

GRIP: Get better Results from Interactive Prototypes

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ABSTRACT

Prototypes are often used to clarify and evaluate design alternatives for a graphical user interface. They help stakeholders to decide on different aspects by making them visible and concrete. This is a highly iterative process in which the prototypes evolve into a design artifact that is close enough to the envisioned result to be implemented. People with different roles are involved in prototyping. Our claim is that integrated or inter-operable tools help design information propagate among people while prototyping and making the transition more accurately into the software development phase.

We make a first step towards such a solution by offering a framework, GRIP, in which such a tool should fit. We conducted a preliminary evaluation of the framework by using it to classify existing tools for prototyping and implementing a limited prototyping tool, GRIP-it, which can be integrated into the overall process.

Author Keywords

Prototype, Tool support, Interaction Design, Classification

ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: User Interfaces-*Prototyping, User-centered Design.*

General Terms

Design, Documentation

INTRODUCTION

Prototyping is an integral part of development and testing of design ideas in user-centered design methods. It helps interaction designers to define user interfaces, and evaluate usability issues in early stages of design. Many current tools, however, do not support the complete set of tasks of an interaction designer and other team members very well. They may be excellent at one, or even several points, but do not support the transition between different stages in the user-

centered design process, and especially to implementation and more generally software engineering very well.

We are not the first to notice problems with the tool support for both user-centered design and software engineering. Seffah et al [17] also noticed the problem and stressed both the need for “computer-assisted usability engineering” tools as well as a framework to share best practices between software engineering and user-centered design. Grigoreanu et al [8] focused on tool support for designers and noticed similar issues: tools should better support the “flow” of the design process and support the evaluation and communication about the look-and-feel of an application. Campos et al [4] also noticed the problem with the flow. They have a more software engineering focus, and noticed that in early user interface design stages there was a frequent change in workstyle. They thus proposed a tool, CanonSketch, that supports different workstyles and a framework that allows to evaluate tools on their support for different workstyles.

We propose a framework, GRIP, that complements the workstyle framework by Campos et al [4] and focuses on the flow of information between different roles involved in the creation, evaluation and implementation of *digital interactive prototypes*. The framework is based on a literature study and our own experience and validated through its application to existing research and commercial tools used for prototyping. GRIP focuses on the relations between artifacts involved in the prototyping process.

To illustrate the use of the GRIP framework, we developed tool, GRIP-it. The tool is based on the functionalities provided by framework. It addresses the specific problems that occurs in the early design of prototypes (for example integration of design artifacts).

PROTOTYPING

User-Centered Design (UCD) processes typically include several iterations of prototyping. Because of the multidisciplinary approach in UCD projects, team members with different backgrounds are involved, and design artifacts are transferred between these people frequently.

Team members that are involved in prototyping usually have one of the following roles: interaction designer, human-factors and ergonomics expert and software developer and end user [9]. In the remainder of this paper, we will make the distinction between the aforementioned roles to provide a clear under-

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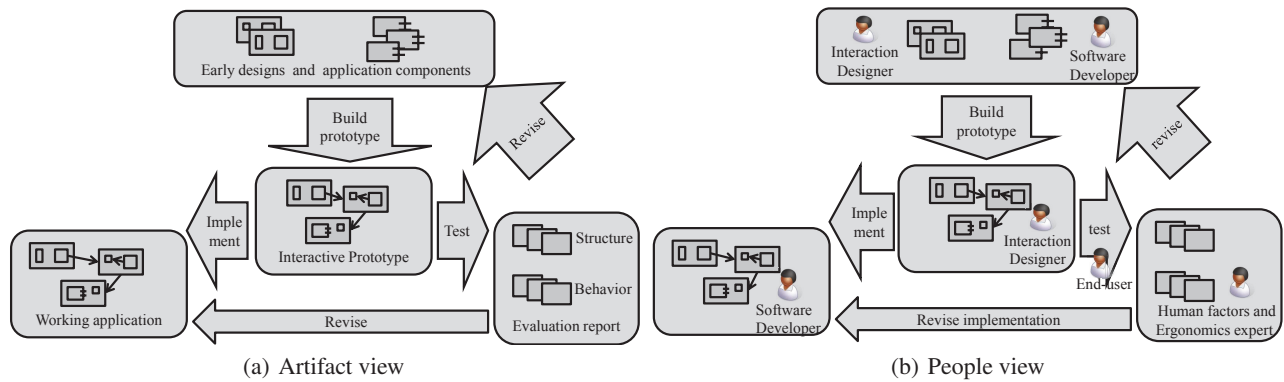


Figure 1. GRIP Framework

standing of what type of practitioner is involved for a particular prototyping activity. Nevertheless, we are aware that team members can combine several roles in a UCD project.

Besides the involvement of a multidisciplinary team in prototyping, the cooperation with end-users is inevitable. The level of involvement of end-users in UCD can vary according to the type of project and prototype that will be designed and developed. In general, end users will be involved during a user needs analysis before any prototyping takes place, and in the evaluation of several prototypes [9, 16]. In some projects, participatory design allows end-users to be involved in prototyping activities as well [14]. In this paper we mainly consider end-user involvement before prototyping activities and during design evaluations, but participatory design activities are not excluded.

The most accessible and ubiquitous tool to translate design ideas into visible User Interface (UI) designs is pencil and paper [3, 19]. Sketches can be easily understood by all team members, including end-users. Usually, an interaction designer is in charge of creating these designs, but all team members can be involved in brainstorm sessions. End-users can be involved in early evaluations of these sketches, which is the cheapest and quickest way to collect feedback.

Despite the reduced cost and time investments to create and evaluate sketches, these paper prototypes cannot contain all interactions exemplifying content and other application components [19]. Therefore, in the prototyping process sketches may very soon evolve into digitally created interactive prototypes using prototyping software or UI toolkits, which often have a longer lifespan [1]. This level of prototyping involves interaction designers. Once interactive behavior needs to be included in the prototypes, software developers contribute by developing a working application. Usability evaluations are conducted by human-factors and ergonomics experts or interaction designers and result into evaluation reports.

The involvement of team members with diverse backgrounds demands extra efforts to transfer designs and accompanying information (such as design decisions and evaluation reports). Each team member may prefer another prototyping

tool to contribute to the prototyping process [1]. Furthermore, it is likely that some information gets lost during these transfers. Some prototyping tools support the creation and transfer of UI designs. However, a general tool for interaction design that supports the entire prototyping process, described above, is lacking.

GRIP FRAMEWORK

The GRIP framework defines the required artifacts and stakeholders that participate in the prototype development process. We discern four groups of artifacts: Early designs and application components, Evaluation reports and a Working application (Figure 1(a)). We classify the different roles involved in the creation, evaluation and further usage of prototypes as follows: *Interaction designer*, *Human factors and Ergonomics expert*, *Software developer* and *End user*. The involvement of each role is explained in more detail below and is illustrated in Figure 1(b).

The Interaction designer plays a crucial role in the creation of prototypes as he is responsible for the creation of (*early designs*) (depicted by wireframes) and the creation of the combined prototype. Note that in subsequent iterations, he may be assisted by a visual designer to create more detailed designs. UI designs (or even sketches) can be combined with *software components* (depicted by the UML symbol for software components) to create *interactive prototypes* (depicted by interconnected wireframes).

These interactive prototypes should be tested by experts and at least some of the time involve end-users of the application. The results of these tests are documented by the human factors and ergonomics expert in an *evaluation report*. Notice that this evaluation report contains an evaluation of the look and feel (*structure* and *behavior*). We make no assumptions about the form of this report, but it preferably presents the interpretation of the results, as well as the supporting data in a format this is understandable by all stakeholders. Understanding the evaluation results and the implications this has for the implementation may be beneficial to convince software developers to *revise* the software components used or the actual *working application*. Similarly visual and interac-

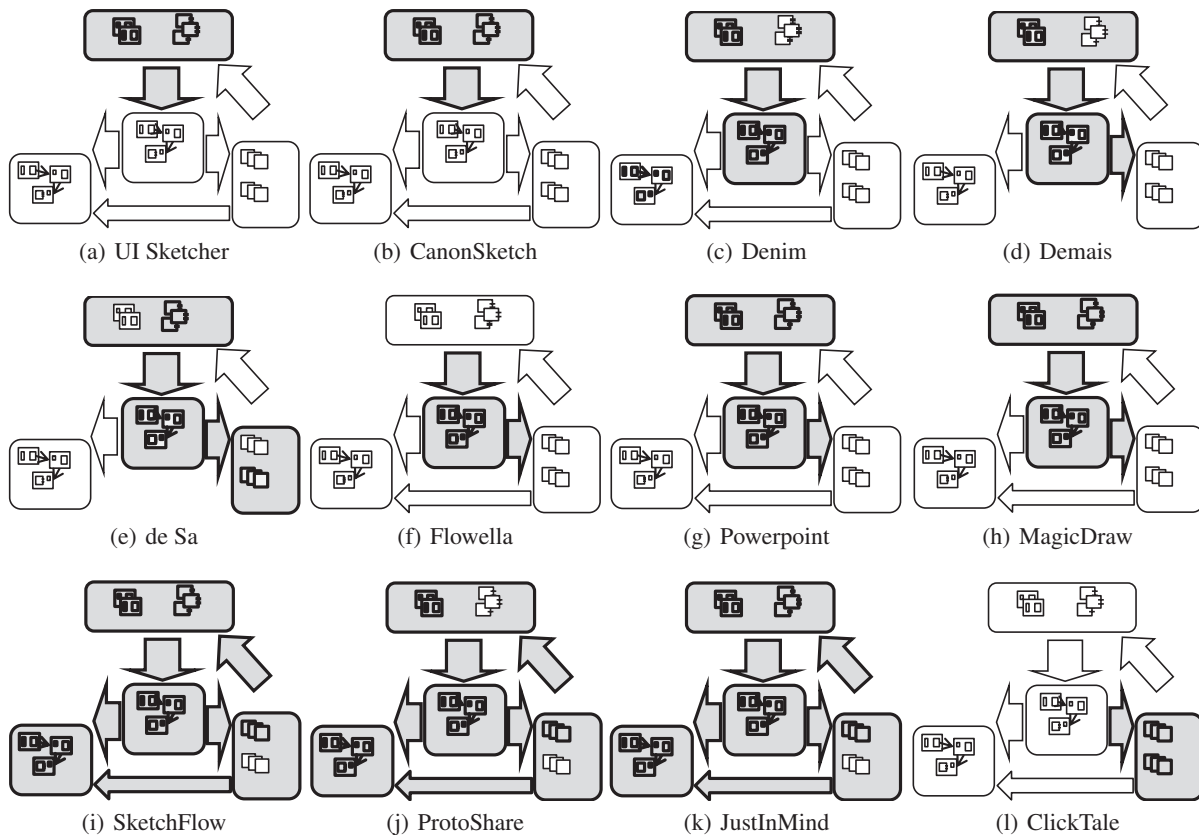


Figure 2. GRIP Framework applied for commercial and research prototyping tools

tion designers need this information to revise their designs or the integration thereof in the interactive prototype.

To optimize the flow of information it is useful in some situations that the interactive prototype can (at least partly) be exported to a format that allows the software developer to access the prototype from within his programming environment. This to ensure an optimal flow of information and a minimal duplication of efforts.

To illustrate the coverage of the ideal tool set, we use the line weight and the background color of the different parts of the diagram. In this way, one can instantly grasp the features. As the ideal tool set covers all activities and artifacts, all activities (arrows) and artifacts have the same line weight and background color in Figure 1. Support for an activity can be accomplished in a variety of ways. The fact that an interactive prototype can be exported as a website supports the testing of a prototype, and the ability to export a design as a picture, may enable the creation of an interactive prototype.

CLASSIFYING PROTOTYPING TOOLS

This section and Figure 2 illustrate how GRIP can be applied to classify and/or compare a diverse set of existing tools for the support they can provide for prototype development and evaluation. The tools are both research and commercial, selected to differ in scope and target users. To visualize the capabilities of the tools, we adapt the line weight

and the background color of the activities (arrows) and artifacts (rounded rectangles and specific illustrations). The line weight of activities and artifacts that are not supported is reduced and their background color is removed. For example, UI Sketcher [18] (Figure 2(a)) and CanonSketch [4] (Figure 2(b)) support the creation of (early) designs, but not the creation of application components. The illustration of application components thus gets a white background and has a reduced line weight. Since (early) designs are supported, the rounded rectangle and the early designs illustration retain the original line weight and background color. Both tools are focused on creating designs, but not on the creation of interactive prototypes.

Figure 2(d) illustrates that Demais [2] enables the creation of interactive prototypes (using a diversity of media formats and sketches). Denim [11] supports sketch-based prototyping of both navigation and web page structure (Figure 2(c)). Denim has a feature that exports the design into html for testing, but not with the aim of further development. MS PowerPoint (Figure 2(g)) allows the creation of interactive presentations that can be used for testing but does not facilitate the export of design evaluation data. MS PowerPoint can be imported in MS Expression Blend to a SketchFlow [12] (Figure 2(i)) specification. This SketchFlow specification can be executed in a web-based runtime that supports annotations on the user interface structure. Furthermore, the SketchFlow specifications can include custom components

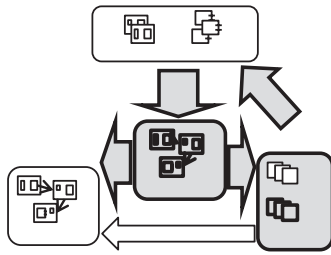


Figure 3. GRIP framework to identify new tool

and are saved in XAML [13], which can be the basis for further development. ProtoShare [15] (Figure 2(j)) and JustinMind [10] (Figure 2(k)) also allow the creation of interactive prototypes, but export the prototypes to regular webpages, which can be annotated using their hosted services. Web-based prototypes can also offer insights on user behavior using services such as ClickTale [5] (Figure 2(l)). Flowella [7] (Figure 2(f)) is a prototyping tool, developed by Nokia, focusing on building of interactive prototypes for mobile devices from designs (exported as images). The exported prototypes can be executed both on desktops and on the targeted mobile devices.

A special case of a prototyping tool is proposed by de Sà et al [6], as shown in Figure 2(e). The goal of this tool is to allow end-users to create complete interactive prototypes within specific domains. To enable this, a specific set of software components and media can be combined to create complete interactive prototypes that can be executed on mobile devices on a specific runtime that logs all actions, enabling replay.

MagicDraw (Figure 2(h)), a modeling tool, allows the creation of interactive prototypes, realized as models, but with a concrete Windows look-and-feel.

GRIP FOR EXPLORING NOVEL TOOLS

Based on our experience and an analysis of the state of the art using the GRIP framework, we identified a combination of features that was not present in literature and seemed to be promising. The requirements for this tool, GRIP-it, are shown using the GRIP framework in Figure 3. The tool should be able to use early designs, but also software components, to create an interactive prototype (especially for tablet or other touch-based devices). One should be able to use the prototype as a starting point for implementation and be able to analyse interaction logs of user tests.

It complements existing tools such as SketchFlow (Figure 2(i)), ProtoShare (Figure 2(j)) and JustInMind (Figure 2(k)) since the evaluation support is concentrated on the behavior rather than the structure of the interface. It also uses both (early) designs and components as input rather than mainly components as documented in Figure 2(e).

GRIP-it Tool

Our tool support for the GRIP framework facilitates the connection between the creation and evaluation of prototypes at

early stages of interaction design. This section discusses the most important artifacts that were implemented in the tool. A screenshot of our tool is shown in Figure 4. An *interaction designer* uses pre-defined prototypes, which can be scanned sketches on paper, digitized sketches or images to create the user interface design (Figure 4, A-1). Besides creating and editing the designs, the *interaction designer* can add interactive components to the early designs (Figure 4, A-2). The clickable areas of the user interface can be defined by adding resizable interactive regions to the digitized sketches (Figure 4, B). Similarly, multimedia (including image and video components) can be added to the designs to provide a first impression of possible content in the user interface. Once this prototype is finished, *interaction designers* can save the prototype (Figure 4, A-3) in XAML [13] and revise it based on suggestions of a *human factors and ergonomics expert* without having to create a new prototype. Software developers could use this format to start programming a working application.

This tool has the advantage that as soon as an interactive prototype is available, one can immediately explore or evaluate it (Figure 4, C). There is an option to give visual feedback for successfully registered taps. This is especially useful on some tablet devices as some force is required to successfully register a tap.

After the prototypes are being evaluated, a *human factors and ergonomics expert* can analyze how *end users* performed the task. A visual log of the interaction or an export in CSV format can be used for the analysis. The log shows every tap (or click on a desktop system) during an evaluation session using color-coded dots (Figure 4, D). Since these dots focus on direct interaction with the prototype, they provide enough details to compare design decisions such as different navigation options, interaction aspects (such as size of interactive region), and placement of controls. All screens that the user interacted with, are available in a corresponding order (Figure 4, D-1) and team members can opt to show only a subset of the chronologically ordered taps (Figure 4, D-2).

Expert Review

An expert review of the preliminary GRIP-it tool was conducted to evaluate the ideas of the GRIP framework. In contrast to interviewing or surveying practitioners about their opinion of the GRIP framework, presenting a concrete instance of the framework stimulated the experts involved to think about practices in which this type of tool can be used, and possible features that can be supported by the GRIP framework and instances of it, such as our tool.

Three HCI researchers, having 4 to 7 years of experience in prototyping, participated in the expert review. Each of them has a different background: computer science, cognitive psychology and cognitive ergonomics, and sociology. Besides doing research of prototyping and user-centered design within their respective domains, they all participated in various prototyping processes. They received no specific rewards for their participation except for a promise to be kept informed about eventual future versions of the tool.

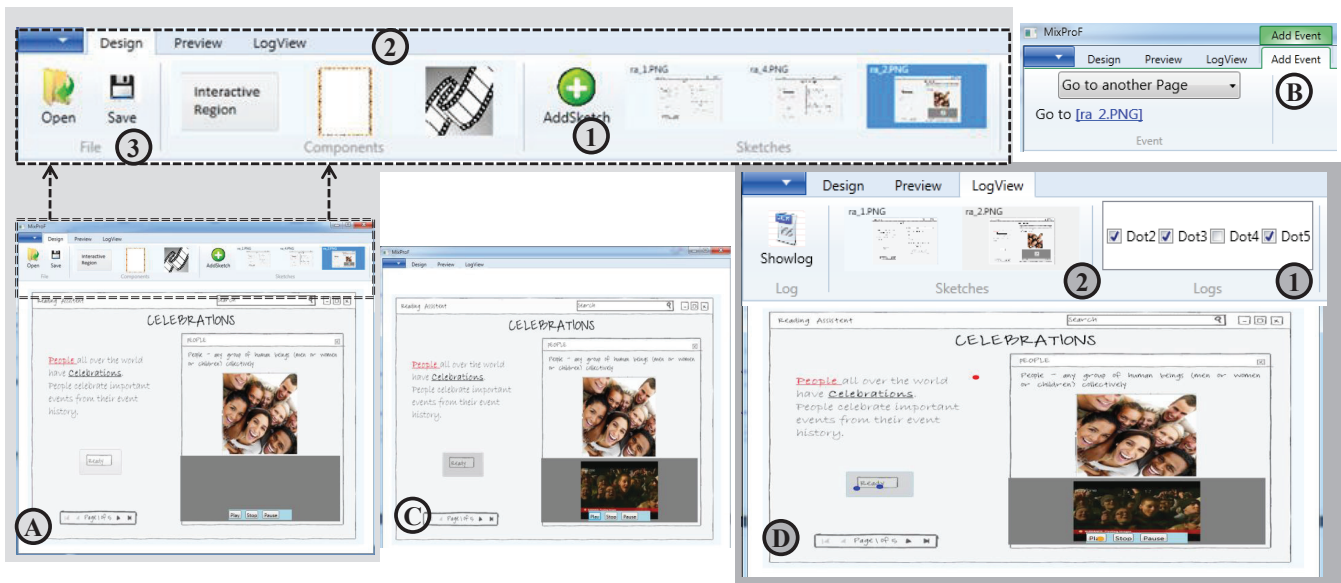


Figure 4. Screenshot of our (revised) tool prototype. Designers create interactive prototypes (A, B), one can explore the prototypes (C), visual logs of prototype explorations are provided (D).

Before the review, there was a briefing session to present the tool, its goals and some examples of UI designs created by the tool. Analogous to cognitive walkthroughs [20], the experts received written instructions, including a list of tasks, and were asked to write a short report regarding their feedback and findings. Furthermore, the tool and some examples of interactive prototypes created using the tool were provided to the experts. Afterwards, the experts presented their findings in a report and provided reasons behind the problems, and possible suggestions. This expert review differs from a typical cognitive walkthrough because we did not ask the experts to focus on ease of learning. We were interested in feedback concerning GRIP-it.

According to the feedback, the general idea of a tool that combines prototyping and the evaluation of UI designs before any working prototype is available, is appreciated by all the experts. One of the experts mentioned: *“The application could be useful for designers when creating UIs to illustrate the interactivity of their design drafts”*. Another expert reports: *“Evaluating these sketched prototypes including interactive features of a prototype is interesting for evaluating a first prototype of an application”*. Furthermore, one of the experts remarks: *“The application could replace paper prototypes and Wizard of Oz experiments. It allows an easy trial of a good way to test alternative interfaces”*. Consequently, this type of tools is suitable to support both the creation and the early evaluation of interactive UI designs.

During the evaluation of the interactive behavior of UI designs, our tool logs actions of participants on the screen. One of the experts assessed this feature as follows: *“The fact that the system logs where the test participant has clicked in the prototype can be very useful”*. Furthermore, this expert recommends to add various visualizations of the logs and to relate more information to the existing dots, such as time in-

formation and a path that shows the navigation actions of a test participant.

One of the experts favors the support for iterative design in the GRIP-it tool. Since only the evaluation of UI designs was considered in this expert review, this expert reports: *“I am very curious about the design feature in this tool, and the interplay between designing and evaluating. A good balance between these two tasks, and features that enhance iterative design, according to the logs, would be very interesting.”*. Another expert mentions that a more advanced version of the tool could be used in co-design sessions, which includes participatory design into the scope of GRIP. Further remarks of the experts concern detailed feedback on the UI of the tool, including comments regarding the size and placement of UI widgets. Most of these detailed comments are already taken into account in GRIP-it as shown in Figure 4.

More general comments suggested to provide an export feature, specifically to better support testing with a larger number of people over the Internet with support for logging and the possibility to also include a questionnaire. Inclusion of a wizard-like interface was another suggestion. These suggestions of the experts on the UI design of the tool will be considered for future iterations.

Although this expert review is a preliminary evaluation of the tool, the feedback of the experts acknowledges the ideas supported by the GRIP framework and encourages us to continue the development of the tool. In this review, the experts, all having relevant experience in several prototyping projects, appreciate this prototyping tool that provides features to easily and quickly add interactive behavior to sketched prototypes. By supporting the creation as well as the evaluation of prototypes, the iterative approach and cooperation within multidisciplinary teams can be benefited.

CONCLUSION AND FUTURE WORK

This paper reports on GRIP, a framework to address tool support for interaction design in (early) design prototyping. We believe GRIP complements earlier work in identifying areas where tool support is needed to improve integration design practices in prototyping. We showed how the framework can be used to compare existing tools for (early) prototype development as well as to identify opportunities for identifying potentially interesting tool support. The latter was illustrated using our GRIP-it tool.

The findings described in this paper have potential to stimulate insightful discussion among researchers. This has been demonstrated through the expert review carried out with researchers from different disciplines with experience in creating interactive prototypes. Our work has not only generated interest among researchers from technical but also among researchers from social science background. Some insightful feedback that the paper already generated includes its contribution in integration towards needs of designers.

The GRIP framework allows to identify areas of attention for prototyping tools that could be beneficial for their adoption. More refinement and analysis on how GRIP fits together with other frameworks is needed to enable more detailed analysis and more focused discussion of tool support for interactive prototyping. One sign of this is that vastly different tools such as Denim (Figure 2(c)), Demais (Figure 2(d)) and MagicDraw (Figure 2(h)) are almost identical. It is however a good thing that commonalities between these tools can be easily identified.

The results of the expert review learned us that there is a desire to have a more advanced version of a tool along the lines of the GRIP-it tool. Future work for GRIP-it includes addressing these more advanced requests, such adding the capability to create questionnaires, and richer visualization options to better understand the results across different evaluation sessions.

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