Ontological Sketch Models of schedule organisers

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Introduction

One important determinant of the usability and utility of a particular device is the degree of fit between the application domain and the device. Ontological Sketch Models offer an approach to determining whether the concepts used by users in their work are compatible with the concepts imposed by a device, or whether instead there are misfits between them. We do this by modelling the conceptual structures (ontologies) in a simple but effective framework. The core of our thesis is that this framework is simple enough to be usable by non-specialists, yet effective enough to reveal real-life problems in ways that could guide redesign or could influence purchase decisions. Previous work (Blandford and Green, 1997) has given preliminary support to these claims.

The present paper pursues the notion of misfit. Although the majority of HCI research and design has ignored this issue, there have been a few seminal papers (e.g. Moran, 1983; Payne, Howes & Squibb, 1990; Payne 1993). Here we shall draw on a study by Payne (1993), in which he found that electronic diaries had failed to replace paper diaries, even amongst technologically-sophisticated employees of a large software and hardware corporation, because the concepts imposed by the electronic diaries were too impoverished and had a poor fit with the concepts brought by the would-be users. This study is noteworthy because Payne drew on empirical research into the cognitive psychology of intentions and rememberings so that, unusually for HCI research, we start with a reasonable understanding of the users' model of the domain. It is also pertinent because present-day computer-based calendar systems offer different ('improved') facilities, allowing us to test some parts of Payne's reasoning: if the fit has been improved, and if Payne's reasoning was correct, then the perceived utility of calendars will have increased.

We shall report on a study, currently in progress, which replicates and extends Payne's investigation. Unlike Payne, who was perforce limited to personal devices, our study investigates users of a networked calendar system which serves both for personal use and for collaborative use in arranging meetings and other multi-person activities. Users' perceptions of arranging meetings, and the requirements that follow, are obviously different from their perceptions of individual scheduling.

As well as demonstrating the value of misfit analysis, we hope that our study will demonstrate that there is an important role for 'sketchy' approaches, and that by sacrificing the detail and the depth of analysis found in many other approaches we can obtain in return an approach that can be stringently formulated and made usable by practitioners and users who are not, and do not wish to be, specialists in HCI or associated evaluative disciplines.

The aims of this paper are therefore as follows.

1. To test the ability of the OSM framework to express the concepts used by Payne.
2. To test Payne's reasoning by investigating users of a contemporary system.
3. To extend the scope of investigation to multi-person systems.
4. To extend the range of misfits considered beyond those discussed by Payne, to include structure-building misfits.

The OSM framework

An Ontological Sketch Model describes three classes of *entity*. User-private entities are 'known' only to the user; they relate to the domain of application and have no form of expression in the device representation. Device-private entities are similarly not available to the user, at least by normal means, although they may sometimes be inferred or invented as explanations of device behaviour. Those two classes communicate via shared entities, accessible to both parties. (For present purposes we shall assume that devices supporting multiple users give equal access to all parties, but obviously the approach can readily be extended.) Entities can be created or destroyed and their *attributes* can be changed by *actions* (and again, for simplicity we shall here limit those actions to users' actions). Entities participate in *relationships* such as 'consists-of', 'affects', and two classes of constraint relationship: 'domain constraints', which are domain requirements the user has to achieve through the device, and 'device constraints', which are ones the user has to work within, not ones the user has to strive to satisfy (e.g. system memory limits).

Although this framework has limited expressive power, it lends itself to simple representations and it allows the identification of many kinds of misfit, from 'viscosity' (Green, 1989) to 'unavoidable device-related abstractions with no explicit representation'. It also avoids the need for detailed task analysis, which is difficult to do and whose relationship to real work has been questioned; yet where deemed appropriate, task analysis can be introduced.

Calendars and Organisers

Payne's research was based on interviews with users and non-users of personal organisers. From them and from the cognitive psychology literature on intentions and prospective memory, he presented an analysis of users' concepts and the degree to which they could be represented in the organisers. Notable failings included the lack of any way to indicate relative importance of appointments, the dependency of one appointment upon another, the structure of repetition over time, the distinction between 'steps' and 'pulses', and the distinction between different 'timelines'. The more advanced facilities of contemporary network-based systems appear to address most of these deficiencies: variations in colour and font can signal relative importance; repeated events of different types can be entered; 'steps' and 'pulses' correspond approximately to 'events' and 'to-dos'; and 'timelines' can be realised by consistent distinctions between classes of event, with concomitant facilities for hiding or displaying selected classes. Dependencies remain, at least in the systems we studied, a user-private relationship with no means of externalisation.

Our investigations used Payne's questionnaire supplemented by further questions. The system studied was Meeting Maker, in the context of a multi-campus new university where close attention to interpersonal scheduling is essential. Close comparison between Meeting Maker and another networked system, Now-Up-To-Date, suggests that MM is reasonably representative of the current generation of such systems.

Analysis showed that in the work context we studied, Payne's original analysis was too simple, and a considerably more complex model has been developed. For example, Payne barely mentions the feature of electronic diaries that they demand precision about the end times of meetings; this information is often tacit — i.e. users will have a vague notion of how long a meeting is likely to be and do not make this information explicit unless a conflict is detected. One common approach to implementation in electronic diaries is to set a default meeting length of one hour. Users in our study reported critical incidents where their failure to explicitly override this default resulted in them scheduling meetings too close together. Another concern was that electronic diaries do not leave an "audit trail" (or "scarring") showing changes made. This can be important — for example, if a meeting is accidentally moved (easily done!) or to help the user resolve conflicts when their memory of appointments does not match the written record. Issues of this kind were probably significant at the time that Payne conducted his study; others have emerged more recently with technological developments. The most significant of these relates to the shift from the use of an electronic diary as a personal resource to its use to support collaborative working. Many of the concerns raised by subjects in the ongoing study relate to the dual role of the multi-user diary: as both a personal memory aid, for which only partial information may need to be entered, and as public information, for which the availability of partial information can result in social conflicts. Subjects in the study reported critical incidents where someone had checked their diary and proposed a meeting at a particular time "because I see you're free then", when in fact the subject had mentally allocated that time to a particular task.

Identifying misfits between domain and device models

Green (1989) proposed various Cognitive Dimensions, as informal ways of assessing the structural fit between domain and device. For example, "viscosity" captures the idea that a domain entity or attribute is difficult to change in some way. More specifically, knock-on viscosity captures the idea that changing one attribute may lead to the need to adjust other things to restore the values of others. This can be stated quite precisely:

Changing E(A) has possible knock-on if:
E(A) is modifiable
modifying E(A) affects P(Q)
there is a domain constraint on P(Q)

This precise description can be used to automatically identify possible cases of knock-on viscosity if the model is described in a computer-based tool (Green & Blandford, 1998). For example, in Meeting Maker:

Changing activity start time or end time has possible knock-on if:
activity start/end time is modifiable
modifying activity start/end time affects contiguity of activity sequence
there is a domain constraint on contiguity of activity sequence (a person cannot be doing two things at onc

Viscosity is not always to be avoided: cases of undesirably low viscosity can also be found. For example, when deleting one activity in Meeting Maker that has a "frequency" attribute, it is very easy for the user to delete all future and past instances of the activity without intending to.

Several of the types of misfit identified by Green's cognitive dimensions analysis can be given precise expression through OSM formulation. In addition, other types of misfit can be identified; examples include the conflation of entities that are distinguished by the user but not by the device, and inability to express attributes that are salient to the user but have no device representation. In the case of Meeting Maker, examples include a lack of distinction between scheduled activities and other time-based information, and the inability to express attributes of an activity such as its dependency on some other activity or external event.

Discussion

From one direction, the entity-relationship-based ERMIA approach (Green and Benyon, 1996 is able to exhibit some kinds of misfits between users' conceptual models and the structures imposed by the device; OSM builds on that, but also includes provision for modelling the consequences of actions, so it can be used for analysing a wider range of misfits. Conversely, Programmable User Modelling (PUM; Young, Green & Simon, 1989; Blandford & Young 1996) describes detailed reasoning from knowledge to required actions for desired goal, so actions and effects are explicitly represented, but the nature of the underlying knowledge structure — relating to both domain and device — is dealt with less thoroughly: misfits feature, but only indirectly. OSM combines elements of both.

The development of OSM has also been influenced by our desire to move away from highly detailed approaches, which are by their nature too time-costly for practical use; to decentralise task analysis in favour of 'the language of the user', the actual concepts and activities of work; and to avoid highly abstract concepts accessible only to specialists, such as two-level grammars, in favour of simple but effective tools.

We have found that although today's organisers address some of the difficulties identified by Payne, other misfits still exist. Also, users of contemporary multi-user systems have to work explicitly with several additional concepts that are not needed for single-user systems — for example, deciding whether information is to be viewable by others, and making explicit information that would previously have remained implicit.

In our use of OSM to describe schedule organisers, we have found that it provides an adequate structure to express the concepts used by Payne, as well as those encapsulated within particular electronic scheduling systems, and this has provided a model that supports reasoning about misfits between domain and device. Ongoing research is directed at further testing the OSM approach, extending it to deal with a broader range of misfits and encapsulating it in tools and methods that will facilitate use by practitioners.

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