we seek to answer with this paper is regarding the sketching activity for prototyping. Since designers need to consider many factors while designing a multi-platform system, what are the most important requirements for a multi-platform sketching system for prototyping interfaces.

In this paper we report a pilot experiment conducted with 6 developers from IT companies in Belgium, grouped into pairs on design sessions using a multi-platform sketching system called Gambit (Gatherings and Meetings with Beamers and Interactive Tablets) (Sangiorgi et al., 2012). We performed a discourse analysis of the professionals based on recorded videos of interviews conducted during and after design sessions with the system and aggregated the data in order to investigte the main requirements for

multi-platform sketching systems.

This paper is organized as follows: the next session shows the motivation for sketching user interfaces in the current multi-platform context. Section 3 presents the GAMBIT system and its initial requirements. Section 4 describes the experiment with some indications of improvements for the system and section 5 concludes.

2. Sketching in User Interface Design

Sketching is considered to be a powerful tool for doing design. As the findings of (Goel, 1992) point out, the presence of ambiguity in early stages of design broads the spectrum of solutions that are considered and tends to deliver a design of higher quality.

Some works had already approached the fundamentals of sketching activity, as Van der Lugt's in (van der Lugt, 2002) who conducted an experiment to analyze the functions of sketching in design, in which participants produced individual sketches and then presented them for the group for discussion. Three primary sketching functions were identified:

F1 Sketching stimulates a re-interpretive cycle in the individual designer's idea generation process: Schon and Wiggins (Schön, 1983) describe design as a cyclic process of sketching, interpreting and taking the sketches further.

F2 Sketching stimulates the designers to re-interpret each other's ideas: when sketching to also discuss (as opposed to sketch for self-interpretation), the designer invites others to interpret her drawings as well. The function of inviting re-interpretation is especially relevant for the idea generation process, as re-interpretation leads to novel directions for generating ideas (van der Lugt, 2002).

F3 Sketching stimulates the use of earlier ideas by enhancing their accessibility: Since it is externalized, sketching also facilitate archiving and retrieval of design information.

UI design by sketching is recognized for several proved virtues such as, but not limited to: maintaining an informal representation to foster creativity (Coyette & Kieffer, 2007; Newman et al., 2003; Mangano et al., 2008), complementarity between paper and pencil and software (Bailey & Konstan, 2003; van der Lugt, 2002), capability to take one design idea at a time and work it out in details or consider alternative designs at a time (i.e. lateral

transformation (Mangano et al., 2008)), ability to reveal as much usability problems as if it was a real UI (Johansson, 2007).

In order to support sketching into UI design, we needed to analyze the process in which UI design is included. Currently, the development life cycle of interactive applications consists of a sophisticated process that does not always proceed linearly in a predefined way. The tools available for UI development are usually not focused on UI **design**, in which designers usually explore different alternatives but in UI **modeling** as a final product, where designers must attend to formal standards and notations.

There are many tools available for both modeling and design, however practitioners are currently forced to choose formal and flexible tools. Whichever they choose, they lose the advantages of the other, with attendant loss of productivity and sometimes of traceability and quality.

As the study reported in (Cherubini et al., 2007) mentions, designers desire an intelligent whiteboard because it would not require hard mental operations while sketching during meetings and design sessions.

However, electronic sketching is still behind the classical sketching in paper, since the tool in use becomes too evident (Weiser, 1991). Perhaps until the gap between displays and paper are minimized, (for instance with paper-like displays (Shah & Brown, 2005)), this distance will continue high, hindering the designer's *conversation*.

A great care must be taken to support the designer's reflection when making design software that employs sketch recognition, for instance. If the system interprets drawings too aggressively or at the wrong time, it may prevent the designer from seeing alternative meanings.

Calico (Mangano et al., 2008) and DENIM (Newman et al., 2003) are good examples of "vanishing tools" since they keep out of the way between the designers and the problem at hand, and this can be useful especially during early design stages. The Dazzle system (Oehlberg et al., 2012) is also an example of non-intrusive registration of sketches during design sessions, since it does not use electronic sketching but pictures to register what was discussed and decided.

Therefore, we can observe that fostering creativity is the main concern of current sketching tools for design. This is specially important since design is essentiallly a problem of *wicked nature*, i.e. the process of solving it is identical with the process of understanding it (Rittel, 1973). In wicked problems, the designer does not have a clear understanding of what to produce and has only a vague goal in mind in the beginning.

However, electronic sketching has some important advantages over classical 'pen and paper' approach. While sketches are useful to facilitate discus-

sions on the conceptual level, computer prototypes are useful for discussing operational and interaction issues (Johansson, 2007). Thus, raw sketches and interactive prototypes are complementary.

One important issue with currently sketch-based systems for prototyping of user interfaces is that they are *single-platform*, since they are usually made to be used on Desktop computers (Newman et al., 2003; Mangano et al., 2008), even though the prototypes are targeted at multiple devices (Lin & L, 2002).

A designer could sketch and test interfaces for many platforms using just a single platform such as a large sketching device (e.g. Wacom, TabletPC). However, the main benefit of sketching as a prototyping technique is to allow us to 'see as' and 'see that' (Schon & Wiggins, 1992). That benefit is hindered since only the size of the target device is being considered, while there are other significant factors such as weight, screen resolution, brigthness and interaction modes (e.g. multi-touch, WIMP).

We argue that a more complete prototyping system would allow sketching and simulation on the target device, enriching both designers' and users' experience with an interactive prototype, allowing them finally to have a richer *conversation* with the working design at hand.

Sketching intentions can be classified into one of three categories, as grouped by Mangano et al. (2008): Thinking, Talking or Prescriptive Sketches. We added another category: Prototyping Sketches, since prototypes are used to communicate to a stakeholder (talking) and also produce an interactive artifact, a final product of a design session (prescriptive). Thus, tools might support one or more sketching intentions:

Thinking sketches exploratory models that help the designer think and work out the solution in their mind. When designers externalize a mental model, part of the cognitive process needed to hold it in the memory is relieved (Tversky, 2002). A tool that support this kind of sketching does not "get in the way" between the designer and the model at hand;

Talking sketches models that facilitate rapid, impromptu exchanges between collaborating designers. While sketching, designers often create ambiguous diagrams to be clarified in conversations (Cherubini et al., 2007)

Prototyping sketches They are used to communicate to a stakeholder and also produce an interactive artifact, an intermediate product of a design session.

Prescriptive sketches models that communicate the final solution developed by the designer, or sketches made when a design is so important in order to be archived.

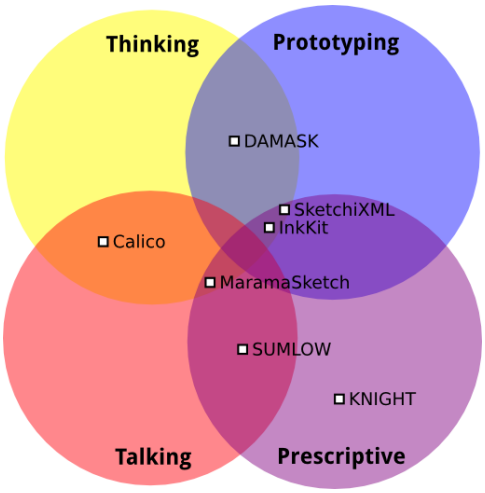

Figure 1: Tools organized based on Sketch Intention.

3. Gambit System

The tool support for the investigation is the GAMBIT system, a distributed software environment designed to be physically deployed around a table, with tablets and a projector. It is multi-platform since it is essentially an embedded website, which might be used through a browser or through a native mobile application (i.e. a 'wrapper' application).

3.1. Requirements

We have observed design sessions conducted in two companies related to user interface development. The people involved on those sessions were designers, project managers, programmers and frequently stakeholders. In overall, in these companies the design sessions are usually done around a central topic, about which people discuss in order to produce some artifact, usually a report with a list of requirements, wireframes and some session log of the decisions made around the interaction. It is important to note that this report is not produced at the site but after the meeting, for what people usually take pictures for remembering and registering what was discussed.

Nevertheless, the design sessions most often proceeded with three distinct phases (Figure 2):

1. Sketch production: one or more participants produce sketches in order to express ideas.
2. Sharing: the participants normally share the drawings using a big sheet of paper and use post-its. The sheets are arranged as a storyboard on a wall for discussion.
3. Discussing: the participants refined the sketches based on what was discussed and learned on the discussion.

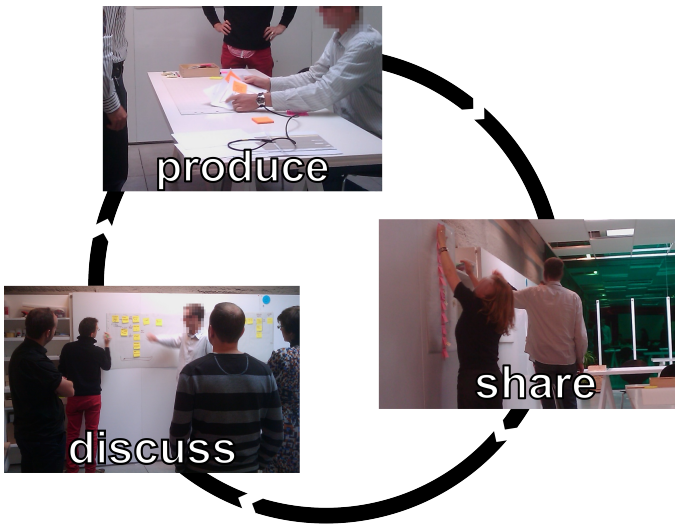

Figure 2: The usual sketching cycle at the observed companies

Based on Van der Lugt's work (van der Lugt, 2002) and on the observation of the design session, a preliminary list of requirements for a system to support collaborative sketching was constructed and the system was developed (Sangiorgi et al., 2012).

GAMBIT's initial requirements and it's current state is described as follows:

R1 *Support drawing sharing, visualization and consequently discussion*: The wall device acts as a sharing repository of sketches, aiding the discussion around a design. It is possible to send sketches to the wall, organize them, put them side-by-side for comparison, etc.

R2 *Support session storage and retrieval*: Sessions storage are supported, and can be loaded, saved and continued. History support is also planned.

R3 *Support private/public production of sketches*: Each input device is able to produce live sketches or to produce a sketch separately for later publication on the wall. Sub-group collaboration of two or more participants to produce a sketch is planned, but yet to be supported.

R4 *Provide a broad view of the drawings*: the wall was designed to serve exactly as a physical wall with 'projected sheets of paper', which are the images and sketches.

R5 *Provide a fine view of a drawing*: the input device can serve as a fine view of any sketch, and they can be re-drawn and sent once again to any other device.

R6 *Support the UI Design with different levels of fidelity*: For the moment, only low fidelity is supported.

3.2. Tool

The system is currently developed as depicted on Figure 3: the many input devices can be tablets, mobile phones, large graphical tablets, etc. They are used to sketch and submit drawings to the device representing the wall (W) showing the sketches as if they are real sheets of papers organized onto a real wall.

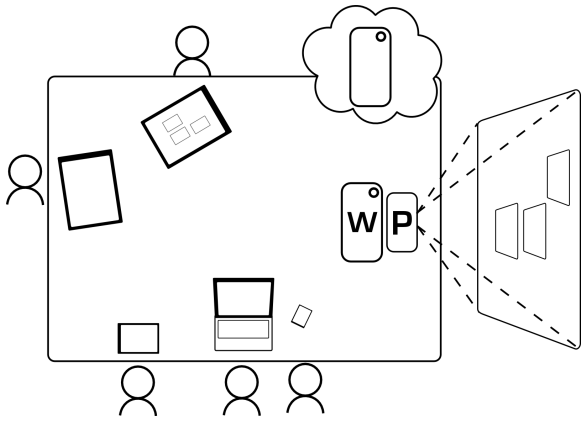

Figure 3: One of many GAMBIT's physical deploy scheme – designers and stakeholders around a table with many interactive devices and a wall projection.

The wall is projected using a common projector (P) and can be controlled using any device in the session. The roles of the devices are interchangeable – a user might request the wall's control at any time, organizing and grouping the sketches. Since GAMBIT is a web-based system operating through a browser, the wall (W) might be a full-screen browser window opened on a desktop computer, a projection or a large interactive display.

Figure 3 shows the deploy scheme of the system, with designers using different devices each around a projector in the middle. In the right part the wall shows the sketches being organized with the control tablet.

The system was developed in HTML5 in order to centralize the code for different platforms. In this sense, the system can run on any device with a browser. The sketch interface of the system is showed on Figure 4, with a drawing area that uses HTML5 <canvas> element and Javascript routines to capture the mouse/pen/touch events.

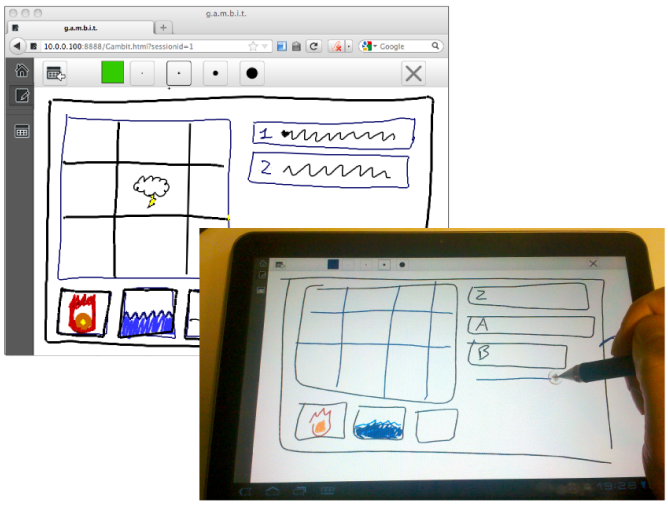

Figure 4: GAMBIT interface for sketch production respectively on a desktop and a tablet.

The left part shows a toolbar that can be used to switch from sketching to control functionalities. Figure 5 shows the wall with the sketches arranged like sheets of paper that can be dragged and grouped. The black background is intentionally put in order to make only the "sheets" to be projected on the wall, so as to mimic the physical storyboard observed during the interviews. The wall is the main part of the system, since the design session progresses around it.

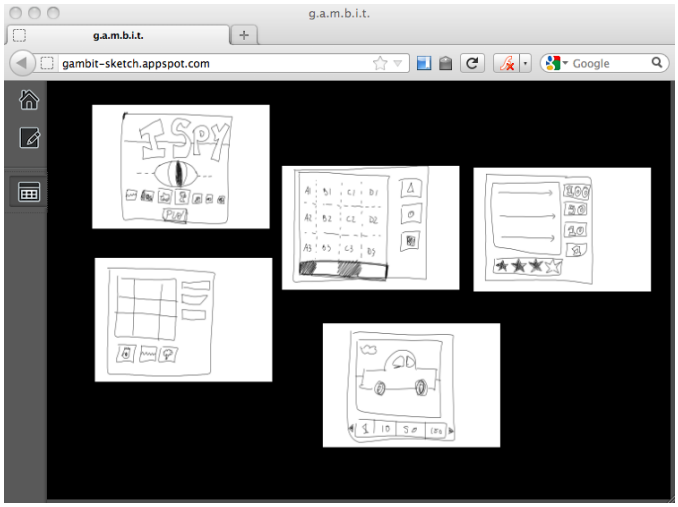

Figure 5: Interface for overview or "Wall sharing" on big displays

4. Pilot Experiment

We conducted a pilot experiment with 6 professionals from IT companies, grouped into pairs on design sessions using GAMBIT. We recorded videos of interviews conducted during and after design sessions with the system and aggregated the data in order to investigte the main requirements for multi-platform sketching systems.

We have used a set of three devices: Smartphone, Tablet and a large Tabletop. The smartphone used was a Motorola Droid 2 with Android, the Tablet used was a Samsung Galaxy tab 10.1 with Android and the Tabletop was a projection system on top of an horizontal smartboard measuring about 30 inches diagonally, as a second display of an iMac with an Intel processor.

We decided to group subjects into pairs in order to enforce the communication about aspects of the system (referring back the references, we therefore stimulated the use of *Talking sketches*). The goal was to aggregate the participants' discourses for analysis.

We asked subjects to design a simple "I Spy Bingo" game for kids to play in the backseat of a car during travels. The chilren would use tablets to tag different objects they see along the way. The parents, prior to the travel, would choose which objects the kids would have in their tablets to tag. Therefore subjects were asked to draw the two interfaces.

Figure 6 depicts the experient design and progression over time. Participants had the chance to design on one device at a time, having a large screen

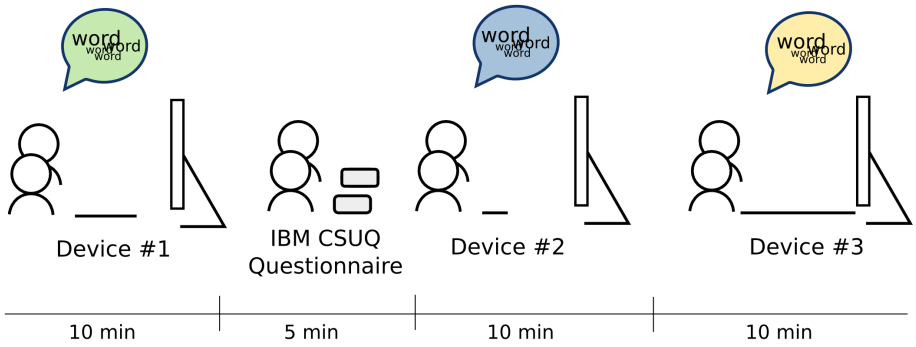

Figure 6: Design of the experiment

in front of them, displaying Gambit's wall. In the first 10 minutes, the pair of developers started the design using the first device. Then they were asked to fill the questionnaire (IBM CSUQ) about overall aspects of the system. After the questionnaire, we gave subjects another device and asked them to continue the design, and again with the third device. After the design session, we conducted an interview for assessing new requirements for the Gambit system.

It's important to notice that we have started with a different device for each pair of developers, in order to normalize the responses for the IBM CSUQ questionnaire. In this way, subjects were not influenced by previous experience with the system on other devices.

5. Results

By observing the questionnaire results, it's possible to see that subjects were not very satisfied with the system (questions 1, 2 and 19), and did not think they could complete the work very quickly or efficiently (questions 3, 4, 5 and 8) even though they felt confortable with it (6) and reported it was easy to use (7). Overall, subjects did not rated any question with more than 5, except for the question 7.

We have also analyzed the discourse of the subjects by using word clouds. A word cloud is a special visualization of text in which the more frequently

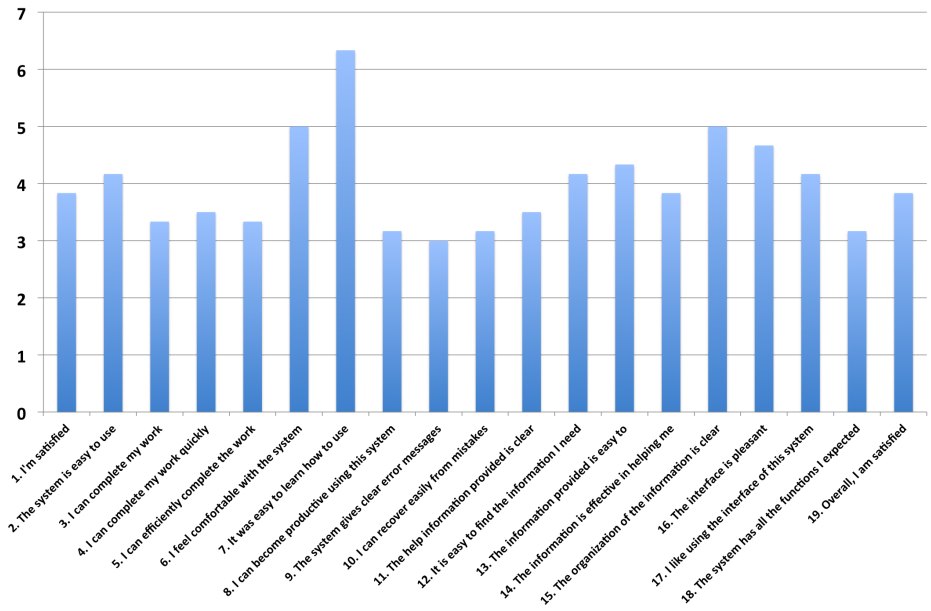

Figure 7: results for the IBM CSUQ questionnaire

used words are effectively highlighted by occupying more prominence in the representation.

The work of Mcnaught & Lam (2010) describes an experience on using word clouds to inform qualitative research. This kind of visualization allows researchers to grasp the common themes in the text, and sometimes even to find out main differences between sets of responses.

Even though a more profound analysis need to be done in order to grasp the context of words at different utterances, it is possible to compare the overall differences in subjects' discourses while using the three types of devices, like in Figure 8.

The most common occurence is of the word *faire* (*do/make*), since during the whole design session subjects discussed about how the user (the parent, in this case) would do to make the list of objects to be tagged by the children.

Subjects used the tablet to simulate the interface to be used by the children. That is why the words *là* and *ici* (*there* and *here*) have a high occurrence rate. Subjects also complained about the smartphone's scren size, this is why the word *écran* (*screen*) have a high occurence rate in the cloud for the smartphone.

About the post-experiment interviews, we have asked several questions

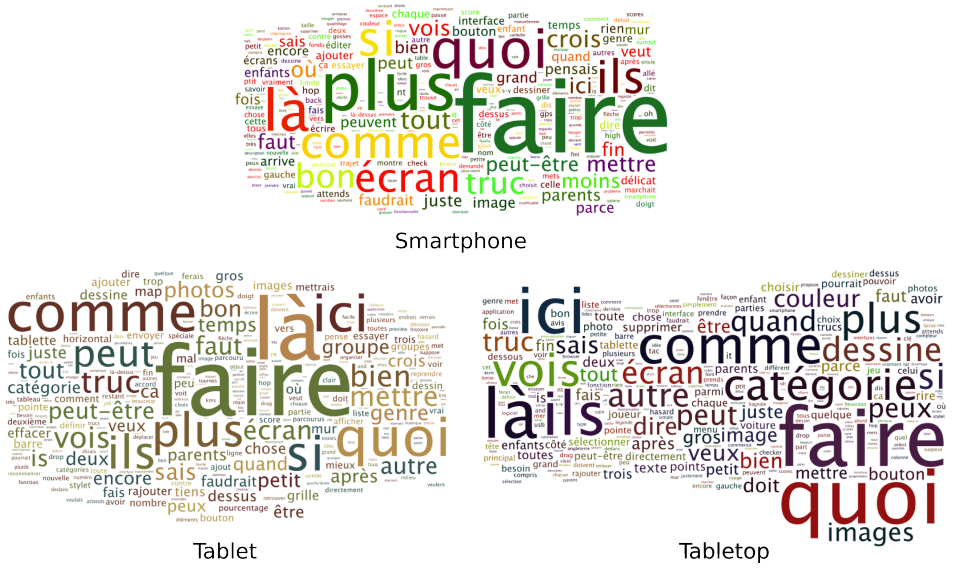

Figure 8: Word clouds for each device type

about the system current state and how it could be improved. Overall, all the three groups indicated that:

1. The system need predefined forms (lines, squares, circles, etc) which would ease the process of producing "reasonably good looking" interactive screens with minimum effort. That would utimately improve their experience with the smartphone, since they do not felt much comfortable;
2. It difficult to sketch using the smartphone due to its' screen size;
3. The system's speed matched the screen size, being ranked from fastest to slowest as Tabletop, Tablet, Smartphone, in their opinion.

6. Conclusion

We presented the current state of Gambit system for electronic sketching on a multi-platform context. The tool is a fundamental part of a research on sketching, whose goal is to advance the state of the art in electronic sketching, and its usage in current design practices taking into account the diverse multi-platform context.

With the pilot study presented on this paper we began to assess the current state of the system in order to evolve based on requirements of

different parties on a design session: designers, developers, stakeholders and users. This pilot study will serve as a comparison between discourses of those different parties in future experiments.

7. Acknowlegdements

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