Context and Continuity for Plastic User Interfaces

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Abstract

Mobility coupled with the development of a wide variety of computational devices, has engendered new requirements such as the capability of user interfaces to adapt to the context of use. In this position paper, we discuss the notion of context for plastic user interfaces. We suggest a framework for reasoning about the degree of plasticity that a user interface demonstrates as changes occur in the context of use.

1. INTRODUCTION

Mobility coupled with the development of a wide variety of computational devices, has engendered new requirements such as the capability of user interfaces to adapt to the context of use. In this position paper, we discuss the notion of context for plastic user interfaces. The term *plasticity* is inspired from the property of materials that expand and contract under natural constraints without breaking, thus preserving *continuous usage* (Calvary , Coutaz & Thevenin, 2001). Applied to HCI, plasticity is the "capacity of an interactive system to *withstand variations* of *context of use* while *preserving usability*". In the following subsections, we successively develop the key elements of our definition: context of use and a framework for reasoning about usability in the context of plastic user interfaces.

2. CONTEXT OF USE

A context of use for a plastic user interface is defined by two classes of physical entities:

- The physical and software platform(s), that is, the computational device(s) used for interacting with the system.
- The physical environment where the interaction takes place.

A *platform* is modeled in terms of resources which, in turn, determine the way information is computed, transmitted, rendered, and manipulated by users. Typically, memory size, network bandwidth and interactional devices motivate the choice for a set of input and output modalities and, for each modality, the amount of information made available.

An *environment* covers "the set of objects, persons and events that are peripheral to the current task(s) but that may have an impact on the system and/or the user's behavior, either now or in the future". According to this definition, an environment may encompass the entire world. In practice, the boundary is set up by domain analysts whose role is to elicit the entities that are relevant to the case at hand. For example, surrounding noise should be considered in relation to sonic feedback. Lighting condition is an issue when it may influence the robustness of a computer vision-based tracking system. User's location provides context for information relevance.

In a nutshell,

- a context of use, which consists of the association of a platform with an environment, is definitely anchored in the physical world. Therefore, it does not cover the user's mental models;
- plasticity is not only about condensing and expanding information according to the context of use. It also covers the contraction and expansion of the set of tasks in order to preserve usability.

3. PLASTICITY, USABILITY AND CONTEXT OF USE

The quality of an interactive system is evaluated against a set of properties selected in the early phases of the development process. "A *plastic user interface preserves usability* if the properties elicited at the design stage are kept within a predefined range of values as adaptation occurs to different contexts of use". Although the properties developed so far in HCI (Gram & Cockton, 1996) provide a sound basis for characterizing usability, they do not cover all aspects of plasticity. We propose additional metrics for evaluating the plasticity of user interfaces.

Figure 1 makes explicit the association of a platform with an environment to define a context of use. We suppose that platforms and environments can be ranked against some criteria computed from their attributes. For example, screen size, computational power and communication bandwidth, are typical attributes of a platform. Using these attributes, a PC would be ranked lower than a PDA since it imposes fewer constraints on the user interface. Similarly an environment with no noise would be ranked lower than the open street. Then:

- the plasticity of a user interface can be characterised by the sets of contexts it is able to accommodate,
- contexts at the boundaries of a set define the *plasticity threshold* of the user interface for this set,
- the sum of the surfaces covered by each set, or the sum of the cardinality of each set, defines an overall objective quantitative metrics for plasticity. In other word, this sum can be used to compare solutions to plasticity: A user interface U1 is more plastic than a user interface U2 if the cardinality of the set of contexts covered by U1 is greater than that of U2.

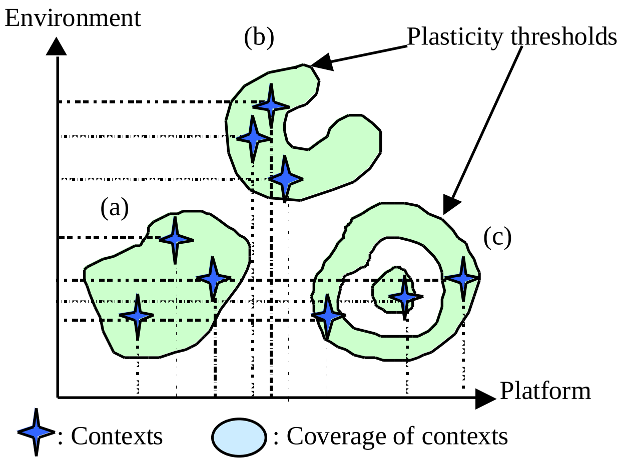

Fig. 1. Measuring plasticity from the system's perspective. Greyed areas represent the sets of contexts that a particular technical solution covers. Environments and platforms are ranked against the level of constraints they impose on the user interface.

We suggest additional metrics to refine the overall measure of plasticity in relation to discontinuity (Graham et al., 2000). These include:

- The size of the largest surface: large surfaces denote a wide spectrum of adaptation without technical rupture.
- The number of distinct sets: a large number of sets reveals multiple sources for technical discontinuities. Are these discontinuities compatible with user's expectation? Typically, GSM does not work everywhere. This situation translates as a discontinuity when moving along the environment axis of figure 1. A solution we have developed for home heating control systems works for the Palm and the mobile phone, but not for the Psion. In this case, there is discontinuity when moving along the platform axis.
- Surface shapes: a convex surface denotes a comfortable continuous space (cf. Figure 1a). Conversely, concave curvatures may raise important design issues (cf. Figure 1b). Typically, ring shape surfaces indicate that the interior of the ring is not covered by the user interface. It expresses a technical discontinuity for contexts that are contiguous in the ranking scheme. Is this inconsistency, a problem from the user's perspective? A hole within a surface depicts the case where the user interface is nearly plastic over both sets of contexts, but not quite. Is this "tiny" rupture in context coverage expected by the target users?

Intuitively, from a technical point of view, a large unique convex surface characterises a "good" plastic user interface whereas a large number of small concave surfaces denotes a large number of technical discontinuities. Although size, shape, cardinality, and topology of surfaces, are useful indicators for reasoning about the plasticity of a particular technical solution, we need to consider a complementary perspective: that of users. To this end, we suggest two indicators: context frequency and migration cost between contexts.

- *Context frequency* expresses how often users will perform their tasks in a given context. Clearly, if the largest surfaces correspond to the less frequent contexts and/or if a multitude of small surfaces is related to frequent contexts, then designers should revise their technical solution space: the solution offers too much potential for interactional ruptures in the interactional process.

- *Migration cost* measures the physical, cognitive and conative efforts (Dowell & Long, 1989) users have to pay when migrating between contexts, whether these contexts belong to the same or different surfaces (cf. Figure 2). Although this metrics is difficult to grasp precisely, the notion is important to consider even in a rough way as informal questions. For example, do users need (or expect) to move between contexts that belong to different surfaces? If so, discontinuity in system usage will be perceived. Designers may revise the solution space or, if they stick to their solution for well-motivated reasons, the observability of the technical boundaries should be the focus of special attention in order to alleviate transitions costs.

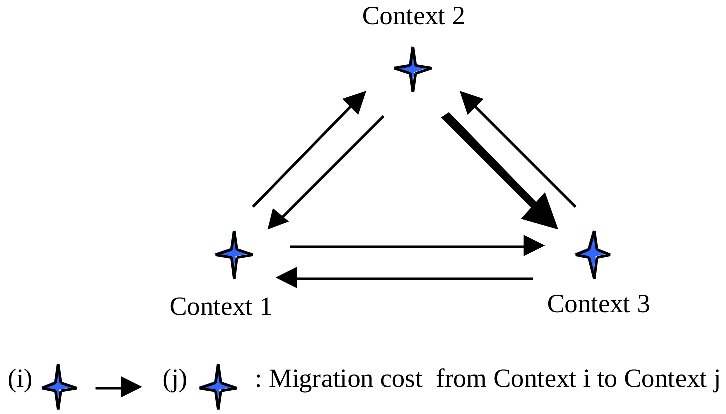

Fig. 2. Measuring plasticity from the human perspective. An arrow expresses the capacity of migrating between two contexts. Its thickness denotes human cost.

As *plasticity threshold* characterises the system capacity of continuous adaptation to multiple contexts, so *migration cost threshold* characterises the user's tolerance to context switching. The analysis of the relationships between the technical and the human thresholds may provide a useful additional perspective to the evaluation of plastic user interfaces.

4. CONCLUSION

Our framework provides a basis for reasoning about the degree of plasticity a particular interactive system can support. It. can be used to compare multiple design solutions. We need now to define metrics in order to provide the HCI community with an effective engineering tool.

5. REFERENCES

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