# Use of Mobile Appointment Scheduling Devices

**Thad E. Starner, Cornelis M. Snoeck, Benjamin A. Wong, and R. Martin McGuire**
College of Computing and GVU Center
Georgia Institute of Technology
Atlanta, GA 30332-0280 USA
{thad,cmsnoeck,bbb,haileris}@cc.gatech.edu

**ABSTRACT**
One hundred thirty-eight subjects participated in a study on mobile appointment scheduling. Subjects completed a questionnaire on their primary method of managing appointments when away from their desks. Immediately afterwards, subjects completed a session of scheduling four appointments with the interviewer. The most common scheduling systems, in order of popularity, were paper-based day planners, memory, scrap paper, and PDA's. However, 43% of the claimed PDA users and 68% of day planner users switched to another, more readily accessible method when scheduling an appointment. Interviews revealed a practice of using memory or scrap paper to "buffer" appointments for later entry into the PDA or planner.

**Categories & Subject Descriptors**
H.5.2 Handheld Devices and Mobile Computing

**Keywords**
mobile computing, PDA, calendar, scheduling

**INTRODUCTION**
The personal digital assistant (PDA) market has now reached the level of billions of dollars a year. Yet informal surveys of technical audiences reveals that only a third to one half of PDA owners carry their device. Here, we study one of the most common uses of a PDA, appointment scheduling. We show that both PDA and paper-based day planner users demonstrate a reluctance to use their devices, preferring to revert to memory or scrap paper. We hypothesize that the length of time required to access a scheduling method significantly effects how often it is used. We perform timing tests to support this hypothesis.

**MOBILE APPOINTMENT SCHEDULING USER STUDY**
To gain insight into currently used scheduling strategies, we performed a user study inside the main entrance of Georgia Tech's Student Center, asking passersby to volunteer as subjects. A total of 138 subjects participated in the study, with a predominance of young male students (88% age 18-25, 70% male, 90% students).


*CHI 2004*, April 24–29, 2004, Vienna, Austria.
ACM 1-58113-703-6/04/0004.

The study consisted of two parts: a short questionnaire and an appointment scheduling session. The questionnaire requested demographic information, an exhaustive list of all calendar systems used by the subject, the primary calendar system the subject uses when away from his desk, how long the subject has been using this calendar system, and how many appointments the subject schedules per week. Eight Likert scale questions (ranging from 1 for strong agreement to 7 for strong disagreement) were used to elicit the subjects' opinions on their calendar systems (ease of use, necessity, adequacy, expense, etc.). We ended the survey with open-ended questions on the most liked features of the subject's current calendar system.

Next, each participant was asked to sit at a table for an interview with one of our researchers to perform timing tests on appointment scheduling practices. A single researcher performed all of the appointment scheduling with the subjects, using a script of four tasks:

A. Schedule an appointment for a date seven days in the future. *'Could we meet sometime next Monday?"*.

B. Schedule an appointment for a date three months in the future. *'Could we schedule a time to meet in the second week of February?"*.

C. Schedule an appointment for tomorrow. *'Could we schedule a time to meet tomorrow?"*.

D. Reschedule the second appointment to the next day. *'Could we reschedule our appointment in February from the 10th to the 11th?"*.

Subjects were encouraged to schedule the appointments as if they were of significant importance, and scheduling conflicts were resolved as part of the task but not included in the recorded times.

In order to capture timing data accurately, the experiment was videotaped with two cameras: one pointing forward toward the test subject and a second pointing down at where test subject was likely to place their scheduling device while in use (see Figures 1 and 2). The cameras were time synchronized, and both recorded audio.

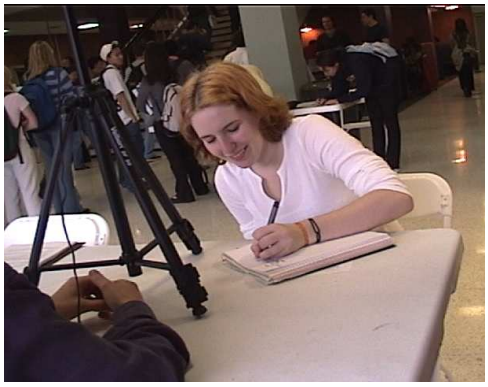

**Figure 1: Forward pointing video image.**

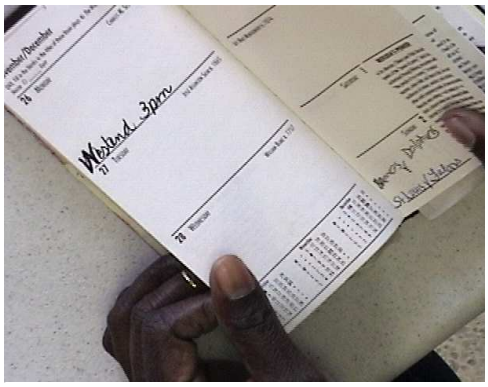

**Figure 2: Downward pointing video image.**

Although extracting data from video is difficult, the alternative of instrumenting each individual's scheduling device to record data would have sacrificed ecological validity. Additionally, this practice would not have allowed the observation of any discrepancy between the claimed and actual scheduling device used.

Based on an extensive preliminary examination of the data, a protocol was formulated to extract the time required to interact with each calendar mechanism. Timing is only considered for the first scheduling task. By the second task, the participants may have already retrieved their device. The overall time was divided into three parts: physically retrieving the device (e.g. removing the device from the user's pocket), navigating the device's interface (e.g. selecting the correct date and time), and entering the appointment (e.g. transcribing participant and location information). A single researcher used the protocol to transcribe all scheduling tasks on the recorded video. Samples were checked for accuracy by three additional researchers. There was good agreement between the researchers.

## RESULTS

A significant fraction of subjects do not use the device they claim when scheduling appointments. Table 1 shows the distribution of the devices that subjects claimed to use on the questionnaire and devices that were actually used during the completion of the first task. Note that of the 14 claimed PDA users, only 8 actually used their PDA for the task. Six, or 43%, used a different device: four used memory, one used scrap paper, and one used a day planner. Of planner users, 66% switched to scrap paper or memory (one used an unlisted mechanism, such as writing on skin).

Table 2 shows the mean retrieval, navigation, entry, and total scheduling times of various calendar mechanisms recorded during the subjects' appointment scheduling tasks. Due to its nature, interaction times for memory are difficult to perceive. Therefore, for the purposes of this study, we assume interaction times for memory are near zero compared to the other mechanisms. The sum of retrieval and navigation times shows significant difference between devices. The more structured scheduling mechanisms, PDAs and planners, require the most time to reach the appointment entry location (retrieval + navigation time). In contrast, scrap paper requires significantly more time for appointment entry, probably due to a need to note the time and day information that is specified through the navigation step for PDAs and planners. As a result, scrap paper, planners, and PDAs have very similar total interaction times

Scheduling devices are often manipulated while the user is gathering appointment information through speech. For example, a subject may flip through the pages of his paper calendar during a conversation. Therefore the times measured in this study are probably higher than those required for each device when the user does not have to divide his attention. Also, device retrieval times might vary greatly, depending on where the users stored their device before participating in the study (e.g. backpack, pocket, etc.). The study was designed to preserve these effects since it models the actual practices of users.

### Disuse vs. Retrieval and Navigation Time

Our hypothesis, that device usage is related to the amount of time required to access it, is supported in the combination of these results. The rows and columns of Table 1 are sorted by the average amount of time required to retrieve the device and navigate its interface, taken from Table 2. Zeros were left blank. Note that very few entries cross the diagonal boundary in the table, indicating that almost all users who did not use their claimed mechanism switched to a faster device in practice. Devices with lower retrieval and navigation times tend to have higher usage. Interestingly, a similar effect is mentioned by Miller in 1968 [3] when discussing response times in multi–user systems. Miller observed that user efficiency dropped significantly when the computer's response times increased beyond two seconds (which is the limit when the user would attempt another parallel task instead of waiting for the computer). Perhaps there is a similar "minimally tolerable" threshold in access time to mobile devices.

| *Actual Usage* \ *Claimed Usage* | Memory | Scrap | Planner | PDA | Other | # Used |
|---|---|---|---|---|---|---|
| Memory | 24 | 9 | 16 | 4 | 4 | 57 |
| Scrap | 1 | 13 | 13 | 1 | 4 | 32 |
| Planner | | | 14 | 1 | 1 | 16 |
| PDA | | | | 8 | | 8 |
| Other | 1 | | 1 | | 6 | 8 |
| # Claimed | 26 | 22 | 44 | 14 | 15 | 121 |

**Table 1: Claimed vs. Actual Device Usage on the first task.**

| *Device* | *Retr.* | *Nav.* | **Retr. + Nav.** | *Entry* | *Total* |
|---|---|---|---|---|---|
| Scrap | 17.8 | | **17.8** | 18.1 | 35.9 |
| Planner | 11.8 | 7.6 | **19.4** | 12.5 | 31.9 |
| PDA | 11.0 | 12.7 | **23.7** | 14.0 | 37.7 |

**Table 2: Timing results per commonly used device (average in seconds). Navigation time for scrap paper is considered effectively zero.**

### Disuse vs. Cognitive Load

Interacting with a scheduling device during a conversation requires the user to divide his attention between the interlocutor and the device, which may cause an increase in cognitive load. Various researchers have observed cognitive load effects in similar situations [1, 2, 4, 5, 6]. Perhaps devices that increase peak cognitive load are not preferred during a scheduling conversation? Some of the study data and anecdotal evidence support this hypothesis.

For the first task, less experienced day planner users were found to be more likely to abandon their interface than those with more experience ($p = 0.012$, using the Welch modification to the t–test). This effect may be the result of an attempt to avoid the cognitive load of navigating a less familiar device during the conversation. The abandonment of a PDA is not significantly correlated with experience. However, many PDA users have been observed to make filler conversation while accessing their devices (e.g. "Let me get that down...November 3rd...there it is...OK...what room again?"). Perhaps the user does not want to slow down or interrupt the conversation but is forced to devote most of his attention to navigating his calendar device.

### Disuse vs. Forgetting the Device

Some PDA and day planner users explain their disuse behavior by indicating that they left their device at some other location. Figure 3 shows the percentage of subjects who used a different device instead of their claimed primary mechanism during the first and second tasks. Planner users tended not to use their planners for all four tasks, which supports the explanation that the users forgot their planner. However, a number of PDA and scrap paper users retrieved the device for the second task but not for the first.

Perhaps when these users realized after the first task that the interviewer was going to ask them to schedule several appointments, the benefit of using their PDA or scrap paper became apparent. In other words, the barrier of access time or cognitive load might have been lessened by the batch nature of the tasks. Another possible explanation is that these subjects were willing to rely on their memory instead of their device to schedule an appointment in the near future (task A), but needed the device to schedule an appointment several months in the future (task B). In support of this, every subject who switched to their primary device on the second task used memory to complete the first task. This hypothesis is also supported by the large percentage of claimed memory users who switched to more permanent memory mechanisms (scrap paper, planner, phones, writing on skin, etc.) for the appointment made in the distant future. The use of a temporary mechanism to "buffer" appointments is examined in more detail in the next section.

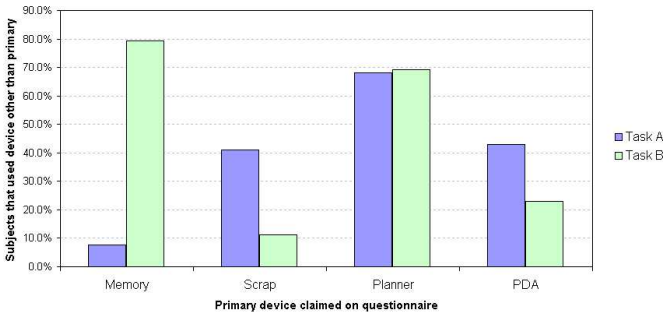


**Figure 3: Abandonment rates of claimed primary device during the first (next week) and second (in three months) scheduling tasks.**

### Buffering of Appointments

In general, two scheduling strategies were observed for subjects that did not use their primary PDA or planner scheduling device:

1. Buffering the obtained appointment information on a temporary device for later reconciliation with the primary device.

2. Using a different device in parallel with the primary scheduling device.

Cued by results from a pilot study, we asked memory and scrap paper users whether they would transfer the appointment information they just received to another mechanism (e.g. planner, PDA, etc.); approximately 42% of the subjects indicated they used this strategy for the first task. With the second task, which required confirming an appointment further in the future, 86% of the users said they would transfer the information to another device. Intuitively, people may use temporary devices such as scrap paper and memory concurrently with their primary scheduling system for short term scheduling (within approximately a week), whereas longer term planning requires more strict reconciliation.

We observed that people postpone the entry of appointments during a conversation by using memory or scrap paper as temporary devices. Perhaps this postponement behavior is to prevent disruption of the conversation?

### General Study Observations

The answers to the Likert scale questions were only surprising in that they were generally consistent across the various devices. No matter which system was used, subjects were inclined to indicate that their mechanism was appropriate, sufficient, and somewhat necessary for reminding them of appointments. While the questions related to mechanism effectiveness had slightly positive scores, questions related to ease of use and speed of access were strongly positive with little variance. Yet, the timing observations made in the mock scheduling tasks suggest that significant improvements can be made.

The notable exception to the consistency of the Likert answers was that PDA users overwhelmingly rated their system as expensive ($p < 10^{-5}$) compared with the users of other devices. This observation may explain why PDA users were less likely to abandon their device even though it required more time to retrieve and navigate than planners. Perhaps PDA users felt that they had invested a significant amount of money in their device and were reluctant to abandon them.

As we reported, many of our PDA and planner subjects did not use their claimed device during the appointment tasks. On the questionnaire many more subjects reported having used PDAs or planners in the past but did not consider these devices their primary calendar mechanism while they were away from their desks. Thus, these subjects, for some reason, decided not to use PDAs or planners. The numbers are significant, representing 36% more potential PDA users and 45% more potential planner users that would be added to the claimed usage table above if they had declared these devices as their primary mechanism. Of these potential users, at least 72% reported less formal mechanisms (e.g. scrap paper, memory, etc.) as primary. This evidence of abandonment corroborates anecdotes from former PDA users who claim that the effort required to maintain the data in their devices outweighed its benefits.

| *Device* | *# appointments* |
|---|---|
| PDA | 9.6 |
| Planner | 8.7 |
| Memory | 6.7 |
| Scrap | 5.4 |

**Table 3: Average number of appointments per week per device.**

Given the issues suggested in previous sections, why are PDAs and planners used? As shown in Table 3, PDA and planner users in our study averaged more appointments per week than the other common mechanisms. Perhaps such users feel that they have too many, or too far removed, appointments to remember them. Our Likert results hint at this sentiment. Memory users agreed more strongly than planner users ($p = 0.026$) that they still forget or are late to appointments more often than they would like. Meanwhile, PDA users perceive that their system more reliably reminds them of appointments than subjects who use their own memory ($p = 0.049$). In addition, PDA users found the active beeping of their PDA to remind them of an appointment to be an important feature.

## FURTHER STUDY

This study has provided some insight into how calendar mechanisms are used and users' opinions about these systems. However, the study also raises many unanswered questions. We hope to improve our method and attempt the study with a population that is more likely to schedule a large number of appointments a week, such as the business travelers at Atlanta's Hartsfield airport,

## REFERENCES

1. W. Blackwood. *Tactical Display for Soldiers.* National Academy of Sciences, Washington, D.C., 1997.

2. L. Karl, M. Pettey, and B. Shneiderman. Speech versus mouse commands for word processing applications: An empirical evaluation. *Intl. J. Man-Machine Studies*, 39(4):667–687, 1993.

3. R. Miller. Response time in man computer conversations. In *AFIPS Fall Joint Computer Conference Vol. 33 Part 1*, pages 267–277, San Francisco, CA, 1968.

4. D. Schacter. *The Seven Sins of Memory*. Houghton Mifflin, Boston, 2001.

5. B. Shneiderman. The limits of speech recognition. *Communications of the ACM*, 43(9), September 2000.

6. C. Wickens. *Varieties of Attention*, chapter Processing resources in attention. Academic Press, New York, 1984.