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A REVIEW OF STANDARD USABILITY PRINCIPLES IN THE CONTEXT OF MOBILE COMPUTING

The advent of mobile computing brings, together with advantages and exciting new opportunities, some novel challenges, among which mobile usability is a prominent one. Ensuring usability is made difficult by the presence of non-conventional aspects like: mobility, device limits, and changing contexts, which are rather peculiar of the mobile setting and that require some non-conventional and/or new knowledge to be addressed. It is necessary, in fact, to see if the tools at disposal of the interaction designer are still appropriate and, where not adequate, apply some refinements. Usability principles represent the basic knowledge of the interaction designer and are the foundation for usability evaluation methods, therefore, in this paper, we start addressing the problem by proposing a review of standard usability principles. We selected a wide set of commonly accepted principles and went over them to see how they apply in mobile computing. In this paper, we report on this activity, pointing out new requirements and interesting findings. The inquiry is also supported by a description of limits and opportunities posed by mobile devices and a short review of appropriate and new usability evaluation methods.

Keywords: mobile user interfaces, usability principles, usability methods, mobile interaction.

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1. Introduction

In a mobile era, it is common to encounter a user who "carries out one or many parallel activities from virtually anywhere at anytime while at the same time interacting with other user(s) and/or device(s)" (Bertini 2003). Besides the privileges associated with it (e.g., ubiquity, portability, etc), mobile computing does also pose some challenges (e.g., inherent device limitations, input/output challenges, etc.); human-computer interaction is not an exception. Human-computer interaction has to come to terms with the ramifications of mobile computing. In particular, usability faces awesome challenges in mobile computing. While some of the conventional usability principles and methods could be applied to the mobile computing, some would need to be revised. In some cases, it might be necessary to introduce usability principles and evaluation methods that are unique and relevant to the mobile computing arena.

While there exist various usability proposals relevant to mobile computing, most of them are either: a) partially done or are not specified in a concrete or precise way e.g., (Giller 2003) which reports an evaluation from which the authors were able to realize a few guidelines for text presentation, content structures, and speech interfaces; (Dey 2004) which focuses on predictability; b) rather too specific to a particular domain/field to be applied to other cases e.g., (Buchanan 2001) which focuses on WAP-based devices; (Mankoff 2003) which is specific to ambient displays; (Vetere 2003; Greenberg 1999) which are applicable in CSCW.

We take a rather systematic and concrete approach that does not restrict itself to a specific domain but focuses directly on mobile computing as its target. We decided to go over a set of commonly accepted usability principles. For this purpose, we consider those provided in (Dix 2004), which is a widely adopted HCI book and contains principles that have a broad coverage and are commonly accepted. Therefore, we propose a review of these principles challenging their applicability, reasoning about their relevance in the new context, putting the accent on critical aspects, and where appropriate proposing relevant principles. Since the applicability of principles in practice, through some form of usability study, is also an issue, we finally shed light on a few usability assessment methods in mobile settings.

2. Limitations and Opportunities of Mobile Computing

In this section, we discuss the limitations posed and opportunities provided by mobile computing.

2.1. Limitations Posed by Mobile Devices and Context

We discuss the limitations posed by first mobile devices and then the context/interaction.

Devices

- *Small-screen* – Mobile devices tend to have small screens in order to be portable. The problem of the screen real estate is thus intrinsic.
- *Limited input* – Similarly, because of device format, input mechanisms are inherently limited and difficult.
- *Limited bandwidth and cost* –Mobile Internet connections are still slow. These reduce both the kind of content single web pages can have and the number of pages users are able to navigate. Moreover, we should consider the cost model in that some companies offer their Internet access in a pay per KByte policy.
- *Limited connectivity* – The latency of the connection affects the pace of interaction that is the rate at which communicating agents can engage in dialogue. Furthermore the limited coverage of different networks and the consequent intermittent connection both make the latency variable to an extreme point as well as giving rise to problems of how to portray these hidden network properties to the user. An additional problem is that of seamlessly switching between different networks.
- *Limited computational resources* – This means that the capabilities of application are limited.
- *Limited power* (batteries) – This has big impact on end users: limited autonomy means limited availability that in turn means limited reliability.
- *Wide heterogeneity* – Wide heterogeneity (of OSs and physical properties). The users of mobile systems must always adapt to new forms of interaction as they switch to different mobiles due to different OS, application, and physical properties.

Context/Interaction

- *Variable context* – Since mobile devices, by definition, are mobile, this means that also the context in which they are used is continuously changing.
- *Kind of interaction* – The nature of interaction also changes in mobile settings. In general, users tend to interact in small and focused chunks of activities, more than in fixed settings. A large fraction of tasks in

mobile environment consists of few fast steps that the user should be able to execute without cognitive effort. In addition, mobile tasks may happen in conditions where users' attention is necessarily reduced, or may be part of more complex activities with which they should not interfere.

- *Interruptions* – Mobile devices/applications are always "with us". If this, on one hand, means that computation and data are always available, it is also true that notifications and requests for attention can happen in inappropriate moments and that in general some tasks may need to be interrupted and/or (re)started.
- *Privacy and security* – Privacy issues become more prominent. While staying mobile, users find themselves in a variety of spaces, in a variety of situations, and in a variety of infrastructures. Moving through these settings raises different privacy and security concerns.
- *Intimacy and availability* – Because mobile devices are mobile, they are personally available in a way that fixed devices are not. Moreover, they seem to engender a sense of being "personal" in a deeper sense than desktop PCs. Users therefore tend to depend more on their computing systems than in the past. Their unavailability thus can create problems that are more serious and intrusive.

2.2. Advantages/Benefits of mobile devices

Mobile devices present new opportunities in the field of information technologies and in the society. They tend to blend, challenge and sometimes even break conventional Human-computer interaction paradigms.

- *Ubiquitous access* – While being mobile, the user can communicate or be able to use/access remote services/applications and documents. Mobile devices are instrumental in facilitating the exploitation of the context/environment of the user and the consideration of non-conventional interaction paradigms.
- *Portability* – The size and weight of mobile devices make them easy to carry and handle.
- *More personal than personal computer* – There tends to be a more personal significance that the user attaches to his/her mobile device than to the desktop computer. Although this aspect does raise the issue of privacy in the wider context, it still is of tremendous importance to the user at a personal level.

- *Democratization of information access* – Mobile computing breaks barriers that have limited information systems to a particular type of professionals or workers.
- *Opportunistic interaction* – Access to application and network is allowed where it is needed and when it is needed. This is probably one of the biggest advantages of mobile devices. It represents a powerful resource for mobile users, opening the space for the design of new and challenging applications and services.
- *Reduced complexity* – While it is true that small screen and limited interaction capabilities extremely reduce the amount of accessible information and the complexity of operations, we can also consider the benefits of a reduction of complexity. While this can be considered a limit, it also has potential advantages that should be taken into account. Fewer options and reduced information density mean that the user's cognitive effort can be reduced.

3. Usability Principles Review

In this sequel, we present a discussion on usability principles in mobile computing. In our discussion, the usability principles are drawn from (Dix 2004). In the foregoing reference, the usability principles are discussed with respect to the conventional desktop computing. The principles are classified into three principal categories: learnability, flexibility, and robustness. We analyze each principle with regard to mobile computing.

Learnability

Learnability refers to how easy it is to learn and remember functions and modalities provided by the system.

Predictability:

Predictability measures how easy it is to predict the outcome of future interactions according to the knowledge acquired in past interactions. Because output is limited, it is likely that the memory load is increased, though the system is less predictable. Very often, potential actions in a given state are hidden behind complex combinations or in menu options that cannot be seen (things are less visible thus cannot be predicted). At the same time small screen also inevitably means a reduced set of choices, thus a decrease in complexity. Therefore, we can say that this indirect reduction in complexity can lead to improved predictability. For instance, the number of menus and menu items a small screen application can host is significantly reduced compared to a standard environment. This means that the number of options a user must search through is also reduced, thus improving learning time and access cost.

In case of contextual interaction, pre-emptive behavior can create problems in terms of predictability because the interaction is triggered by external events in an opportunistic way. In this case it is hard to predict how the system will behave and, in some cases, it will be almost impossible to predict when interaction will happen. It would be interesting to explore how to overcome this inherent lack of predictability introduced by context aware systems.

Synthesizability:

It refers to the ability of the user to infer the effect of past operations on the current state and build upon these a model of how the system works. It is tightly connected to visibility of the system status and the effect that operations made. Considering that synthesis can be achieved especially if internal changes can be seen (immediately), the limited output of mobile devices can be an issue. However, it is also true that the dialog and the information architecture of a mobile system is usually less complex than standard applications, so it should be easier to build a model of the system behavior after some preliminary exploration of the interface and its functions. Context awareness can have a major impact on synthesizability. In context-aware systems the internal state can easily change because of external events, therefore the user must build a model of the system behavior based not only on his active actions but also on his perception of external events. This poses a new and probably unexplored issue. The user must perceive and see not only the effects but also the causes of the events that happen at the level of the interface and infer a connection between what happened in the system and what happened in the environment. Accidental simultaneity is a connected issue. Since explicit input can possibly overlap contextual input, multiple actions may occur at the same time, thus creating confusion in determining causes and effects. In this case, the cause for a change in system status can be misinterpreted and, consequently, a wrong mental model may be synthesized. Even when there is no confusion as to the contextual cause of events/effects there may be confusion due to scarce visibility, especially location. Looking for boundaries that exist in the digital world but not in the physical one can be difficult.

Familiarity:

A user interface is familiar when a user can determine how to initiate any interaction when the interface is first perceived. Familiarity is still very important and not very well supported in mobile devices. PDAs and cellphones appear with different keyboard layouts or modalities (keyboard VS stylus). Very often, they are provided with special access keys that are unique to the specific model. This can affect the immediate understanding of the (physical) interface especially when switching from a previous device to a new one. Icons and natural mapping of keys become crucial in this context. In the case of location-independent applications familiarity with PC versions of applications can be exploited. Part of the knowledge can be automatically transferred so that the user interface becomes easily familiar. However, there are also problems of consistency when the applications are familiar yet slightly different (hence, this issue pertains to the consistency principle as well). Therefore, care must be taken when transferring applications from PC version to the mobile one, trying to exploit to the maximum what the user already knows, but at the same time being aware of not introducing dangerous inconsistencies.

Generalizability:

This actually is very critical in that every cellphone has its own operating system with different ways to accomplish the same tasks (e.g. insert a new item in the address book). As for generalizability across different applications/OS, we are still far from supporting it. It is especially important considering that users change their cellphones and even vendors very often. As for generalizability within a single application, it still holds with the same relevance. Due to overloading of functions associated to the keyboard, it may be interesting to check whether the user can generalize the behavior of certain keys across many different situations.

Consistency:

Apart from familiarity and generalizability, which can be considered as a form of consistency, here we consider consistency of input/output with respect to the meaning of actions in some conceptual model. The use of indirect input by means of a keyboard opens a wide space of possible consistency flaws. The user learns that some keys are always used to trigger certain actions (e.g. open a menu), if in special cases this does not happen there is a consistency problem. For sure the extensive use of keyboards as primary means of interaction poses consistency problems, mainly due to the fact that button functions are overloaded. Consistency issue could arise also when signaling contextual events/information, the way contextual information is transmitted could be susceptible to consistency problems (audio/video output), the same signal could be interpreted in different ways. However, sometimes we can also ignore high-level consistency if users are focused on the device. For example, some cell phones have a 'scroll' button that scrolls through names in phone book mode but at the same time raises and lowers volume whilst talking. Even if one does not know what the button does, it is easy to tell as soon as one starts to use it and it is easy to reverse its effects, as it always is a "natural inverse".

FLEXIBILITY

Flexibility refers to the extent to which the user and the system exchange information and control.

Dialog initiative:

This refers to the property of who has the initiative of starting a dialog. The system can initiate a dialog and request the user to respond, or the user can be the initiator of the dialog and wait for system feedback. This is one of the principles that is most affected by mobile context. The usual suggestion is to minimize system-preemptive dialog but in mobile context, it could be crucial because users might want to be notified about external events. A major issue is to estimate the level of importance of some events or changes in state to predict how intrusive a notification should be or how important an event is, compared to another that requests to be notified at the same time.

Multi-threading:

Multithreading is very limited in mobile devices and this is due to many factors such as: the limited screen size and computation reduce the ability to run multiple applications concurrently; it is not easy to advice the user on the existence of multiple open applications; there does not exist the concept of loading an application, the application is there and maybe there is not the concept of application at all. The various functions are perceived as features of a single application running on the device; if multiple applications run concurrently the user should be able to first temporary halt a task and then resume an interrupted task. This can be very cumbersome in a limited device; multimodality is very promising and can be used to operate multiple tasks in parallel or to run a complex function. Although it may help overcome some problems, users may need more training than before.

Task migratability:

It refers to the ability to transfer control of tasks between the system and the user. Such transfer often has an impact on the performance/efficiency of the application. Given the small size, reducing the explicit bandwidth between user and computer task migratability becomes if anything far more important. However, in a computing era where interactivity or response time is critical, task migratability should be employed with due care. There definitely are cases where it is especially suitable. For instance, the mobile system can be used to run for the user, tasks that are mundane, routine, repetitive and obvious. Moreover, it can be appropriately used to minimize the need for requiring explicit input from the user. Task migratability might also be appropriate in highly crucial/sensitive cases in which the system takes over the control (e.g., in security considerations and medical decisions).

For location-dependent applications contextual data gives opportunity to infer things about the user, like user activity. For location-independent applications, the situation is more difficult in some ways as, almost by definition, any contextual information is irrelevant. There may be some room for learning things like "Ann always reads her email while on the train home" and thus automating some decisions, but this kind of adaptations are difficult to generalize and can easily become annoying if not well designed. However, there may be some opportunities even in this case. The general principle that predictive interfaces that may be annoying when you can easily do things by selecting from numerous menus, toolbars etc., may become more acceptable when normal free selection is more difficult. In other words, the users may accept more easily some kinds of automatic adaptations if they see in then some added value. What in a standard PC interface would be a subtle improvement, in the mobile version may mean a significant speed up.

Substitutivity:

This is the extent to which an application allows equivalent input and output values to be substituted for each other. In mobile systems, there is a critical need to ensure that the specification of input is kept to a minimum and, again because of limited bandwidth, introducing forms of substitutivity becomes extremely important. In the case where input has to be explicitly specified, the application should make it as much convenient/easy as possible. For instance, in the case of context aware systems, the context could be the input to a particular task; typically, location functions as input to location-based navigation/map applications. In a more general sense, an application should have a framework that is flexible enough to allow output to be used as input for another task. In fact, input and output could be so linked that there appears to be no distinction between

them on the user interface. Again, the employment of adaptive techniques may be beneficial in this case. If history of past interactions is continuously recorded, adaptive systems can transform input to output e.g., explicit text input in web forms can be converted to menu selections, or past web searches can be proposed as a list of automatically constructed bookmarks.
Customizability:
The term refers to the ability of the user or the system to modify the user interface. The presence or the absence of some user interface objects and features could imply that the computing resources would be strained, or could even directly mean a higher bill on the part of the user. It would therefore be appropriate to allow the user to customize the user interface inline with pertinent needs. Mobile devices are characterized by diversity of technologies, user types and context. Situations where the user runs across unfamiliar, complex and intimidating technical choices and decisions are commonplace. Such situations afford great opportunities in which the system could adjust the application inline with the characteristics of the device in use. One of the crucial design considerations is the resource cost of supporting customizability. For instance, in adaptivity, the amount of processing that would be expended on capturing and inferring knowledge about the context and the user. A respective decision would heavily rely on the purpose for which the application is developed. As we consider supporting customizability, we should therefore keep in mind the purpose of the application.

Since mobile applications cost of interaction is higher, there is more reason to invest effort in customization possibly aided by "intelligent" suggestions. Moreover, availability of mobile devices means that they are a potential thing to "play with" when waiting for a bus, or a meeting to start etc. This "cheap" spare time available, potentially changes the cost side of customization, making the occasions for customization more frequent and desirable.

ROBUSTNESS
This refers to "the level of support provided to the user in determining successful achievement and assessment of goals".

Observability:
This is the extent to which the user can evaluate the internal state of the system from the representation on the user interface. This feature is very crucial in the development of mobile applications. While it is important for the user to be able to determine the internal state, it should be taken

into account that the user is also greatly interested in perceiving other aspects. Aspects such as signal and connection status, power consumption and cost are extremely important to the user and therefore they should be made observable. The user need not get out of his/her way in order to get information about critical aspects. On one hand, the issue of status observability is transversal to applications i.e. status observability should be available across applications. On the other hand, the components of the interface dealing with status communication and change events should interfere minimally and appropriately with running activities. An appropriate representation on the part of the designer and a glance on the part of the user could be enough to deal with it.

Recoverability:

It refers to the extent to which the user can reach the intended goal after recognizing an error in the previous interaction. Recoverability is currently not widely supported by mobile applications. Mobile settings involve largely the real world and in the real world, people are far from perfect. As they interact with devices, they will make mistakes and, even as we consider ways to avoid mistakes, we should be prepared when they occur. The application should therefore be able to recognize an error, "forgive" the user and provide relevant guidance to reach the intended goal. On the same note, it is rather interesting to also realize the opportunities and implications brought about by context in mobile settings. One aspect of recoverability in mobile devices, especially mobile phones, is tightly connected to navigation. Navigation through menus and functions, when stepping back, is like a cross between a "back" button in a web browser and an "up" button on a web page, permitting to recover previous stages and trace back in case of wrong selection. It is a navigation feature and not an undo as: (i) the backup stops at the top level and (ii) it does not reverse the effect of actions. Nonetheless, back navigation is very effective and generally used without any cognitive effort. At a broader level, one way to aid recoverability is through backups and checkpoints. It is amazing that phones do not make better use of the fact that they are semi-permanently connected to the network. It would seem easy to have the phone always maintain a synchronized copy of data held centrally as both backup, resources for recovery and online version for access and management via a web interface.

Responsiveness:

It is a measure of the rate of communication between the user and the system. This is a key feature in mobile computing. The level of respon-

siveness can easily repel users from or draw users to a mobile application. In the real world at least, time is key in determining whether an opportunity is seized or lost. If mobile devices are intended for such a setting, and they are, then responsiveness is crucial. As a matter of fact, mobile computing users normally perform tasks with a sense of urgency. They realize that there are various aspects that are at stake. There are also cases where mobile computing tasks are not the main tasks. They are rather supportive/auxiliary tasks. Naturally, people would rather spend more time on the main tasks than spend a lot of time on the auxiliary tasks.
Task conformance:
This refers to the extent to which the system services support all the tasks the user would wish to perform and in the way the user would wish to perform. It is interesting that this feature tends to be more applicable to mobile devices than to desktop computers. Each task in this case tends to be self-contained and small and also relatively limited, generic, and focused. Mobile systems are rarely designed to support a specific workflow whose steps are some small inter-related tasks (e.g., writing and editing a paper). There definitely are some exceptions, e.g., when making a telephone call through a cellular phone. This means that the aim probably is to design for small well understood tasks that can be very directly supported fitting into a much more situated larger scale view. However, there is an extent to which mobile devices have a better idea of "purpose" or goal; both because of sensed and digital contexts, which can be exploited as a resource to make the task more conformant. Moreover, conformance is made more difficult than usual by the fact that interaction must naturally fit not only the way the users perform tasks in general but also how they carry them in specific situations.

4. Usability Assessment Methods

While acknowledging that there are some gains associated with mobile computing, it is no secret that there too are some pains associated with the same. Evaluation has not been spared in this respect. In the sequel, there is a discussion of some of the challenges that mobile computing poses to the evaluation of applications.

In this era, the real need to take into account the real-world context has become more crucial than at any other time in the history of computing. Evaluation methods intended for mobile computing have to come to terms with that need. Contextual aspects such as: network connections, devices, people, location, etc., have a major impact on the user's interaction experience with the underlying application. Although the concept of context is not new to the field of usability (e.g., ISO 9241 guidelines do propose a "model" consideration of context), evaluation methods have however found it challenging, in practice, to adequately and completely integrate the entire context during the evaluation process.

In mobile settings, context structured activities depend on a context that is more likely to change than in standard settings and often in complex and unexpected ways. This does not match very well with the conventional HCI evaluation techniques, which tend to be task-centric. The task-centric methods may not be directly applicable in evaluating mobile systems (Abowd, 2000). While it is true that low-level tasks are easy to test in a standard usability testing fashion, the higher-level activities need studies that are more situated. However, the former are shaped and made more complex by interactions between environmental effects and the low-level tasks (e.g. dialing whilst walking), so this is perhaps more difficult for more controlled studies. Mobile devices are also hard to study physically as by definition they are moved around. For instance, even if there exist some special kinds of cameras that can be attached to mobile phones to capture the screen and user's actions, we are still far from having mature technologies capable of capturing interaction in real settings in a non-intrusive way.

The technology required to develop mobile systems is often on the cutting edge. Finding people with corresponding skills is difficult. As a result, developing a reliable and robust mobile system is not easy. Actually, most of the existing efforts remain at prototypical level and are therefore not robust (Abowd, 2000; Abowd, 2002). Such efforts are therefore usually not reliable and stable enough to be deployed and to be subjected to user-based experiments in the real-world context of use. The mobile technology also is often unpredictable and unstandardized. As well as the technology itself often being hard to test, novel applications are also unfamiliar to both users and experts; therefore, it is very hard to assess how they would behave in real and long-term use.

4.1. Expert methods

Considering the phases of usability inspection: analyst preparation, candidate problems generation, selection/elimination, recommendations (Cockton 2003), it is crucial to enhance these with new rules and tools to take into account the new requirements of mobile computing. In particular, analyst preparation and the candidate problem generation are in need of refinement.

The analyst must be prepared. He must know: basic usability principles, the context of the system, and the system itself to conduct a reasoned evaluation. While in the past considering context meant knowing a very well structured set of elements, e.g., user population, domain knowledge, system capabilities, etc. now the expert must be prepared to analyze a richer context where crucial situations are harder to predict and analyze. For example, as long as the user is supposed to be mobile, there is a wide spectrum of situations that should be considered that presents different key characteristics, e.g., the user is walking, the user is on a moving means (e.g. a car).

To take into account rich and evolving context the expert must be supported in some way. One option could be that of providing him, along with common guidelines, a set of common "situations" and/or "environments" that must be reviewed to see if they match with a possible relevant arising issue for the specific system designed.

Another option is that the expert immerses himself in possible contexts building possible rich scenarios in which the focus is shifted from tasks to activities in which external agents and situations plays key roles. The expert should prepare a small set of possible scenarios and challenge himself in finding richer interesting situations continuously refining them until a set of really relevant to the application contexts are found. In other words, as well as the expert deeply inspects the common set of tasks he should also inspect the common set of context relevant to the specific problem. In fact, (Dix 2004; Abowd 2002) propose the employment of techniques that can gain a richer understanding of the real world setting e.g., ethnography, cultural probes, and contextual inquiry.

4.2. User methods

Ethnographic methods can actually be used to complement user-based evaluation of mobile applications. These are particularly useful to analyze context of use, especially in real-world settings. In the sequel, we describe various ways in which ethnographical methods can be applied:

- Observing the users in the mobile computing setting as they interact with the system, without (or with) their knowledge (Lindroth 2001).

- The user observes himself/herself and writes his/her observations (regularly e.g.) daily in a diary (Lindroth 2001).
- Following the users around as they interact with the mobile application, with occasional interruptions to ask them relevant evaluation questions (Dey 2001).
- Subjects involved in the evaluation have a pager that occasionally interrupts them with evaluation questions (Dey 2001). The method is referred to as "beeper study".
- The system automatically (and remotely) logs user actions and activities so that a complete record of these can be analyzed later.

Another approach is to use 'Wizard-of-Oz' technique and even other simulation techniques e.g., virtual reality. Such methods are especially appropriate where the mobile application is not fully complete (Dey 2001). However, the simulation should closely reflect the real context as much as possible, which is a non-trivial requirement.

It is also worth mentioning methods based on video data in which video representations of typical interactions happening in real world context are used as a way to support imagination and immersion in the real setting. They can be used to support both expert and user methods.

Researchers are deploying mobile devices into various real world settings e.g., libraries, museums, etc. They are setting up "living laboratories" by creating test beds for advanced research and development in mobile computing (Abowd 2002).

5. Conclusion and Future Work

In this paper, we have presented a review of a standard set of usability principles as a way to investigate new needs arising in mobile computing. Our review can be useful to HCI experts (including interaction designers, evaluation specialists, etc) as a support for the design and evaluation of mobile interactive systems. It is also interesting to note that the review can be used as a starting point to critique the current methods and approaches in the design and evaluation of mobile systems. Starting from the indications obtained from this activity, we intend to conduct some new studies. We plan to undertake an empirical assessment on the revised principles. We want to see if applying the knowledge coming from this activity, mobile applications can be designed better. Furthermore, we want to carry a follow up study in which a large set of mobile usability studies is analyzed and collect encountered problems and interesting findings. We intend to classify them according to some attributes and use the list as a way to probe usability principles. We are confident that this activity will be useful to further refine the existing methods, to check whether they cover all the possible encountered, and if necessary to propose some new ones.

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