Towards a More Conscious Use of Prototypes in Mobile User Experience Design

Thorsten Hochreuter
University of Applied Sciences Mannheim
t.hochreuter@hs-mannheim.de

Kirstin Kohler
University of Applied Sciences Mannheim
k.kohler@hs-mannheim.de

Mareen Maurer
University of Applied Sciences Mannheim
m.maurer@hs-mannheim.de

ABSTRACT

We introduce a model (called Filter-Fidelity-Model), which allows us to describe, classify and systematically compare prototypes for mobile systems and applications. Our Filter-Fidelity-Model reflects the quality of elements represented by the prototype in relation to those of the final product.

Based on our literature survey, as well as our experience in industrial projects, the creation of prototypes is often not very goal directed. Therefore it might miss opportunities in terms of efficiency and effectiveness during the design process. The reason being, that prototypes might have the wrong focus, and therefore might even cause errors during evaluation. In order to focus more on the relevant aspects of a prototype, our model works towards a definition of fundamental building blocks. This is a necessary first step to make a prototypes' fidelity more conscious and reveal its appropriateness for answering particular design questions.

Author Keywords

Prototyping; User Experience Design; Mobile Interaction Design; Description Model;

ACM Classification Keywords

H.5.2 User Interfaces: Prototyping.

INTRODUCTION

The importance of prototypes in the design process is widely accepted in academic and industrial practice. Whereas in general many approaches, like Design Thinking [4] or the User Experience Design Process ([1], [10]), emphasize the importance of prototypes, their detailed usage might widely vary or even be underspecified. In this context prototypes can be used for exploring different ideas, for specification or documentation, or to evaluate alternative solutions in design ([9, 11]). Taking a closer look at the method descriptions, which explicitly name prototypes as artifact of the design or development process, it becomes obvious that prototypes can be very different in their appearance. Most approaches describe the prototype in more detail by referring to the material (e.g. paper based, computer based, etc.) or by referring to the tool, which was used to create the prototype (e.g. Photoshop or Axure). The only established term used to characterize the prototype related to its content, is the "fidelity". Prototypes are named as Low-Fidelity (Lo-Fi) and High-Fidelity (Hi-Fi) prototypes (e.g. [15, 18]). And again these terms also often refer back to the material: paper-based (for Lo-Fi) and computer based (to Hi-Fi) prototypes. From our point of view this characterization is not sufficient. It does not provide a closer characterization of the prototype-aspect, which is of low or high fidelity. Let us look at an example: a prototype created with Photoshop, portraying strong visual qualities, like the color scheme or the typography, can be classified Hi-Fi in these static aspects, because these characteristics are very close to those of the final product. Concerning the dynamic qualities on the other hand, the prototype might be classified as pretty Lo-Fi, because for example, the transition between screens is not covered, nor are any user actions or system reactions defined.

The given example makes it obvious, that a characterization along a single "low to high" fidelity scale is an oversimplification. Building upon works done by McCurdy et al. [13] as well as Lim et al. [11] we provide a description model, suitable to overcome this oversimplification. The model we will describe in the following paragraphs, allows us to profile a prototype according to its aforementioned qualities. These profiles, can then be compared against profiles created from seasoned prototypes of past projects with similar context. The basic idea is to create an explicit awareness for the things that make (or made) a prototype good related to its intended usage (as means for evaluation or documentation etc). We see this as a first necessary step to a more efficient usage of prototypes. Furthermore our model can be used as a checklist, helping to explicitly decide which parts of a product need further investigation in design and should be presented by a more detailed prototype.

After putting our work in the context of existing work on prototyping in the next section, we give a short overview about the model itself and exemplify the model by introducing two examples of prototypes for mobile systems characterized by our model. For the reasons of space

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restriction in this paper we refer to a more detailed description of our model in Hochreuter et al. [8] tailored for the context of tangible interactions.

RELATED WORK

According to McCurdy et al. the "distinction (of prototypes) is especially difficult to make when an artifact is particularly well developed in one area but not in others" [13]. Prototypes of this kind can be described as „mixed fidelity" [13]. McCurdy and colleagues propose five dimensions in which a prototypes mixed fidelity can be distinguished, yet only referring to classical WIMP interfaces. Lim et al. build upon the same notion of prototyping dimensions but introduce a more elaborated model [11], including the tangibility of interfaces/devices and therefore even cover aspects of product design, e.g. physical button placement on a mobile device. Lim and colleagues propose five so called filter-dimensions: the appearance, the functionality, the interactivity, the data and the spatial structure of a prototype. Lim et al. chose the term filter-dimension because prototypes allow a designer/developer to filter certain points of interest out of a possibly huge design space [11]. Prototypes are therefore always incomplete compared to the final product, but focus on certain interesting aspects, in most cases for either exploration or evaluation of design solutions.

Furthermore, the filter dimensions consolidate a number of quality attributes (called variables), which in their sum define properties of a product as a whole. The appearance dimension for example contains a variable called "color", defining the overall degree of color specification for interface elements. Lim and colleagues only hint at a small set of possible example-variable but do neither give a complete set of variables nor a detailed specification. The selection and the definition of these variables under the filter-dimensions given by Lim et al. in a mobile context marks our contribution.

DEVELOPMENT OF THE MODEL

The selection and definition of the mentioned variables was done through a survey of multiple prototypes, either from an academic or industrial context. In our research project "proTACT" we prompted our project partners (designers, computer scientists and psychologists) to classify prototypes of their choice along the filter dimensions given by Lim and colleagues. Furthermore we prompted them to criticize and review the example-variables mentioned in [11]. During our own literature survey we came across well founded approaches/models of other authors (like the interaction vocabulary provided by Diefenbach et al. [3] or the concept of proxemics by Greenberg et al. [6]), which deliver a more distinct and explicit definition of certain prototype/product aspects. In addition to these efforts, the variables of our model are validated by their review during various (master-)student projects at the University Of Applied Sciences (UoAS) Mannheim and in projects with our industrial partners in the proTACT.

FILTER-FIDELITY-PROFILES

The aforementioned profiles, in the following paragraphs called Filter-Fidelity-Profile (short: FFP), describes the fidelity of the prototype according to the chosen variables of the corresponding filter-dimension. The FFP is scaled along a 5-point scale ranging from "undetermined" to "developed". As a result one obtains a profile, which describes the fidelity in a more detailed manner. The following paragraphs explain the variables of the profile/model and their definitions in more detail.

Variables of the "Appearance" Dimension

The appearance of a prototype is not constrained to visual aspects only, but also encompasses the tactile and acoustic appearance. Especially in the context of product design, like the design of a mobile phone, aspects like haptic [e.g. 7] cannot be ignored.

- Size: The variable "Size" describes the size of all relevant elements of the prototype and its goals of study, as well as their size relations to each other (for more details see Cooper et al. [2]). Elements with varying sizes, e.g. through scaling, and the corresponding layout changes are also part of the variable size.
- Color: the "Color" variable defines the color of all the elements of the prototype, relevant for the design questions it is addressing. This variable also contains the gradation, light and shadow, transparency, the behavior in case of overlapping visual elements, as well as the resulting effects of these attributes.
- Shape: the "Shape" describes the visual and physical shape of the prototypes elements [cf. 2].
- Weight: the "Weight" variable describes the weights of physical prototype elements or the prototype as a whole (e.g. a camcorder prototype [11] or a weight-shifting mobile device [7]).
- Hardness: the "Hardness" of prototype elements is especially relevant for device prototypes and material studies 11.
- Haptic: the "Haptic" variable defines the haptic qualities of physical prototype elements, e.g. the shell of the smart phone. A 'perceivable haptic' of solely digital prototype elements may also be considered.
- Sound: the variable "Sound" encompasses the audible feedback of the prototype, e.g. sound samples and volume.

Variables of the ‚Data' Dimension:

The Data Dimension summarizes a set of variables dealing with the data represented in the System:

- Closeness To Reality: the "Closeness To Reality" variable defines how close the data, used for the prototype, is to reality, e.g. does the prototype contain real-life data or realistic sample data or maybe only placeholders?
- Information Architecture: the "Information Architecture" describes the underlying structure through which information is grouped and organized [cf. 5].
- Data Model: the "Data Model" defines the structure of the data processed or saved by the prototype. The objects of the application domain and their relations to each other are defined through the data model. Common representations are class-diagrams.
- Amount: this variable defines the amount of data used within the prototype, e.g. is the amount of data close to the real-life scenario or does the prototype contain only a few data units.
- Data Type: the "Data Type" variable defines the type of information used, e.g. images, or texts. This variable also defines the concrete data formats like mp3, avi etc.

Variables of the ‚Functionality' Dimension

The following variables aim to group the McCurdy et al.'s dimensions „Breadth of Functionality" and „Depth of Functionality" [cf. 13] under the "Functionality" Filter-Dimension [11].

- Breadth of Functionality: Which functions are realized within the prototype?
- Depth of Functionality: How detailed/complete are the functions, chosen under the "Breadth of Functionality" variable, compared to the intended final product features?

Variables of the ‚Interactivity' Dimension

According to Cooper et al. [2] as well as Löwgren & Stolterman [12], a product is not solely defined through form and structural aspects, but also through dynamic, time-based behavior. This aspect gained increasingly importance during recent years because interactions have become richer in their expressiveness by the shift from menu and pointer interactions to free-from and touch gestures (e.g. shaking the mp3-player to change the order of a playlist, or pinch to enlarge a photo). Each of these single interactions can be divided in an „action", and a corresponding "reaction" [cf. 14, 17]. An action could be a "slide gesture" over a picture and the respective reaction may be a flip through the gallery. In order to make the complexity of interactions, and their aesthetic qualities more manageable, Diefenbach and colleagues [3] produced the so called "Interaction Vocabulary", which provides a vocabulary to describe the feel of interaction [cf. 1]. Resting upon the interaction vocabulary we propose the following variables for the interactivity dimension.

- Action: this variable describes all actions a user can perform to "communicate" with the prototype. The interaction vocabulary can help to describe these actions according to their dynamic qualities. For example tilting a smartphone can either be done "gentle" or "powerful". A powerful tilt may be considered a "throwing" gesture.
- Reaction: the „Reaction" variable is used to define all system reactions for the aforementioned actions. An appropriate reaction for the exemplary throwing gesture may be a "fast" display of the "thrown information" on an interactive whiteboard.
- Input Modality: the input modalities of a prototype are the primary means through which a user performs actions on the system. The fidelity of this variable may range from a vague "motion sensor" to a concrete "3 degrees of freedom, build by manufacturer X".
- Output Modality: the output modalities of a prototype define the means of feedback provided by the system. The description is analogue to the input modality variable.

Variables of the ‚Spatial Structure' Dimension

The spatial structure dimension describes the two- as well as the three-dimensional structure of a system. Besides the positioning of UI elements (Garrett's „skeleton plane", [5]), this dimension also considers the aspects spatial position of the mobile device in the space as well as the orientation of the user in relationship to the device or other devices.

- Arrangement: this variable describes the actual "arrangement of interface or information elements" [11], as well as their spatial relationships among each other [11, also cf. 2]. For example the position of a toolbar.
- Spatial Position: this variable describes the spatial position of the system as a whole inside the interactive space. This aspect gained increasing importance since the invention of GPS sensors and gyrometers. This variable covers be for example the GPS coordinates (as needed for navigation app) or the relative distance to another systems (as in application built on near field communication). For a more details definition of this variable we refer to the concept of *distance*, *orientation* and *context* defined in the proxemic concept of Greenberg et al. [6].

PROTOTYPES AND THEIR FILTER-FIDELITY-PROFILES

We will elaborate the FFP of two prototypes in the mobile context in more detail. The given examples represent two different aspects of mobile interaction design: Prototype one (see Fig. 1) exemplifies a mobile device, a system with hardware and software elements; prototype two (see Fig. 2) is a mobile app. This supports the comprehensive applicability of our model in the mobile context.

Figure 1 presents the prototype for a cell phone designed for elderly people. The prototype is made out of cardboard and was designed by students of the UoAS Mannheim. The prototype was built as part of a design exercise and served to evaluate, whether the size of the mobile phone, its buttons and display is appropriate for the target user group and their needs. The user asked for large buttons and reduced functionality. During the interviews they mentioned their limited set of contacts and a need to easily switch-off the phone by folding it. In Fig. 3 its FFP is illustrated by the red crosses. Without our model, one could call this prototype a Lo-Fi one, but the FFP makes obvious, that it is highly developed concerning the shape, size and color. At the same time the variables weight and hardness were undetermined. It does also not show any aspects of the variable reaction because it doesn't provide any feedback on user actions. Looking on the profile in more detail makes it obvious, that in order to evaluate whether the phone feels right for elderly people, we also should pay attention on its weight and haptic. This might ask for another prototype build with a different material.

Figure 1: Cardboard prototype of a cell phone for the elderly.

Figure 2 illustrates two scribbles of a home automation app running on an iPhone. The left part shows a circular interface element used to change the brightness of light in a room through a rotation gesture. The right part shows the functionality for changing the temperature by sliding the blue handle up and down. The FFP of this prototype was not very developed in the area of action and reaction. The black dots in Figure 3 show the FFP for this prototype. To evaluate the intended gestures with users, a further prototype, with a higher fidelity on the dimension of interaction, is needed. For this purpose a follow-up prototype was developed in JavaScript, allowing an interactive usage of the handles for temperature and light during a usability test.

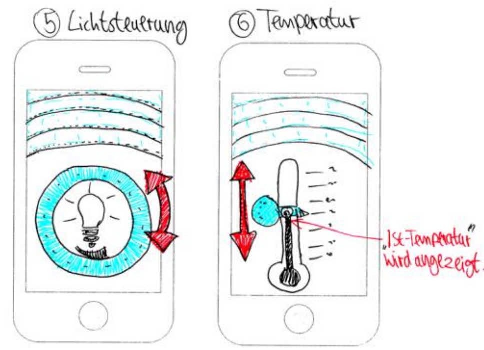

Figure 2: Paper prototype of an app for home automation.

Fig. 3 shows how different even prototypes made of the same material can be. It also shows that different prototypes might have a very different set of variables. For the home automation app for example weight, hardness and haptic are not of interest (made obvious by the "not-applicable" mark). For this app even the variable spatial position wasn't applicable, which is not true for apps in general. For example most navigation apps hook on GPS information, which belongs to the "spatial position" variable. Concerning the cardboard device prototype, one can see, that the focus was directed to the appearance dimension, especially the haptic aspects.

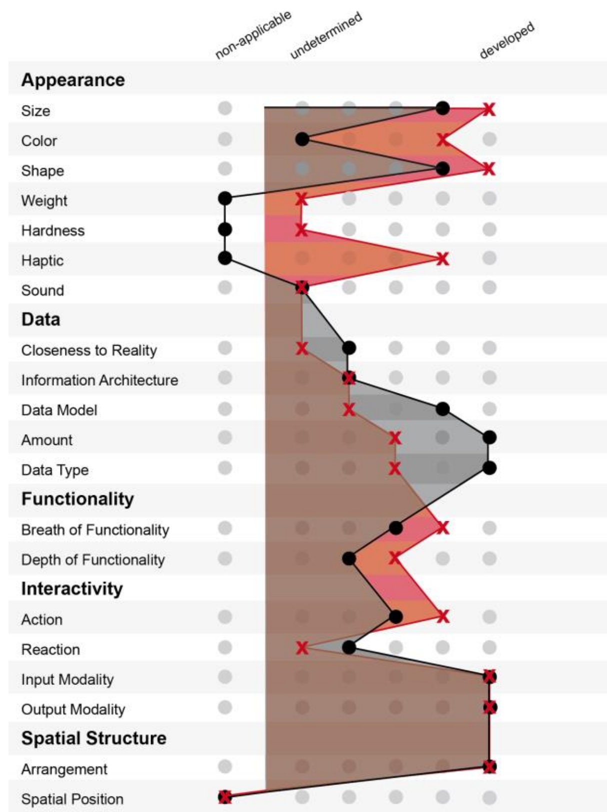

Figure 3: FFP of the cardboard prototype (red crosses) and the home automation app (black dots).

CONSIDERATIONS AND FUTURE WORK

In order to use the given model more effectively it is necessary to tailor the model to the users needs. A more concrete definition of the variables and their scaling, is a task, which ultimately resides with the designer. It is simply impossible to proclaim a general "one-size-fits-all" prototyping model, which never fails for whatever project context it is used in. Tailoring the model to ones needs is therefore a necessary step, not only to make this tool more applicable, but also to reflect on ones own prototyping methods.

Concerning future research we would like to relate certain profiles or variables to prototyping tools. By this means we hope to support a more goal oriented selection of prototyping tools, fitting to certain characteristic of the mobile system or app. Referring for example to de Sá et al. [16]: They used a video prototype to evaluate a Virtual Reality (VR) app. In terms of our FFP, de Sá and colleagues were aiming for a prototype with a highly developed spatial structure in order to evaluate their app. Existing prototyping tools didn't cover this aspect at that time, so they decided to base the study on video prototyping. The study shows that the evaluation of the video prototype gave helpful insights. Thus a video prototype might be well suited to evaluate an app with a strong focus on the "spatial position" variable.

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