The Tools We Live By:
A Description of Personal Support Media in Work Life

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ABSTRACT

This paper reports on results of an extensive, ethnographically-informed survey that queried workers in a high tech company about their uses of digital and non-digital media for managing appointments, reminders, to-dos, availability, and communications—activities that comprise what we call *meta-work*. From our approximately 1500 respondents, we found that workers spend the equivalent of one day per week working at home and a quarter of their time in meetings. They manage an array of devices each—laptops, PDAs, phones—in their daily work, many of which are personally owned. Workers also manage multiple complementary calendars to support both mobility and coordination while still depending on email for time and task management. Job function, mobility, and number of meetings affect use of tools to varying degrees.

ACM Classification Keywords

H.5.m Information Interfaces and Presentation: Miscellaneous, K.4.3 Computers and Society: Organizational Impacts, K.8.0 Personal Computing: General

Author Keywords

Time, task, file, contact, communications, coordination management; mobile phones; PDA; calendars; groupware calendar system (GCS); personal information management (PIM); mobile workers; mobility

INTRODUCTION

This paper reports on results of a large, ethnographically-informed survey that queried workers in a high tech company about their uses of digital and non-digital media for managing appointments, reminders, tasks, to-dos, communications and availability. Digital media, including personal digital assistants (PDA), mobile phones, and cross-platform collaborative technologies like groupware

calendar systems (GCSs) and instant messaging (IM) are now easily available, and people use them within and across all realms of life. These devices and applications would seem to simplify the ways in which we stay in touch with people and manage our work; however, the growing number of devices and applications means that they themselves need to also be managed. Furthermore, non-digital media like paper calendars, lists and notes continue to exist side-by-side with digital media in the workplace, in the home, and in our backpacks and briefcases. This array of personal support media is at once a sign of our ongoing quest to more cohesively manage our lives, as well as a sign of how fragmented [9] an effort it really is.

Our objective is to supplement our own and other qualitative research on the use of personal support media by surveying a large population about the number and kinds of artifacts they use. This will not, of course, account for all support media for all people, but by examining the devices and artifacts that survey participants can tangibly provide information about, we feel that the general state of affairs for our study population will be represented.

Specifically, we examine how pervasive PDAs and mobile phones are in today's high tech workplace. The research also inquires about calendar media use, and what role paper and digital calendars play together. We are particularly interested in the array of calendar media people use in an environment where groupware calendar system (GCS) use is high, and where calendars are kept highly public. Finally, we also consider the work that happens across the boundaries of work and home by examining PDA and mobile phone ownership as well as calendar content. These lines of inquiry are described in terms of job position, worker mobility, and other features of modern work life.

Our work extends and is inspired by previous studies of calendar use in the workplace [2,10,11,17,20,21,22]; personal information, filing, retrieval and management [3,12,15,29]; PDA and mobile phone use [7,19]; and to-do creation, notation and task management [1,4,13]. The work in email research and design is extensive, and while email use for our population was examined in the context of other personal support media, we leave detailed data collection and analysis to those studies that have already done this so well (including [1,5,14,25,27,28]). These lines of research

are directed toward an understanding of how people conduct the background or supporting activities of work, activities that are ephemeral but pervasive and therefore difficult to pin down. Even so, people do distinguish them from their "real" work: In her studies of PDA use, Geisler explains that the management of tasks and the tasks themselves are conceptually separate in the minds of users [6]. They are often collectively referred to "personal information management" (PIM) in the literature.

The Work that Enables Work

"PIM," however, isn't an entirely appropriate moniker. PIM refers to both Personal Information *Management* and Personal Information *Managers*, hence the acronym is used interchangeably to mean both the management activity and the media by which the activity is managed. This has become conceptually problematic, as it leads to thinking about PIM as that which is only supported by PIM technology like PDAs. A second concern is that, because of its name, PIM tends to be restricted to tasks around organizing information like files, email and bookmarks. However, other activities such as the management of To-dos, tasks lists, and schedules are loosely subsumed under the term, for lack, we believe, of a better organizing framework. Yet a third limitation is that PIM emphasizes the personal component of work. However, completion of personal work often depends on other people—what Bellotti et al. call the "network effect" [1]. Awareness of colleagues' activities, whereabouts, and accessibility is a component of (an expanded notion of) PIM.

Alternatively, Strauss' "articulation work" comprehensively accounts for these activities, which he defines, in part, as "the meshing of the often numerous tasks, clusters of tasks, and segments of the total arc of work" [26:8]. To explain the space in which we believe our work sits, we propose a conceptualization that lies between the restricted definition of PIM and the more expansive one of articulation work; it is what we call *meta-work*. We outline five types of management that we propose comprise meta-work:

- **Time Management**: Scheduling meetings and events, orienting to deadlines, attention to use of time,

- **Task Management:** Planning and tracking tasks

- **File Management:** The organization of papers, electronic files, email, web bookmarks, and so on.

- **Contact Management**: The organization and management of contact information (phone numbers, addresses, email) as well as the frequency by which contacts have been or will be made.

- **Coordination and Communications Management**: Making contact by email, phone, IM or other means, and to conveying one's availability to others. Because the means by which people can communicate are growing—phone (landline or mobile), email, postal mail, SMS, IM, pagers—the media for those communications must be managed. Managing one's own availability by certain communications media also matters. For example, a person might use a GCS to communicate schedule availability and IM to maintain a virtual presence.

With this definition, we separate the *activities* of meta-work from the *means* by which the activities are performed. Any of these five activities might generate to-dos, for example, but the to-dos are the means in which these goals of meta-work get done. Using this conceptualization, we see how people's meta-work can include features of time management even if they do not keep a calendar. Instead, they might rely on memory, the email inbox, or post-it notes as prompts for attention to time-based events.

Of course the presence or absence of meta-work activities might vary by profession, or by personality, or even within the multiple realms in one's life. Also, what is some people's meta-work might be another's "real" or core work. In the worlds of real estate or financial brokerage, for example, contact management might be better described as the core work rather than the meta-work.

Our research is concerned with assessing and describing the means by which people in a high tech environment use a constellation of tools and technologies to manage their time and tasks and, to a lesser extent, communications. We leave the study of file and contact management to other, non-survey-based studies that have better addressed these concerns [3,5,7,14,29]. What is the array of artifacts that today's often more mobile workforce use to conduct these particular activities of meta-work?

THE STUDY

Study Site

Sun Microsystems is a high tech global company, and had about 40,000 employees at the time of data collection. Founded in 1982, it was an early adopter of computing technologies that supported coordination, including cooperative, shared calendaring. For this, Sun was the focus of research by Palen [20,21] in the mid- to late 1990s when Sun had roughly 20,000 employees. At that time, an "open" groupware calendar system—one where most users kept their calendar content nearly completely viewable by others in the company—was in wide use across the company, and distinguished Sun from other organizations. PDAs were just beginning to be adopted, and an interest in syncing them with the corporate GCS was beginning to emerge.

For this study, we return to Sun, which has almost doubled in size and expanded geographically in the approximately 6 years hence. Additionally, the company launched a formal telework program with flexible on-site office space use, which also spurred on a greater degree of mixed platform use than was seen in the 1990s, mostly in the form of laptops. PDAs and mobile phones are also far more pervasive now than in the 1990s, and workers are including these technologies in their work; the degree to which this is done is one subject of our research.

We return to Sun now because these changes to company size, platform homogeneity, worker mobility, and the easy availability of mobile technologies have likely influenced how people coordinate and conduct meta-work. As we present in this paper, it is also an opportunity to inquire about the roles and significance mobile and calendaring technologies have in everyday meta-work for workers in such an environment, and how they align with more conventional methods of conducting meta-work.

Method

We designed a web-based survey that queried respondents about job position and work-related demographics; their temporal, organizational, and physical proximity to workgroup members; the tools and technologies they use to conduct and manage their own work and coordinate with others; the calendar artifacts they use; and, if users of GCSs, the privacy configuration of their calendars. Qualitative research informed the design of the survey. Both the ethnographic research work conducted at Sun in the mid-to-late 1990s as well as a new set of employee interviews informed the survey questions. For this study, we began with 11 face-to-face interviews to understand how nomenclature and certain features of work life might have changed in the approximately 6 years since the original research. Additionally, contacts within Sun granted us access to technologies and background information that guided the investigation.

The survey, which underwent multiple design iterations, included 40 multi-part questions. In Spring 2003, we sent an invitation to several email lists that reached a wide range of people across the organizations, functions, and geographic regions of the company. We estimate that there were between 3800 and 4000 unique individuals on these lists. 1539 people participated yielding a response rate between 38% and 41%. After cleaning and reliability checks, we removed data from 53 respondents, leaving 1486 for analysis. Participants remained anonymous unless they volunteered to be contacted in follow-up. We offered a small incentive for completing the survey—entry into a raffle for four $100 bookstore gift certificates—but identities for the raffle were not linked to responses.

Participant Population

The 1486 participants came from across all of the company's organizations and job roles (see Table 1).

Job Role	% R
Manager *First-, Mid-, & Executive Level*	17%
Product Development *Engineers, Developers, Testers, Marketing*	44%
Customer Facing *Sales, Customer Support*	11%
Internal Support *Administrative, Business Functions, IT*	15%
Other *Respondents who self- classified outside these categories*	13%

Table 1. Percent of respondents in each Job Role

Roughly 11% of the respondents were from outside the US. Participants also represented a broad range of longevity within the company, ranging from 1 month to 19.5 years. On average, they had worked at Sun for 5.8 years (*sd*=4). Most respondents (97%) were regular employees; only 3% described themselves as contractors or interns.

FINDINGS: NATURE OF WORK

We examine technology and meta-work practice by features that in part describe the nature of employees' work. *(Note that an alpha level of .01 was used for all statistical tests reported in this paper; therefore, we do not report the p value for individual statistics.)* Although a number of dimensions that could define the Nature of Work (as we refer to it), here we focus on three:

- *Job Role* describes the primary function of job position. There are other ways of describing job role for technology use [8,16], we used our knowledge of how the company scopes its job positions to define *role*.

- *Work Locale* describes where people conduct their work—percent of time spent *at home*, *onsite* at Sun, or *on the road*. Because these three factors are not independent, we select two for each analysis, depending on the nature of the question. Together, these measures indicate the mobility of a work and the degree of context-switching as it might bear on meta-work.

- *Meeting Intensity* describes how much time is spent in meetings.

For Work Locale, we found that most employees split their work time between working at home, working on site and working on the road (see Figure 1). On average, respondents spend most of their time (71%, s*d*=30) working onsite; although almost one day a week (19%, s*d*=24) is spent working from home and 10% (s*d*=18) is spent on the road. For Meeting Intensity, they spend on average 23% (*sd*=19) of their time in meetings. Note the large variability in the responses, which can be explained in part by job role.
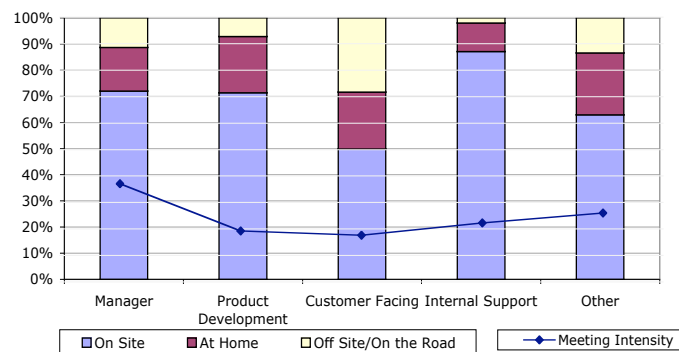

Figure 1. Work Locale & Meeting Intensity by Job Role

Job Role significantly influences the amount of time respondents spend at work, $\_^2$=.11, $F(4, 1412)$=43.00, on the road $\_^2$=.14, $F(4, 1412)$=59.55, and in meetings, $\_^2$=.12, $F(4, 1408)$=47.62. A-priori contrasts show that respondents with Customer Facing job roles spend significantly more of

their time on the road than those in other job roles, $\_^2$=.07, F(1, 1412)=99.19; respondents with Internal Support roles spend significantly more of their time onsite, $\_^2$=.08, F(1, 1412)=118.95, and Managers spend significantly more of their time in meetings than people in other job roles, $\_^2$=.09, F(1, 1408)=143.01.

FINDINGS: TOOLS FOR META-WORK

In this section, we describe patterns of tool use overall and we look at how these patterns are influenced by the Nature of Work. We report the types and numbers of computers and mobile devices people use. We then turn to a detailed discussion of calendar media use.

Computers

Employees in this company use multiple computers in their work. Laptop usage is prevalent. On average, respondents use 2.3 (sd=1.0) computers. Approximately 14.7% report using only one computer, 56.0% use two, 29.3% use three or more. Nearly all participants (97.7%) report using a desktop or workstation, and well over half (59.6%) are using laptops. Further, over one-third (34.5%) of the laptop users indicate that the laptop is their primary machine; roughly 10.2% of primary laptop users also use another laptop as a secondary machine.

Overall, this fairly high use of laptops is a notable sign of mobility for a company like Sun, whose commercially available operating system, Solaris, runs on desktop machines that are visible throughout the environment. Still in keeping with its "the network is the computer" concept, the company has become more platform heterogeneous than it once was in an effort to support mobility.

Closer examination of how laptop use differs by Job Role, Work Locale (time at home and time on the road), and Meeting Intensity indicates that the Nature of Work is predictive of laptop use. First, a Multiple Regression (MRC) regressing Work Locale and Meeting Intensity on number of laptops used shows that more mobile workers — who work more at home ($\_$=.18, t=6.85), on the road ($\_$=.31, t=11.71), or in meetings ($\_$=.08, t=2.86) — rely more heavily on laptops than others (R^2=.13, F=60.75). Additionally, an ANCOVA using Work Locale and Meeting Intensity as covariates and Job Role as the IV suggests that Job Role significantly predicts laptop usage beyond the measures of mobility, $\_^2$=.04, F(4, 1245)=12.67. In particular, Internal Support workers use significantly fewer laptops than other workers $\_^2$=.03, F(1, 1245)=41.05.

Mobile Devices

Mobile devices—pagers, PDAs and mobile phones—play a role in work life, but to what extent? Both mobile phone and PDA use is high: Across all participants, 78.3% report using mobile phones and 52.1% report using PDAs in their work. On average, respondents use 1.49 (sd=.9) mobile devices each. Only 15.5% of respondents do not use any mobile device; 31.2% use one mobile device, 44.0% use two, and 9.3% use three or more mobile devices.

Especially notable is the high numbers of personally owned PDAs and mobile phones used in work. As Table 2 shows, well more than half the respondents (64.3%) include personal mobile phones in their work and half (49.8%) include personal PDAs. In comparison, pagers are in relatively low use, and most are company issued.

Mobile Device	Company Issued	Personally Owned	Total *
Pagers	10.3%	3.4%	13.4%
Mobile Phones	17.3%	64.3%	78.3%
PDAs	3.8%	49.8%	52.1%

Table 2. Percent of respondents using mobile devices
Total column is not cumulative reports total number of people using each device, even when more than one of a particular type is used.

A look at adoption of these mobile devices across job roles reveals a few interesting patterns. First, adoption rates for PDAs and laptops across job roles are similar; and indeed, laptop and PDA use are moderately correlated (r=.239, N=1296). Second, although pager use is fairly low overall, we observe that it is substantially higher for Managers and Customer Facing roles—nearly 2 and 3 times the overall usage rates, respectively. As shown in Figure 2, there is a consistent pattern of use across devices. Consistent with what one might expect, Customer Facing and Management roles are using more mobile devices than people in more stationary roles (Product Development and Internal Support), $\_^2$=.07, F(4, 1255)=25.26; $\_^2_{CF\&MgrvsPD\&IS}$=.06, F(1, 1255)=81.04.
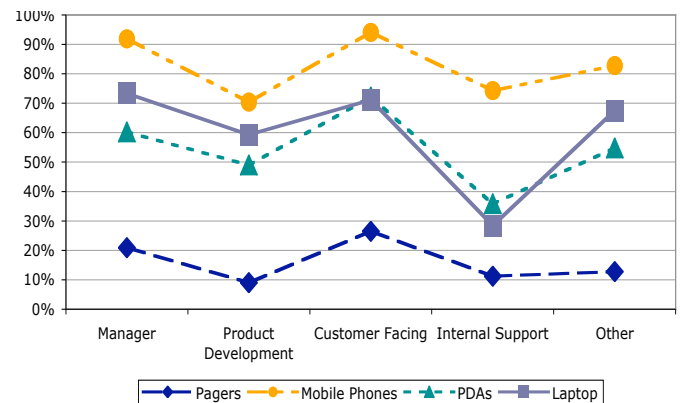

Figure 2. Mobile device use by Job Role

Since these two groups appear to spend more time offsite than the others, and Managers more time in meetings, we explore the extent to which Work Locale (here, we focus on time onsite and on the road) and Meeting Intensity influence mobile device use, and explain the effects of Job Role. Via MRC, we found that both Work Locale and Meeting Intensity significantly predict the number of mobile devices someone uses, (R^2=.10, F=48.95). People who work less onsite and more on the road tend to rely more on mobile devices ($\_{onsite}$=-.14, t=-4.19; $\_{onroad}$=.20, t=6.01). Further, the more they are in meetings, the more they rely on mobile devices ($\_{onroad}$=.12, t=4.42). While the differences in Job Role may be due in part to these spurious factors, they cannot be attributed solely to them. An

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ANCOVA shows that the effects of Job Role are significant beyond the effects of Work Locale and Meeting Intensity, $\_^2$=.07, $F(7, 1255)$=27.81; $\_^2_{jobrole}$=.03, $F(4, 1255)$=10.89, $\_^2_{CF\&MgrvsOther}$=.03, $F(1, 1245)$=41.63.

Next, we examined the use of company devices by Job Role, since their deployment was relatively small and perhaps directed to managers. Figure 3 shows that the number of company issued devices is in fact high for managers, but even higher for customer facing roles. ANOVA looking at the extent to which Job Role predicts the number of company issued devices shows that these differences are statistically significant, $\_^2$=.07, $F(4, 1255)$=21.67; $\_^2_{CF\&MgrvsOther}$=.05, $F(1, 1255)$=65.62; $\_^2_{ISvsMgr}$=.01, $F(1, 1255)$=9.43. One interpretation is that Customer Facing roles might require worker availability to customers—or to those who directly support customers—across place and greater spans of time than conventional work hours. Correlations between the use of personal and company-issued devices suggest that people who rely more company-issued devices rely only slightly less on personal devices (r=-.18). The noteworthy effect here appears to lie with mobile phones. The more people rely on company-issued phones, the less they use their own (r=-.44).

Note that Managers and Customer Facing personnel are the highest mobile phone users *and* pager users, suggesting that pagers serve a particular coordination function, which mobile phones do not necessarily replace. At the time of data collection (and even at the time of this writing) SMS, or mobile phone "texting," which is much like text pager communications, was not a common practice in the US. This helps explain why phones and text pagers continue to exist side-by-side, and the company continues to issue. Additionally, since most pagers are company issued, use of them over personally owned phones is perhaps a way of partitioning work and home [18] for after-hours contact.
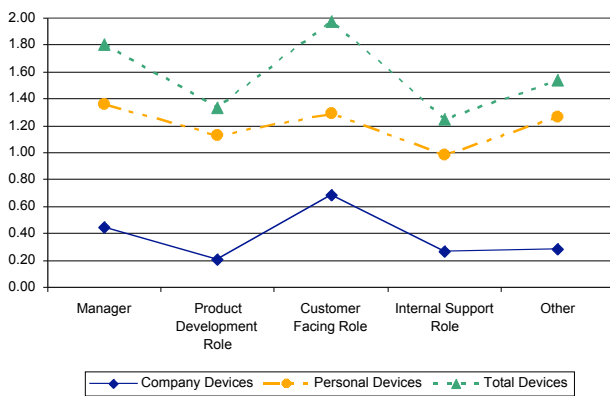
Figure 3. Number of devices used by Job Role

As a whole, these findings suggest that people who have work situations that take them away from a dedicated office, are more likely to carry devices such as PDAs, mobile phones, pagers and to use laptops. And even though the most mobile of the groups—Customer Facing

personnel—receive more company issued mobile devices, they continue to bring personally owned mobile devices to work. These are perhaps not surprising findings, but what they do show is that the flexible office environment and the creation of a more mobile workforce is changing the way work [24]—and therefore meta-work—is conducted.

Calendars

We report on number and type of calendars people use, with additional detail about PDA and GCS calendars, and privacy settings as they concern the latter. We also report on the amount and kind of information people record in their calendars. The calendars in our investigation are:

- *Sun's Corporate GCS Calendars*: calendars on one of multiple versions of Sun's groupware calendar system.

- *Other Online calendars*: Outlook, Netscape, etc.

- *Paper-based calendars*: paper planners/organizers, monthly or date calendars wall planner calendars.

- *Mobile electronic calendars:* PDA calendars, mobile phone calendars, and pager calendars.

Calendar Media

When asked to report on their use of primary and secondary calendar, respondents indicated that they use almost 2 calendars each on average (1.9, sd=.9). Only 1.4% report using no calendar at all, 33.5% use one calendar, 45.4% use two, and 19.7% use three or more.

Figure 4 shows how much calendars are used in total by the respondent population, as well as how many use each type as their primary calendar. PDA calendar use (47.1%) is second only to use of Sun's GCS. Paper planner (14.4%) and other paper calendar use (11.7%) is fairly high, and on par with other online calendars (14.4%), and we note that many of these tend to be predominately secondary calendars. Even in this high tech environment, people are using non-digital media in support of meta-work.

Closer examination of secondary calendar use shows when and how people combine calendars to meet needs. First, we consider how many secondary calendars are used for each type of primary calendar (corporate, other online, paper, and mobile). Our analysis (ANOVA) suggests that there is a significant but small difference between the number of calendars used to supplement any given primary calendar, and that primary corporate calendar users are using slightly more secondary calendars (M=.99, sd=.03) than primary mobile calendar users (M=.79, sd=.05), $\_^2$=.01, $F(3,1247)$=3.76; $\_^2_{CorpvsMobile}$=.01, $F(3,1247)$=3.76. Further examination of the *types* of calendars used to supplement primary calendars yields additional insights.

As shown in Figure 4, the GCSs, by far the most commonly used primary calendars, are sufficient for roughly one-third of their users; 31.2% use only their corporate calendar. However, most of remaining users supplement with either mobile calendars (37.8%) or with paper calendars (21.4%). Half (49.4%) of the other online calendar users also

supplement with the mobile calendar. Here again, about one-third (30.6%) of other online calendar users feel no need to supplement. Paper calendars are supplemented with the GCSs (30.7%), another paper calendar (18%) and mobile electronic calendars (17.6%), which again leaves a third who do not supplement. Lastly, primary mobile calendar users supplement these calendars with a Sun GCS calendar (33.0%), and a full 40.1% do not supplement.
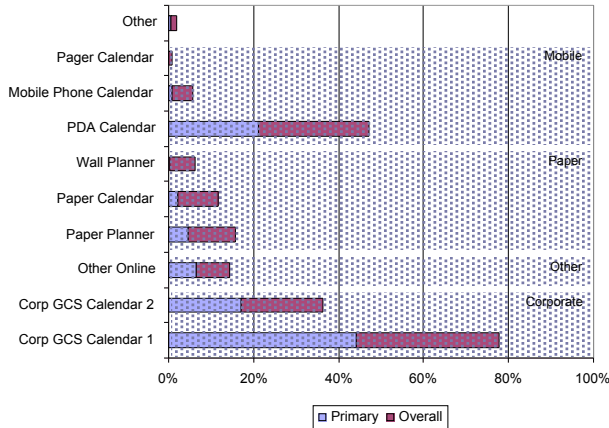
Figure 4. Percent of respondents using a calendar overall
(primary and/or secondary use) **and for primary use only**

We notice a tight coupling between GCS and mobile calendars, be they primary or secondary (Figure 5). This indicates that both the convenience of online desktop calendars —especially those that can be shared with others to support coordination—and mobility are important. Mobile electronic calendars are satisfactory when out of the office, but when in the office, a means of entering appointments more easily is desirable. We also see a coupling between GCS and paper calendars, probably because of the same in-office and out-of-office access benefits. But the choice to use a complementary paper calendar over a mobile electronic calendar suggests that the versatility of paper brings benefits beyond portability, including annotation, fluid note taking, and task planning.

Second, we are struck by the consistency across all calendar media of the number of people who only keep one calendar. For each calendar type except mobile electronic calendars, a near uniform one-third of users keep just one calendar. Mobile electronic calendars show an even greater number of 40% who do not rely on any secondary calendars. These findings suggest two things. First, mobile calendar users more satisfactorily manage their time than other calendar users. Portability is clearly important. Second, in terms of calendar users, there appear to be two distinct user populations: those who keep just one calendar (a full one-third no matter the calendar type), and those who more intensively keep multiple calendars (almost 2.5 on average for this group of multiple calendar users). For those who use just one calendar, it could be that one calendar suffices, or that, alternatively, people cannot or do not want to manage more than one calendar.
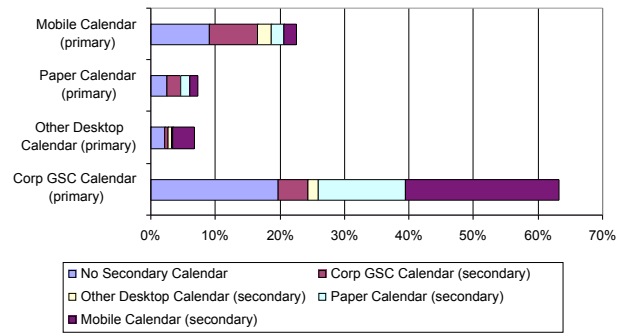
Figure 5. Secondary calendar use by primary calendar

Next, we consider the potential role that Nature of Work plays in influencing the numbers and types of calendars people use. What we see is that, while job role does not appear to influence the *number* of calendars people use, it does seem to affect which *kinds* they choose (Figure 6). When we look at primary calendar adoption, we see a notable contrast in the extent to which people in Customer Facing and Internal Support roles rely on the various calendars. The large majority (75.4%) of the Internal Support employees use a corporate GCS as their primary calendar. In contrast, many Customer Facing employees use mobile calendars (34.8%) for their calendar of choice, though the GCSs are still dominant (47.0%). Adoption rates for paper and other online calendars are low for all.
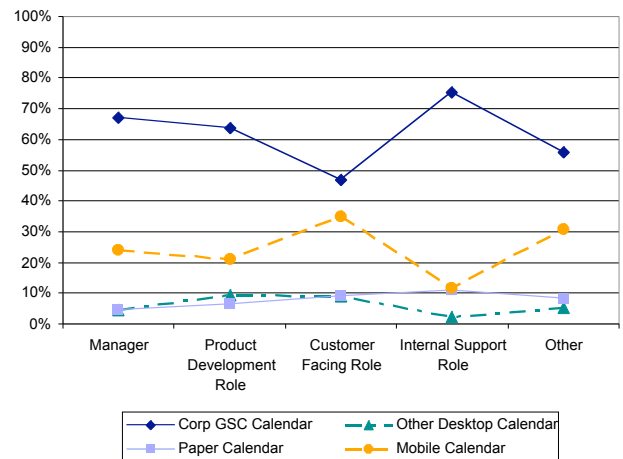

Figure 6. Job role and primary calendar use

Does the mobility of someone's work help to explain calendar media use between GCS and mobile electronic calendars? A MRC in which work locale (time onsite and time on the road) and meeting intensity were regressed on corporate calendar use suggests that people who work more onsite at Sun are slightly more likely to use the corporate calendar, R^2=.03, $F(3,1263)$=11.1; β_{onsite}=.01, t=2.84. Neither meeting nor time on the road were significant. Similar analyses for mobile calendar use suggest that the less someone works at Sun, the more he works on the road, and the more he works in meetings, the more likely he is to

use a mobile calendar R^2=.05, $F(3,1249)$=23.8; β_{onsite}=-.13, t=-3.6; β_{onroad}=.12, t=3.46; $\beta_{meetings}$=.09, t=3.22.

Home vs. Work Content. We wanted to know whether (and how) the balance of calendar content varies as a function of the calendar used or its privacy settings. For example, do more mobile calendars contain more home-related content? Do people record less personal content in more publicly available calendars? We asked respondents to count the work-related and personal appointments recorded in their primary calendars for a two-week period.[1]

Users reported having a mean of 6.39 (sd=8.77) personal appointments, and 21.92 (sd=15.70) work-related appointments for two weeks, though the number of entries in each of these categories was quite variable. To help examine the work-to-home spilt, a work-to-home ratio was calculated for each respondent. The overall mean work-to-home ratio is 7.42 (sd=15.70); mean ratios for different calendars are shown in Figure 7. The work-to-home ratio is similar to what Geisler and Golden call a "Work-Life Balance Index" in their study of PDA use [6]. An ANOVA comparing these ratios for each calendar type suggests that the content of the Sun GCS calendars is more work intensive than the content of mobile calendars, with the work-to-home ratios at 8.43 and 5.41 respectively, η^2=.04, $F(3,715)$=3.90; $\eta^2_{CompvsMobile}$=.02, $F(1,715)$=11.40.
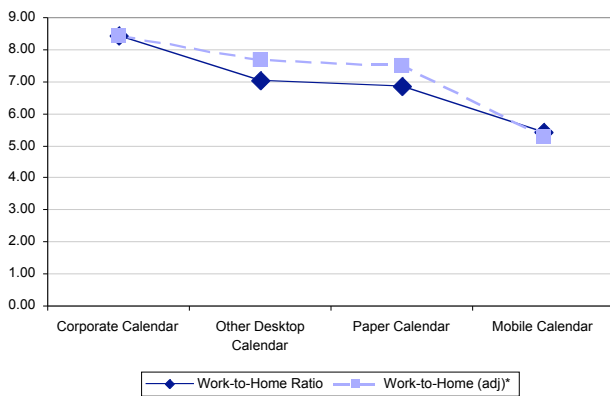
Figure 7: Mean Work-to-Home ratios by type of calendar
* Means adjusted for Nature of Work (meeting intensity)

Does Nature of Work influence calendar content as well? Regressing Work Locale (time onsite and time at home) and Meeting Intensity on the Sun GCS shows that the more people are in meetings, the higher their work-to-home ratio; there continues to be a significant difference between GCS and mobile calendars, R^2=.07, $F(3,715)$=17.83; $\beta_{meetings}$=.24, t=6.60. Neither time onsite nor time at home significantly predicts the work-to-home ratio. When the relationship of

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job role to the work-home ratio after covarying the effects of meeting intensity was examined, we found that job role also did not significantly predict the work-to-home balance beyond time in meetings.

It appears that calendar media predicts work-to-home ratio above and beyond nature of work. An ANCOVA using meeting intensity as a covariate (the only significant nature of work predictor), suggests that there may be something about calendars that drives this ratio, or there may be something about the ratio that drives calendar selection, η^2=.08, $F(4,697)$=14.36; $\eta^2_{calendar}$=.02, $F(3,697)$=4.18; $\eta^2_{CorpvsMobiles}$=.02, $F(1,697)$=12.51.

Calendars that are portable—all mobile calendars as well as paper planners—can more easily span the physical boundary between home and work and therefore are more likely to include home-related appointments. Calendars that are more likely to remain stationary at work—GCS calendars, other online calendars, wall and some paper calendars—are less likely to include personal appointments. In addition to the portability issue, calendars either inherently or explicitly have a privacy/publicity dimension that we expect to influence the work-to-home ratio. The more mobile a calendar is, the more likely it is to be private simply because of the reduced opportunities others have to look at it. Wall calendars invite more viewing, although still less than a GCS calendar, because the wall calendar is restricted by physical proximity. GCS calendars can be kept private or public, depending on user settings.

To test whether the calendar's privacy appears to influence the content within them, we examined the relationship between the View and Edit settings and the work-to-home ratio and found that a two way ANOVA was not significant. Therefore, privacy as measured by these means does not appear to explain the variations in the work-to-home balance of calendars. However, as we show in the next section, users tend not to change their privacy system defaults, and it could be that users' attention to the implications of this is not particularly high. Still the better predictor of calendar differences in terms of content is calendar portability. One other factor that remains open, and that we do not examine explicitly is the perception of calendar ownership—GCS calendars might be perceived by more people as "belonging to the company" which might additionally influence the work-to-home ratio.

Work-Related Content. To understand how central calendars are in work life, we asked respondents to estimate what percentage of their total number of work-related appointments and meetings are recorded in their calendars. Across all participants and calendars, respondents said that the large majority (90.9%) of their work-related meetings and appointments made it into their calendar. See Figure 8 for responses by primary calendar type.
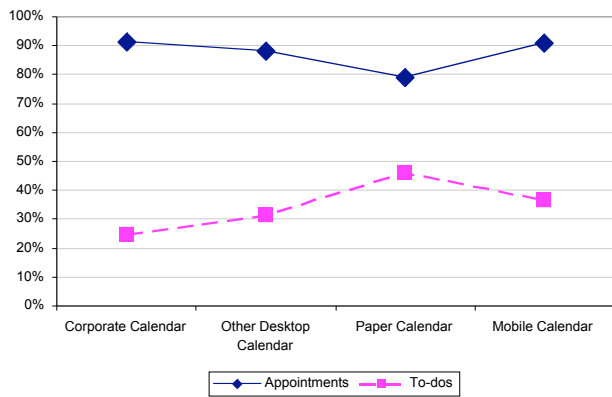
Figure 8. Percentage of work-related appointment and to-dos recorded in different calendars

In comparison, the amount of work-related To-dos, tasks or planning related information (time and task management items that don't always have discrete times associated with them) as well as deadlines (which are sometimes recorded elsewhere) are estimated to be much lower. Across all participants and calendars, respondents said that less than one-third (29.4%) of these kinds of items actually make it into their calendars. This is consistent with findings from other studies [1,2,3,4] that these kinds of meta-work are not always well supported by electronic calendars; people also rely on lists, notes, sticky notes, voicemail, email and memory. Indeed, primary users of paper calendars, which better support list-making and other annotations, estimate the greatest percentage of To-do information in their calendars (45.9%). An ANOVA shows that this difference is significant but that the effect is small, η^2=.04, $F(3,1185)$=16.08; $\eta^2_{PapervsOther}$=.01, $F(1,1185)$=15.20. Note that the reverse trend is true for appointments – a slightly lower percentage are recorded in the paper calendars than on the electronic ones, η^2=.01, $F(3,1233)$=4.09; $\eta^2_{PapervsOther}$=.01, $F(1,1233)$=9.22, illustrating that electronic calendars of all types—perhaps because of email/calendar integration and recurring appointment settings—better support meeting entry, whereas paper calendars better support all other types of calendar work.

Groupware Calendar System Use

Groupware calendar use appears to be alive and well at Sun, despite a shift to greater platform heterogeneity, a much larger and distributed workforce, and greater work mobility, all of which we expected to erode use to a greater degree. In the 1990s, it was estimated that 80% of employees used the GCS. Today—within our survey participant population—overall corporate calendar use is on par (87.0%) with earlier reports [8,20]). Length of use relative to time at Sun also reflects the pervasiveness of corporate GCS. Overall, respondents have used a Sun GCS for 79.2% (*sd*=27.8) of the time they have worked there.

A topic of great interest is how shareable GCS calendars actually are. How private or public do users keep their calendars? As we noted earlier, up through the 1990s, Sun

was remarkable in how "open" users of the GCS tended to keep their calendars. How this practice arose over time and was maintained through design decisions and institutional practices was the subject of earlier work [21].

Here we found that GCS calendars continue to be very open, despite the company almost doubling its size; the subsequent availability of PDAs; and its much larger telework workforce. All these factors, we hypothesized, could erode calendar publicity: for the first factor, the earlier calendar culture could be diluted by other, different incoming calendar practices. In the case of the latter two factors, we hypothesized that attention to privacy would be heightened by the greater overlap between work and home.

Users across Sun's GCSs show the same consistent pattern for privacy settings, where roughly 75% keep them completely open for others to view, similar to earlier practice observed in prior work [21]. Users of one version, however, allow slightly more editing capabilities by the public. In this case, about 50% more allow others to insert appointments into their calendars. We suspect this is because the means for adjusting the edit settings is much more obvious. This is the only noticeable change in practices around calendar privacy management, and we note that it appears to stem from a design decision. GCS users still keep a fair amount of home-related information in their public calendar, although as we noted earlier, privacy settings do not predict the work-to-home content in calendars. Although this open practice could change as time goes on and more workers become more mobile, Sun remains a compelling example of how affordances of technology and organizational culture co-adapt into a situation where workers can integrate some features of home-based meta-work with work-based meta-work.

A Constellation of Tools

People use a constellation of means to manage their time and tasks as our results here, and as earlier studies on these topic areas, have carefully pointed out [1,2,5]. We see remarkably consistent trends across both types of calendars and job role, with one exception. As one would expect, people who use the corporate GCS calendars rate their reliance on them higher than other calendars; the reverse is true for other online calendar users.

Figure 9 shows the very consistent pattern of use across Job Role. Whether managers, internal, or product developers, workers rely on a variety of personal support media to manage their time. Interestingly, it is not the online calendars (GCS or other) that are most important for time management; rather, it is email, a communications application. Online calendars are close behind in importance and are on par with phone/voicemail, lists/notes, and even memory. In contrast, online to-dos have not yet found a place (even among PDA users, who do presumably have easy access to such a feature). Also interesting is that another communications application— IM—does not play an important role in managing one's

time. (Use of IM as a communications tools was low; only about a quarter of respondents used it at the time of study).
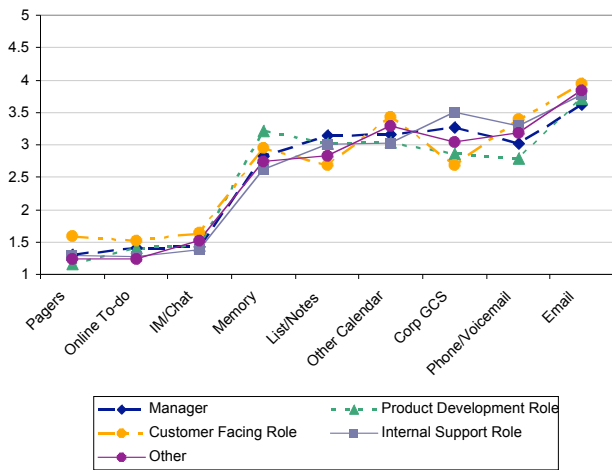
Figure 9. Ratings of the use of time and task management tools
(1=almost never, 5=almost always)

CONCLUSIONS

The results of our investigation of the use personal support media — computers, mobile devices, calendar artifacts — in a high tech organization extends a growing and important field of research into what we generally refer to as meta-work. We found that high-tech workers at Sun spend a good deal of time working at home: on average, our respondents—including those in support and internal positions—spend the equivalent of one work day a week at home. They spend nearly a quarter of their time in meetings. These workers manage multiple media, using typically not just one computer, but an average of well over two each. Furthermore, laptops are common, notable in an environment where that has not always been the case [21]. Mobile devices in work, particularly personally owned phones and PDAs, are numerous. Overall, these workers manage 3-4 digital tools each. And, where once only company-available technologies determined what people used, we now see much more heterogeneity.

Additionally, people maintain 2 calendars on average, with a high mix of media—corporate GCSs, other online calendars, paper planners, PDA calendars and others. GCSs are in high use in this company; notably, about 75% of all GCS users allow their calendars to be globally viewable—a feature of calendar practice that continues to distinguish Sun from other environments. In such an environment, calendars become a utility for group use, as explored in earlier studies. While content is affected by the portability of calendars, people continue to populate open calendars with personal appointments, once again illustrating how liberal the notions of privacy are in this environment [21]. We think of calendar use as comprising two populations: those who just maintain one, and those who are more intensive calendar users. For the latter group, a particularly common pairing is a GCS and mobile digital calendar.

Furthermore, examination of the use of calendars in the context of other tools for time and task management shows that calendars—and the GCS calendars in particular—are supplemented by other methods and media—notably other calendars, lists and memory—as well as conventional communications applications such as email, phone and voicemail. People are most dependent on email to manage time and tasks as other research has convincingly shown [5,25,28]. Clearly, thoughtful integration of email and calendar media is an essential but nontrivial step in advancing the state of the art for meta-work support.

The nature of work plays an important role in shaping the tools people use: the more mobile people are, the more laptops and mobile devices they use, and the greater the tendency to rely on mobile alternatives to the corporate GCSs. Clearly, mobility is changing the way meta-work is conducted; mobile workers remotely manage work and even home activity. The more stationary people are (at work and out of meetings), the simpler the array of digital support media. They also rely more on the basic tools provided by the company and include less of their own. An implication of these differences in media use by nature of work is that it can help target user populations for new applications and technology deployment. Grudin [8] pointed to a similar strategy when he suggested that designers think about executive managers as a user population distinct from individual contributors. Managers do distinguish themselves from product development and internal support positions we found, but customer facing personnel have similar personal media use patterns. Although managers have many more meetings than customer facing personnel, the latter work more offsite, and the effect—being out of a dedicated office—is the same as being in many meetings. Furthermore, contrary to the stereotype, product development personnel, which include the most technical people in the company—engineers, developers and testers—carry fewer mobile devices than their managerial and customer facing counterparts.

Finally, we that see calendars and mobile devices span the spheres of work life and personal life [7,18], with workers including personally owned devices as part of the constellation of tools they use to conduct meta-work. Perhaps it does not serve to think about the activities of meta-work as belonging to either the domain of work, the domain of home or some other. Instead, for today's more mobile workforce, meta-work is the means by which different realms of life are brought together, where management of work-at-home and management of work-at-work are moving toward a singular orchestration.

The ongoing integration of home and work suggests another design implication. In terms of time management and calendar practice, calendar design could benefit from a relatively easy solution—but one that is usually not well implemented—of enabling overlays of views of one's own calendar that represent different realms of life. This would allow not only home and work schedules to be managed in

concert but also separate from the other; it would also allow schedules of family members, affiliated institutions (like children's schools or an intramural sports league), and so on to be considered as well. People orient to schedules that influence their own, or are even "larger" than their own (like the bus schedule). This notion of "calendar inheritance" [21] could be translated into technological capabilities that would allow the inclusion of important features of other schedules into one's own.

Our research explains some of the variability we see in the use of personal support media, but meta-work is complex, and the means of conducting it are many. We expect that further investigation of the social context of work will further illuminate our understanding of the tools we live by.

FUTURE DIRECTIONS
We plan to extend our analyses beyond the individual factors discussed here to include a broader view of how social context influences meta-work. We will report on more detailed analyses of nature of work variables and media use; social parameters—including co-worker temporal, physical, and organizational proximity—that explain and describe coordination technology use and adoption; the relationship between coordination technology and co-worker awareness; and the norms, perceptions, and practices around calendar privacy and publicity.

REFERENCES
1. Bellotti V, Dalal B, Good N, Flynn P, Bobrow DG, Ducheneaut N (2004) What a To-Do: Studies of Task Management Towards the Design of a Personal Task List Manager, *Proc. of CHI '04*, 735-742.

2. Blandford AE & Green TRG (2001) Group and Individual Time Management Tools: What You Get is Not What You Need, *Personal and Ubiquitous Computing*, 5(4), 213-230.

3. Boardman R & Sasse MA (2004) "Stuff goes into the computer and doesn't come out": A Cross-tool Study of Personal Information Management, *Proc of CHI '04*, 583-590.

4. Campbell C & Maglio P (2003) Supporting Notable Information in Office Work, *Proc. of CHI '03*, 902-903.

5. Ducheneaut N & Bellotti V (2001) Email as Habitat: An Exploration of of Embedded Personal Information Management, *interactions*, 8(5), 30-38.

6. Geisler, C (2002) Time, Technology and Text, *Bakhtin, Vygotsky, Composition & Rhetoric SIG, 55th Conf on College Composition & Communication,* San Antonio.

7. Geisler C & Golden A (2003) Mobile Technologies at the Boundary of Work and Life. *National Communication Association, Human Communication and Technology Division,*. http://www.rpi.edu/~geislc/Manuscripts/Circuit.pdf

8. Grudin J (2004) Managerial Use and Emerging Norms: Effects of Activity Patterns on Software Design and Deployment., *Proc. HICSS-37*.

9. Jones W & Maier D (2003) *Personal Information Management Group Report 2* NSF IDM 2003 Workshop Sept. 14-16, 2003, Seattle, WA.

10. Kelley JF & Chapanis A (1982) How Professional Persons Keep their Calendars: Implications for Computerization, *Journal of Occupational Psychology*, 55, 241-256.

11. Kincaid CM, Dupont PD & Kaye AR (1985) Electronic Calendars in the Office: An Assessment of User Needs and Current Technology, *ACM TOIS,* 3(1), 89-102.

12. Lansdale M (1988) The psychology of personal information management, *Applied Ergonomics*, 19(1), 55-66.

13. Lin M, Lutters WG & Kim TS (2004) Understanding the micronote lifecycle: improving mobile support for informal note taking, *Proc. of CHI '04*, 687-694.

14. Mackay WE (1988). Diversity in the Use of Electronic Mail: A Preliminary Inquiry. *ACM TOIS*, 6(4), 380-397.

15. Malone TW (1983) How do people organize their desks? Implications for designing office information systems, *ACM TOIS,* 1, 99-112.

16. Mintzberg H (1984) A Typology of Organizational Structure, In D. Miller and P.H. Friesen (Eds.), *Organizations: A Quantum View,* Prentice-Hall, 68-86

17. Mosier JN & Tammaro SG (1997) When Are Group Scheduling Tools Useful? *CSCW: The Journal of Collaborative Computing*, 6, 53-70.

18. Nippert-Eng C (1996) *Home and Work: Negotiating Boundaries Through Everyday Life*. Univ. of Chicago Press.

19. Palen L, Salzman M, & Youngs E (2000) Going Wireless: Behavior and Practice of New Mobile Phone Users, *Proc. of CSCW '00*, 201-210.

20. Palen L (1999) Social, Individual & Technological Issues for Groupware Calendar Systems, *Proc. of CHI '99*, 17-24.

21. Palen L (1998) *Calendars on the New Frontier: Challenges of Groupware Technology*. Dissertation, UC-Irvine.

22. Palen L & Grudin J (2002) Discretionary Adoption of Group Support Software: Lessons from Calendar Applications. In B.E. Munkvold (Ed), *Implementing Collaboration Technologies in Industry*, Springer Verlag 159-180.

23. Payne SJ (1993) Understanding Calendar Use. *HCI,* 8(2), 83-100.

24. Perry M, O'hara K, Sellen A, Brown B, Harper R (2001) Dealing with mobility: Understanding Access Anytime, Anywhere, *ACM TOCHI*, 8(4), 323 –347.

25. Rohall SL, Gruen D., Moody P., Wattenberg M, Stern M, Kerr B, Stachel B, Kushal D, Armes R, & Wilcox E (2004) ReMail: A Reinvented Email Prototype. *Proc of CHI 2004*, 791-792.

26. Strauss A (1985) Work and the division of labor. *The Sociological Quarterly*, 26(1), 1-19.

27. Tyler J & Tang J (2003) Email Responsiveness and Rhythms: Study and Design Implications. *Proc. of ECSCW '03,* 238-258.

28. Whittaker S & Sidner C (1996) Email Overload: Exploring Personal Information Management of Email, *Proc. of CHI'96*, 276-283.

29. Whittaker S & Hirschberg J (2001) The Character, value, and management of personal paper archives, *ACM TOCHI*, 8(2), 150-170.