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# **Technical Report**

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**IBM**

**Direction Stereotypes for Setting Dates and  
Times**

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# **Direction Stereotypes for Setting Dates and Times**

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## **Abstract**

The purpose of this human factors/usability study was to investigate population stereotypes for the association between directional arrows and passage through time for date- and time-setting screen designs. Sixteen participants, given a target date or time, selected arrow buttons on paper mockups of screens with five different arrangements for setting dates and four arrangements for setting times. Some arrangements used vertical arrows and others used horizontal arrows. The dependent variables were error rates (for example, selecting a button designed to control minutes when the target date required a change of hour), consistency rates, and preference ranks. There was a significant main effect of level of setting (month, day, year) for the consistency measure for the date-setting designs, with setting months significantly less consistent than setting days or years. The consistency of operation of all the date-setting designs was about equal, averaging .85 for vertical arrow arrangements and .89 for horizontal arrow arrangements. The consistency of operation of the time-setting designs was about equal, averaging .89 for vertical arrow arrangements and .86 for horizontal arrow arrangements. Consistency of operation did not provide a basis for choosing among the designs. However, error rates, user preferences, and logical argument in combination point to some designs as superior to others. Because the consistency measures were less than 1.0 for all designs (both vertical and horizontal), arrows alone do not suffice to indicate passage through time. For this reason, the recommended designs for date and time setting use + and - characters inside the arrows as redundant cues for the operation of the arrow buttons.



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## Introduction

### Arrows and Population Stereotypes

A population stereotype exists when most of the members of a population share an expectation about the way they expect things to work. For example, almost 100% of the population of the U.S. expects a power switch that moves up and down to turn power on when up, and off when down. For switches that move side to side, 75% expect a movement to the right to turn power on. For switches that move front and back, about 50% expect a movement to the back to turn power on (Lewis, 1986). This stereotype clearly suggests that products designed for use in the U.S. should have power switches that move up and down, with an upward movement turning on the power. (The fact that populations in certain European countries, such as England, have exactly the opposite stereotype complicates matters.)

Bury, Boyle, Evey, and Neal (1982) investigated computer users' stereotypes regarding the way they expected arrow keys to control information displayed on a computer screen. They presented letters and numbers in a cross pattern (with the letter line in alphabetical order and the number line in numeric order) and asked users to select which of four arrow keys (up, down, left, or right) they would need to press to display an off-screen target letter or number. Based on a user's responses, Bury et al. (1982) could infer whether the user expected the arrow buttons to control the window's (display's) virtual movement over stationary text (windowing) or the text's virtual movement under a stationary window (scrolling). They found that 30 of 34 (88%) naive users defined the system to window.

### Up (or Right) Into the Future?

Intuitively, it would seem to be simple to design screens with which users would touch scroll arrows to set dates and times. However, there are two opposing ways to anticipate the effect of arrow buttons on dates and times. For example, suppose the current month is May, and you want to set the date for a meeting in June. Also, suppose you have the choice of touching a button with an arrow pointing up or one pointing down. Which would you touch?

If you tend to think of months as incrementing from 1 to 12 on a number line, you would select the up arrow. If you tend to think of months as normally shown on a calendar (with January at the top and December at the bottom), you would touch the down arrow.

Now suppose the arrows point left and right. Which would you touch? In this case, both a number line and a calendar representation would have January at the left and December at the right, so you would probably choose to touch the right button to change May to June.

## Purpose

The main purpose of this study was to investigate the expectations of users for the action of arrow buttons (both vertical and horizontal) when setting dates and times. A key hypothesis was that the population stereotype for horizontal arrow buttons would be stronger than that for vertical arrow buttons. The basis for this hypothesis was that the two mental representations (number line and calendar) for horizontal arrow buttons are congruent, but are opposed for vertical arrow buttons. A second hypothesis was that for vertical arrow buttons, users would be more consistent in their selections with days and years than with months, because days and years have a stronger numeric component than months. A secondary purpose of the study was to investigate button selection errors and user preference for different date- and time-setting designs.

## Method

### Participants

Sixteen people (both IBM employees and non-IBM employees) participated in this study. There were eight males and eight females, three left-handed and thirteen right-handed. According to self reports, fourteen had used computers for more than two years, and six used computers for more than twenty hours per week. Ten had experience primarily with IBM\* computers, and five had experience with both IBM and Macintosh\*\*. Thirteen were familiar with computer terminology, nine were familiar with both applications and operating systems, and fourteen were familiar with some type of personal organizer. (See Appendix A for a listing of the participants' characteristics.)

### Materials

Figure 1 shows five date-setting designs, and Figure 2 shows four time-setting designs. Using these designs, a set of date- and time-setting problems were constructed. The set included one problem for moving each time element both forward and backward in time. Thus, the set included six problems for each date-setting design and four problems for each time-setting design -- a total of 46 problems (30 date-setting problems and 16 time-setting problems). Appendix B shows the 46 date- and time-setting problems.

### Procedure

I determined the order of presentation of the problems using a random number generator. Half of the problem sets had the problems arranged in the order produced by the random number generator, and the other half had the problems in reverse order to help control any order effects. Participants first completed a short background questionnaire. They next received a set of 46 papers with one problem per paper. For each problem, they read the target date (or time), then circled the button they would touch to change the given date (or time) to the target date (or time). After completing all the problems, they

## Unclassified

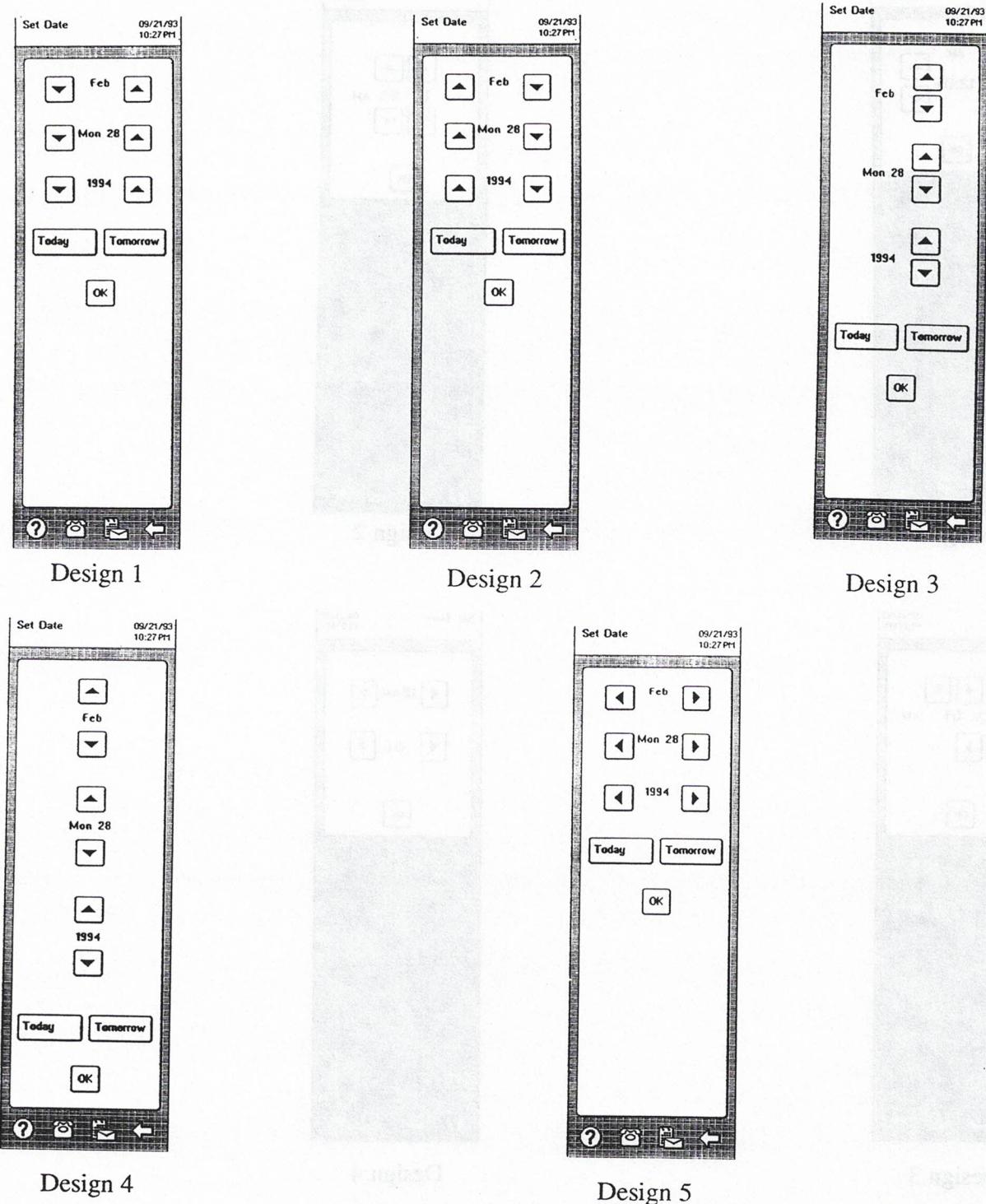
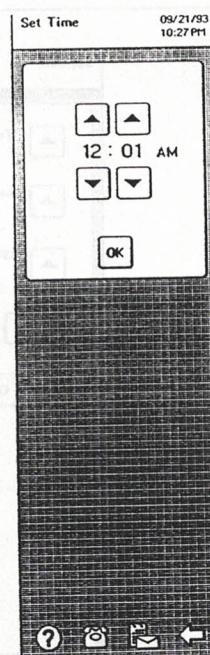


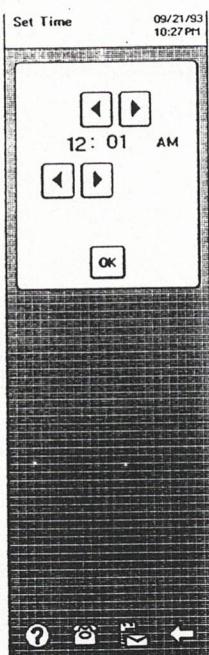
Figure 1. Five date-setting designs



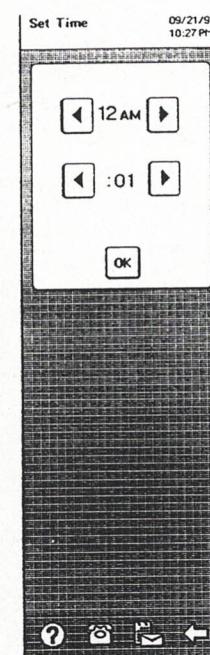
Design 1



Design 2



Design 3



Design 4

Figure 2. Four time-setting designs

## Unclassified

then ranked the date-setting designs from most to least preferred. Finally, they ranked the time-setting designs from most to least preferred.

I organized the results in a database (shown in Appendix A). A response was an error if the participant circled an arrow not associated with the time element given in the problem (for example, circling a minute-controlling arrow when the problem required touching an hour-controlling arrow). I assigned errors a 1 and non-errors a 0 in the errors section of the database. Because most participants followed a pattern in which they circled up arrows to move into the future for vertical arrangements and right arrows to move into the future for horizontal arrangements, I assigned responses consistent with this mental model a 1, and responses inconsistent with this model a 0. I analyzed the dichotomous consistency and error data with F-tests (Myers, DiCecco, White, and Borden, 1982) and the preference data with a Friedman test (Lewis, 1993).

## Results

### Consistency

Analyses of variance showed no significant main effect of design for either setting dates ( $F(4,60)=.392, p=.814$ ) or setting times ( $F(3,45)=.130, p=.942$ ). Figure 2 shows a graph of these main effects.

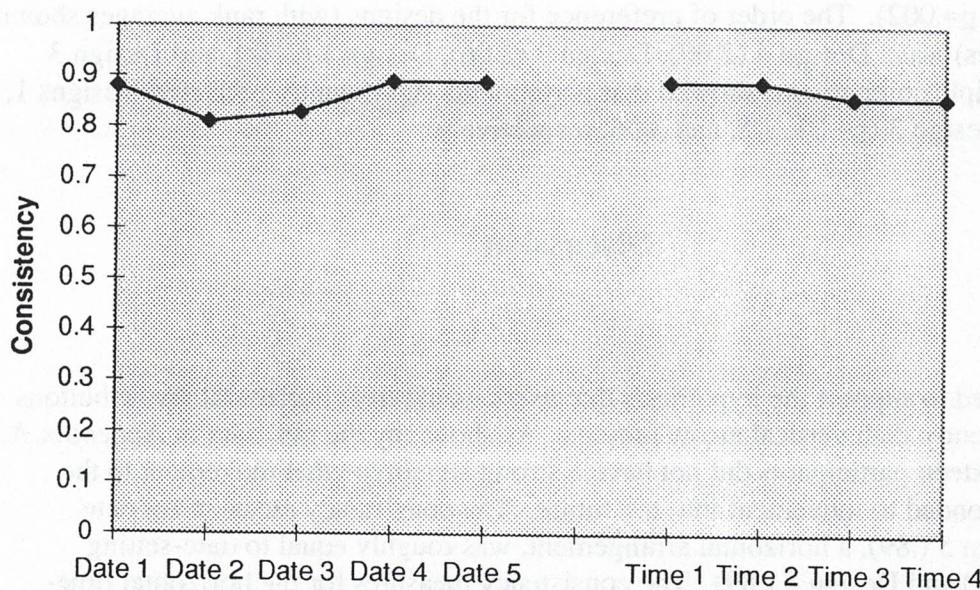


Figure 3. Main effects of design for date and time setting

## Unclassified

The only significant main effect in the consistency analyses of variance was for the main effect of level (month, day, year) for the date-setting designs ( $F(2,30)=2.671$ ,  $p=.086$ ). Selections for months were less consistent than those for days or years (.81 versus .87 and .89, respectively).

## Errors

Participants made no errors using any of the date-setting designs. An analysis of variance using data collapsed across problems for each time-setting design was significant ( $F(3,45)=4.19$ ,  $p=.011$ ). Time-setting Designs 2 and 4 were error-free. Design 1 had 4.7% error responses. Design 3 had 17.2% error responses. Post-hoc t-tests indicated that Design 1 had significantly more errors than Designs 2 and 4 ( $t(15)=1.83$ ,  $p=.09$ ), Design 3 had more errors than Designs 2 and 4 ( $t(15)=2.10$ ,  $p=.05$ ), and Design 3 had significantly more errors than Design 1 ( $t(15)=1.94$ ,  $p=.07$ ).

## Preference

The preferences for the five date-setting designs were significantly different ( $\chi^2(4)=12.9$ ,  $p=.012$ ). The order of preference for the designs (with rank averages shown in parentheses) was: Design 3 (2.19), Design 5 (2.56), Design 1 (3.00), Design 4 (3.19), and Design 2 (4.06). Multiple comparisons showed that participants significantly preferred Design 3 to Design 2 ( $p=.01$ ) and preferred Design 5 to Design 2 ( $p=.10$ ).

The preferences for the four time-setting designs were significantly different ( $\chi^2(3)=15.2$ ,  $p=.002$ ). The order of preference for the designs (with rank averages shown in parentheses) was: Design 4 (2.00), Design 2 (2.06), Design 1 (2.38), and Design 3 (3.56). Multiple comparisons showed that participants significantly preferred Designs 1, 2, and 4 to Design 3 ( $p=.01$ ,  $.05$ , and  $.005$ , respectively).

## Discussion

### Consistency

The data failed to support the hypothesis that users would treat horizontal arrow buttons more consistently than vertical arrow buttons. As shown by the raw data in Appendix A, two of the sixteen participants did not have a strong stereotype that movement to the right corresponded to movement into the future. The consistency measure for date-setting Design 5 (.89), a horizontal arrangement, was roughly equal to date-setting Design 1 (.88) and Design 4 (.89). The consistency measures for the horizontal time-setting designs (Design 3=.86, Design 4=.86) were roughly equal to those for the vertical time-setting designs (Design 1=.89, Design 2=.89).

## Unclassified

The data supported the hypothesis that users treat month-setting less consistently than date- or year-setting. This lends support to the idea that the conflict between the two ways of interpreting movement through time with arrow buttons is greater for months because the link between months and a number line is weaker than the corresponding link for dates and years.

A consistency measure of .90 means that users make an inconsistent choice about 10% of the time. To reduce this inconsistency, future designs should include a redundant cue by imbedding a + in arrows that make values greater (move into the future) and a - in arrows that make values smaller (move into the past). Considering the argument about the correspondence between number lines and calendar representations for horizontal arrow arrangements, future designs should use horizontal arrangements rather than vertical arrangements unless there is a compelling reason to do otherwise.

## Errors

Because participants made no errors with any of the date-setting designs, it is not possible to user error information to promote one date-setting design against the others. For time-setting designs, the error data eliminate Designs 3 and 1 from consideration for future designs.

## Preference

The preference data for date-setting designs support both Design 3 (a vertical arrangement) and Design 5 (a horizontal arrangement). The preference data for time-setting designs support both Design 2 (a vertical arrangement) and Design 4 (a horizontal arrangement).

## Design Recommendations

Users who preferred date-setting Design 3 preferred it because they liked the clarity of its design, with both arrow buttons together, close to the time element that the arrows control. Users who preferred date-setting Design 5 preferred it because they thought the horizontal arrows were easier to use. Figure 4 shows a recommended date-setting design that uses both these features, and includes the redundant +,- cue in the arrows.

Consistency measures, errors, and preferences failed to discriminate between time-setting Designs 2 and 4. A slightly changed version of Design 4 appears in Figure 4 as the recommended design. If the system will use the screen only for setting the time, and provides a separate clock with integrated hours and minutes, then the system should use the recommended design for consistency with the recommended date-setting design. If, for whatever reason, the system must use the time-setting design as a clock, then the system should use Design 2 (supported with the redundant +,- cue in the arrows) because it displays hours and minutes in a conventional, integrated form.

## Unclassified

Note that the recommended designs in Figure 4 are concepts based on the findings of this study. A graphics designer should help produce any final design to ensure design correctness and consistency with the rest of the system.

Also, the sample size and sampled population limit the generalizability of this study. It would be reasonable to replicate the study using an exclusively non-IBM sample. It would also be useful to replicate the study using samples from different countries. On the other hand, these results do provide reasonably strong evidence that arrows alone, in either vertical or horizontal orientation, do not tap into a strong enough population stereotype to stand on their own, and should benefit from incorporating the additional +,- cue.

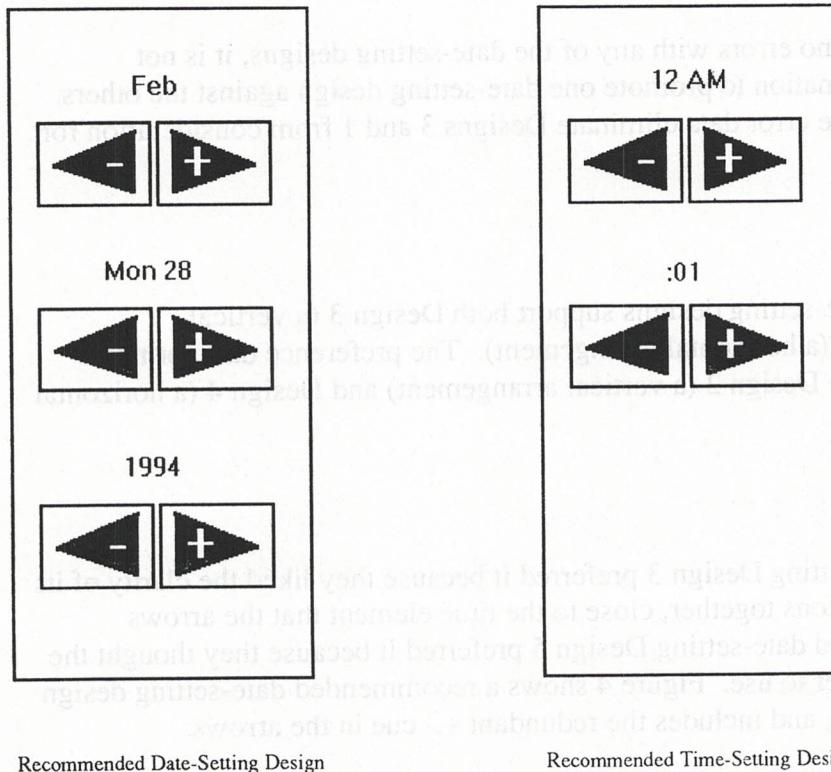


Figure 4. Recommended date- and time-setting designs

## Acknowledgment

Suvit Nopachai contributed to the design and conduct of this study. In particular, I appreciate the work he did creating the stimulus materials.

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## Trademarks

- \* IBM is a trademark of the International Business Machines Corporation, registered in the US and other countries.
- \*\* Macintosh is a trademark of the Apple Corporation, registered in the US and other countries.

## Appendix A. Raw Data

Calendar/Time Arrow-Setting Consistency Study								
Subject	Sex	Handed	CompExp	CompTime	FamTerm	FamComp	Which	FamOrg
1	M	R	>2yr	<10hr	Y	Neither	IBM	Y
2	M	R	<6mo	<10hr	N	Neither	IBM	Y
3	M	R	>2yr	<10hr	Y	Both	IBM	Y
4	F	R	6mo-2yr	10-20hr	N	Neither	None	Y
5	M	R	>2yr	<10hr	N	Apps	Both	N
6	M	R	>2yr	>20hr	Y	Both	IBM	Y
7	F	L	>2yr	10-20hr	Y	Both	IBM	Y (Paper)
8	M	R	>2yr	10-20hr	Y	Both	Both	Y
9	F	R	>2yr	10-20hr	Y	Apps	IBM	Y
10	M	L	>2yr	>20hr	Y	Apps	Both	Y
11	F	L	>2yr	>20hr	Y	Both	Both	Y
12	M	L	>2yr	>20hr	Y	Both	IBM	Y
13	F	R	>2yr	>20hr	Y	Both	Both	Y
14	F	R	>2yr	10-20hr	Y	Both	IBM	N
15	F	R	>2yr	>20hr	Y	Both	IBM	Y
16	F	R	>2yr	<10hr	Y	Apps	IBM	Y (Paper)
Summary	8M, 8F	3L, 13R	14 >2yr	6>20, 4<10	13 Y, 3 N	9 B, 3 N	10 I, 5 B	14 Y, 2 N
Notes:	Sex:	M=Male				Familiar	Y=Yes	
		F=Female				with	N>No	
						Organizers:		
	Handed:	R=Right						
		L=Left						
	Computer	>2yr=more than two years						
	Experience	6mo-2yr=between six months and two years						
		<6mo=less than six months						
	Computer	<10hr=less than 10 hours per week						
	Time:	10-20hr=between 10 and 20 hours per week						
		>20hr=more than 20 hours per week						
	Familiar	Y=Yes						
	with	N=No						
	Computer							
	Terminology:							
	Familiar	Apps=Computer applications only						
	with	OS=Operating systems only						
	Computer	Both=Both Apps and OS						
	Programs:	Neither=Neither Apps nor OS						
	Which	IBM=IBM computers						
	Computers:	Mac=Apple computers						
		Both=Both IBM and Mac						
		Neither=Neither IBM nor Mac						

Consistency Measure										
Subject	C1MUP	C1MDN	C1MAVE	C1DUP	C1DDN	C1DAVE	C1YUP	C1YDN	C1YAVE	C1AVE
1	1	1	1.00	1	1	1.00	1	1	1.00	1.00
2	1	1	1.00	1	1	1.00	1	1	1.00	1.00
3	1	1	1.00	1	1	1.00	1	1	1.00	1.00
4	1	1	1.00	1	1	1.00	1	1	1.00	1.00
5	1	1	1.00	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1	1	1.00	1.00
7	1	1	1.00	1	1	1.00	1	1	1.00	1.00
8	0	0	0.00	1	1	1.00	0	0	0.00	0.33
9	0	1	0.50	1	1	1.00	1	1	1.00	0.83
10	1	1	1.00	1	1	1.00	1	1	1.00	1.00
11	1	0	0.50	1	1	1.00	1	1	1.00	0.83
12	1	1	1.00	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	1	1.00	1	1	1.00	1.00
15	1	1	1.00	1	1	1.00	1	1	1.00	1.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0.81	0.81	0.81	0.94	0.94	0.94	0.88	0.88	0.88	0.88
Error Measure										
Subject	C1MUP	C1MDN	C1MAVE	C1DUP	C1DDN	C1DAVE	C1YUP	C1YDN	C1YAVE	C1AVE
1	0	0	0.00	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0	0	0.00	0.00
4	0	0	0.00	0	0	0.00	0	0	0.00	0.00
5	0	0	0.00	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	0	0.00	0	0	0.00	0.00
8	0	0	0.00	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Notes:	1=Response consistent with up (or right) into the future (consistency matrix)									
	1=Control error in button choice (error matrix)									

## Unclassified

Subject	C2MUP	C2MDN	C2MAVE	C2DUP	C2DDN	C2DAVE	C2YUP	C1YDN	C2YAVE	C2AVE
1	1	1	1.00	1	1	1.00	1	1	1.00	1.00
2	1	1	1.00	1	1	1.00	1	1	1.00	1.00
3	1	1	1.00	1	1	1.00	0	1	0.50	0.83
4	1	1	1.00	1	1	1.00	1	1	1.00	1.00
5	1	1	1.00	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1	1	1.00	1.00
7	1	1	1.00	1	1	1.00	1	1	1.00	1.00
8	0	0	0.00	0	0	0.00	0	1	0.50	0.17
9	1	1	1.00	1	1	1.00	1	1	1.00	1.00
10	1	0	0.50	1	1	1.00	1	1	1.00	0.83
11	0	0	0.00	1	1	1.00	0	1	0.50	0.50
12	1	1	1.00	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	0	0.50	1	1	1.00	0.83
15	1	0	0.50	1	1	1.00	1	1	1.00	0.83
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0.81	0.69	0.75	0.88	0.81	0.84	0.75	0.94	0.84	0.81
Subject	C2MUP	C2MDN	C2MAVE	C2DUP	C2DDN	C2DAVE	C2YUP	C1YDN	C2YAVE	C2AVE
1	0	0	0.00	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0	0	0.00	0.00
4	0	0	0.00	0	0	0.00	0	0	0.00	0.00
5	0	0	0.00	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	0	0.00	0	0	0.00	0.00
8	0	0	0.00	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0	0	0.00	0	0	0.00	0	0	0.00	0.00

Subject	C3MUP	C3MDN	C3MAVE	C3DUP	C3DDN	C3DAVE	C3YUP	C3YDN	C3YAVE	C3AVE
1	1	1	1.00	1	1	1.00	1	1	1.00	1.00
2	1	1	1.00	1	1	1.00	1	1	1.00	1.00
3	1	1	1.00	1	1	1.00	1	1	1.00	1.00
4	1	1	1.00	1	1	1.00	1	1	1.00	1.00
5	1	1	1.00	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1	1	1.00	1.00
7	1	1	1.00	1	1	1.00	1	1	1.00	1.00
8	0	0	0.00	0	0	0.00	1	0	0.50	0.17
9	1	1	1.00	1	1	1.00	1	1	1.00	1.00
10	1	0	0.50	1	1	1.00	1	1	1.00	0.83
11	0	0	0.00	1	1	1.00	1	0	0.50	0.50
12	1	1	1.00	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	0	0.50	1	1	1.00	0.83
15	1	1	1.00	1	1	1.00	1	1	1.00	1.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0.81	0.75	0.78	0.88	0.81	0.84	0.94	0.81	0.88	0.83
Subject	C3MUP	C3MDN	C3MAVE	C3DUP	C3DDN	C3DAVE	C3YUP	C3YDN	C3YAVE	C3AVE
1	0	0	0.00	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0	0	0.00	0.00
4	0	0	0.00	0	0	0.00	0	0	0.00	0.00
5	0	0	0.00	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	0	0.00	0	0	0.00	0.00
8	0	0	0.00	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0	0	0.00	0	0	0.00	0	0	0.00	0.00

## Unclassified

Subject	C4MUP	C4MDN	C4MAVE	C4DUP	C4DDN	C4DAVE	C4YUP	C4YDN	C4YAVE	C4AVE
1	1	1	1.00	1	1	1.00	1	1	1.00	1.00
2	1	1	1.00	1	1	1.00	1	1	1.00	1.00
3	1	1	1.00	1	1	1.00	1	1	1.00	1.00
4	1	1	1.00	1	1	1.00	1	1	1.00	1.00
5	1	1	1.00	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1	1	1.00	1.00
7	1	1	1.00	1	1	1.00	1	1	1.00	1.00
8	0	0	0.00	1	1	1.00	0	1	0.50	0.50
9	1	1	1.00	1	1	1.00	1	1	1.00	1.00
10	1	1	1.00	1	1	1.00	1	1	1.00	1.00
11	0	1	0.50	1	1	1.00	1	1	1.00	0.83
12	1	0	0.50	1	1	1.00	1	1	1.00	0.83
13	1	1	1.00	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	1	1.00	1	1	1.00	1.00
15	1	1	1.00	1	1	1.00	1	1	1.00	1.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0.81	0.81	0.81	0.94	0.94	0.94	0.88	0.94	0.91	0.89
Subject	C4MUP	C4MDN	C4MAVE	C4DUP	C4DDN	C4DAVE	C4YUP	C4YDN	C4YAVE	C4AVE
1	0	0	0.00	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0	0	0.00	0.00
4	0	0	0.00	0	0	0.00	0	0	0.00	0.00
5	0	0	0.00	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	0	0.00	0	0	0.00	0.00
8	0	0	0.00	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0	0	0.00	0	0	0.00	0	0	0.00	0.00

Subject	C5MR	C5ML	C5MAVE	C5DR	C5DL	C5DAVE	C5YR	C5YL	C5YAVE	C5AVE
1	1	0	0.50	0	1	0.50	0	0	0.00	0.33
2	1	1	1.00	1	1	1.00	1	0	0.50	0.83
3	1	1	1.00	1	1	1.00	1	1	1.00	1.00
4	1	1	1.00	1	1	1.00	1	1	1.00	1.00
5	1	1	1.00	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1	1	1.00	1.00
7	0	0	0.00	0	0	0.00	0	0	0.00	0.00
8	1	1	1.00	1	1	1.00	1	1	1.00	1.00
9	1	1	1.00	1	1	1.00	1	1	1.00	1.00
10	1	1	1.00	1	1	1.00	1	1	1.00	1.00
11	1	1	1.00	1	1	1.00	1	1	1.00	1.00
12	1	1	1.00	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	1	1.00	1	1	1.00	1.00
15	1	1	1.00	1	1	1.00	1	1	1.00	1.00
16	1	1	1.00	1	1	1.00	1	1	1.00	1.00
Average	0.94	0.88	0.91	0.88	0.94	0.91	0.88	0.81	0.84	0.89
Subject	C5MR	C5ML	C5MAVE	C5DR	C5DL	C5DAVE	C5YR	C5YL	C5YAVE	C5AVE
1	0	0	0.00	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0	0	0.00	0.00
4	0	0	0.00	0	0	0.00	0	0	0.00	0.00
5	0	0	0.00	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	0	0.00	0	0	0.00	0.00
8	0	0	0.00	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	0	0.00	0	0	0.00	0.00
Average	0	0	0.00	0	0	0.00	0	0	0.00	0.00

## Unclassified

Subject	CUDAVE	CLRAVE	Main effect of Level		
			Month	Day	Year
1	1.00	0.33	0.90	0.90	0.80
2	1.00	0.83	1.00	1.00	0.90
3	0.96	1.00	1.00	1.00	0.90
4	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00
7	1.00	0.00	0.80	0.80	0.80
8	0.29	1.00	0.20	0.60	0.50
9	0.96	1.00	0.90	1.00	1.00
10	0.92	1.00	0.80	1.00	1.00
11	0.67	1.00	0.40	1.00	0.80
12	0.96	1.00	0.90	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00
14	0.92	1.00	1.00	0.80	1.00
15	0.96	1.00	0.90	1.00	1.00
16	0.00	1.00	0.20	0.20	0.20
Average	0.85	0.89	0.81	0.89	0.87
Subject	CUDAVE	CLRAVE			
1	0.00	0.00			
2	0.00	0.00			
3	0.00	0.00			
4	0.00	0.00			
5	0.00	0.00			
6	0.00	0.00			
7	0.00	0.00			
8	0.00	0.00			
9	0.00	0.00			
10	0.00	0.00			
11	0.00	0.00			
12	0.00	0.00			
13	0.00	0.00			
14	0.00	0.00			
15	0.00	0.00			
16	0.00	0.00			
Average	0.00	0.00			

Subject	T1HUP	T1HDN	T1HAVE	T1MUP	T1MDN	T1MAVE	T1AVE
1	0	1	0.50	1	1	1.00	0.75
2	1	1	1.00	1	1	1.00	1.00
3	1	1	1.00	1	1	1.00	1.00
4	1	0	0.50	1	1	1.00	0.75
5	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1.00
7	1	1	1.00	1	1	1.00	1.00
8	1	1	1.00	0	0	0.00	0.50
9	1	1	1.00	1	1	1.00	1.00
10	1	1	1.00	1	1	1.00	1.00
11	1	1	1.00	1	1	1.00	1.00
12	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	0	0.50	0.75
15	1	1	1.00	1	1	1.00	1.00
16	1	0	0.50	0	1	0.50	0.50
Average	0.94	0.88	0.91	0.88	0.88	0.88	0.89
Subject	T1HUP	T1HDN	T1HAVE	T1MUP	T1MDN	T1MAVE	T1AVE
1	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0.00
4	1	0	0.50	0	0	0.00	0.25
5	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	1	0.50	0.25
8	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	1	0.50	0.25
Average	0.0625	0	0.03	0	0.125	0.06	0.05

Subject	T2HUP	T2HDN	T2HAVE	T2MUP	T2MDN	T2MAVE	T2AVE
1	1	1	1.00	1	1	1.00	1.00
2	1	1	1.00	1	1	1.00	1.00
3	1	1	1.00	1	1	1.00	1.00
4	1	0	0.50	1	1	1.00	0.75
5	1	1	1.00	1	1	1.00	1.00
6	1	1	1.00	1	1	1.00	1.00
7	1	1	1.00	1	1	1.00	1.00
8	0	0	0.00	0	0	0.00	0.00
9	1	1	1.00	1	1	1.00	1.00
10	1	1	1.00	1	1	1.00	1.00
11	1	1	1.00	1	1	1.00	1.00
12	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	1	1.00	1.00
15	1	1	1.00	1	1	1.00	1.00
16	1	0	0.50	1	0	0.50	0.50
Average	0.94	0.81	0.88	0.94	0.88	0.91	0.89
Subject	T2HUP	T2HDN	T2HAVE	T2MUP	T2MDN	T2MAVE	T2AVE
1	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0.00
4	0	0	0.00	0	0	0.00	0.00
5	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0.00
7	0	0	0.00	0	0	0.00	0.00
8	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0.00
15	0	0	0.00	0	0	0.00	0.00
16	0	0	0.00	0	0	0.00	0.00
Average	0	0	0.00	0	0	0.00	0.00

Subject	T3HR	T3HL	T3HAVE	T3MR	T3ML	T3MAVE	T3AVE
1	0	0	0.00	1	1	1.00	0.50
2	0	1	0.50	1	1	1.00	0.75
3	1	1	1.00	1	1	1.00	1.00
4	1	1	1.00	1	1	1.00	1.00
5	0	0	0.00	1	0	0.50	0.25
6	1	1	1.00	1	1	1.00	1.00
7	0	0	0.00	1	0	0.50	0.25
8	1	1	1.00	1	1	1.00	1.00
9	1	1	1.00	1	.1	1.00	1.00
10	1	1	1.00	1	1	1.00	1.00
11	1	1	1.00	1	1	1.00	1.00
12	1	1	1.00	1	1	1.00	1.00
13	1	1	1.00	1	1	1.00	1.00
14	1	1	1.00	1	1	1.00	1.00
15	1	1	1.00	1	1	1.00	1.00
16	1	1	1.00	1	1	1.00	1.00
Average	0.75	0.81	0.78	1.00	0.88	0.94	0.86

Subject	T3HR	T3HL	T3HAVE	T3MR	T3ML	T3MAVE	T3AVE
1	0	0	0.00	0	0	0.00	0.00
2	0	0	0.00	0	0	0.00	0.00
3	0	0	0.00	0	0	0.00	0.00
4	1	1	1.00	1	1	1.00	1.00
5	0	0	0.00	0	0	0.00	0.00
6	0	0	0.00	0	0	0.00	0.00
7	1	1	1.00	0	0	0.00	0.50
8	0	0	0.00	0	0	0.00	0.00
9	0	0	0.00	0	0	0.00	0.00
10	0	0	0.00	0	0	0.00	0.00
11	0	0	0.00	0	0	0.00	0.00
12	0	0	0.00	0	0	0.00	0.00
13	0	0	0.00	0	0	0.00	0.00
14	0	0	0.00	0	0	0.00	0.00
15	1	1	1.00	0	1	0.50	0.75
16	0	0	0.00	1	1	1.00	0.50
Average	0.1875	0.1875	0.19	0.125	0.1875	0.16	0.17

## Unclassified

Subject	T4HR	T4HL	T4HAVE	T4MR	T4ML	T4MAVE	T4AVE				
1	0	0	0.00	0	1	0.50	0.25				
2	1	1	1.00	1	1	1.00	1.00				
3	1	1	1.00	1	1	1.00	1.00				
4	1	1	1.00	1	1	1.00	1.00				
5	1	1	1.00	1	1	1.00	1.00				
6	1	1	1.00	1	1	1.00	1.00				
7	0	0	0.00	0	0	0.00	0.00				
8	1	1	1.00	1	1	1.00	1.00				
9	1	1	1.00	1	1	1.00	1.00				
10	1	1	1.00	1	1	1.00	1.00				
11	1	1	1.00	1	1	1.00	1.00				
12	1	1	1.00	1	1	1.00	1.00				
13	1	1	1.00	1	1	1.00	1.00				
14	0	0	0.00	1	1	1.00	0.50				
15	1	1	1.00	1	1	1.00	1.00				
16	1	1	1.00	1	1	1.00	1.00				
Average	0.81	0.81	0.81	0.88	0.94	0.91	0.86				
Subject	T4HR	T4HL	T4HAVE	T4MR	T4ML	T4MAVE	T4AVE				
1	0	0	0.00	0	0	0.00	0.00				
2	0	0	0.00	0	0	0.00	0.00				
3	0	0	0.00	0	0	0.00	0.00				
4	0	0	0.00	0	0	0.00	0.00				
5	0	0	0.00	0	0	0.00	0.00				
6	0	0	0.00	0	0	0.00	0.00				
7	0	0	0.00	0	0	0.00	0.00				
8	0	0	0.00	0	0	0.00	0.00				
9	0	0	0.00	0	0	0.00	0.00				
10	0	0	0.00	0	0	0.00	0.00				
11	0	0	0.00	0	0	0.00	0.00				
12	0	0	0.00	0	0	0.00	0.00				
13	0	0	0.00	0	0	0.00	0.00				
14	0	0	0.00	0	0	0.00	0.00				
15	0	0	0.00	0	0	0.00	0.00				
16	0	0	0.00	0	0	0.00	0.00				
Average	0	0	0.00	0	0	0.00	0.00				

Subject	TUPDNAVE	TLRAVE	UPDNAVE	LRRAVE
1	0.88	0.38	0.94	0.35
2	1.00	0.88	1.00	0.85
3	1.00	1.00	0.98	1.00
4	0.75	1.00	0.88	1.00
5	1.00	0.63	1.00	0.81
6	1.00	1.00	1.00	1.00
7	1.00	0.13	1.00	0.06
8	0.25	1.00	0.27	1.00
9	1.00	1.00	0.98	1.00
10	1.00	1.00	0.96	1.00
11	1.00	1.00	0.83	1.00
12	1.00	1.00	0.98	1.00
13	1.00	1.00	1.00	1.00
14	0.88	0.75	0.90	0.88
15	1.00	1.00	0.98	1.00
16	0.50	1.00	0.25	1.00
Average	0.89	0.86	0.87	0.87

Subject	TUPDNAVE	TLRAVE	UPDNAVE	LRRAVE
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.13	0.50	0.06	0.25
5	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00
7	0.13	0.25	0.06	0.13
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00
15	0.00	0.38	0.00	0.19
16	0.13	0.25	0.06	0.13
Average	0.02	0.09	0.01	0.04

## Appendix B. Background Questionnaire and Sample Problem Set

Answer the following questions and select the best answer from the options provided.

1. How many hours do you spend on average per week working?

- 0 to 10 hours
- 11 to 20 hours
- More than 20 hours

2. On average, how many days per week do you work?

- Less than 10 days a week
- 11 to 20 days a week
- More than 20 days a week

3. Do you consider yourself highly competitive in your field?

- Yes
- No

4. Do you consider yourself a team player?

- Considerable application

- Considered average

- Not considered average

5. What is your current computer usage?

6. In the following statement, which best describes your job?

Before we start, please complete this short Background Questionnaire. Thank you.

**Background Questionnaire**

P: \_\_\_\_\_

1. How many months of computer experience do you have?

- None to six months
- Six months to two years
- More than two years

2. How many hours/week do you spend using computer applications?

- Fewer than 10 hours/week
- 10 to 20 hours/week
- More than 20 hours/week

3. Do you consider yourself familiar with computer terminology?

- No
- Yes

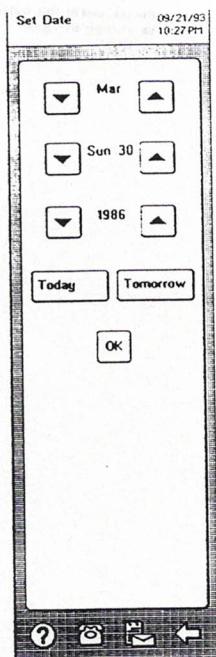
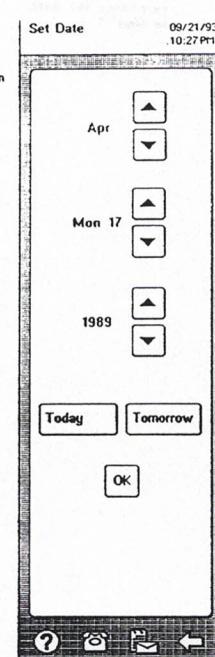
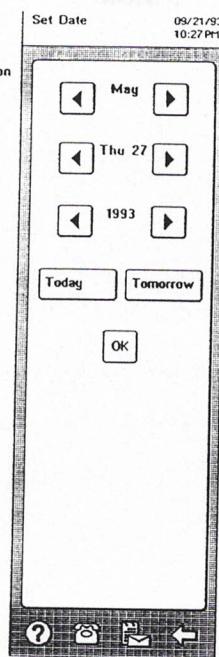
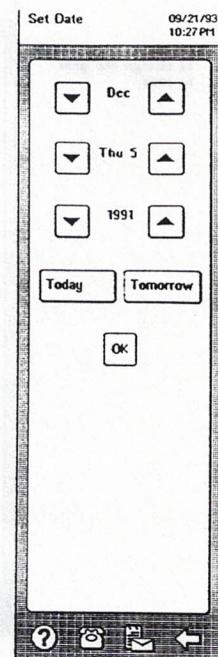
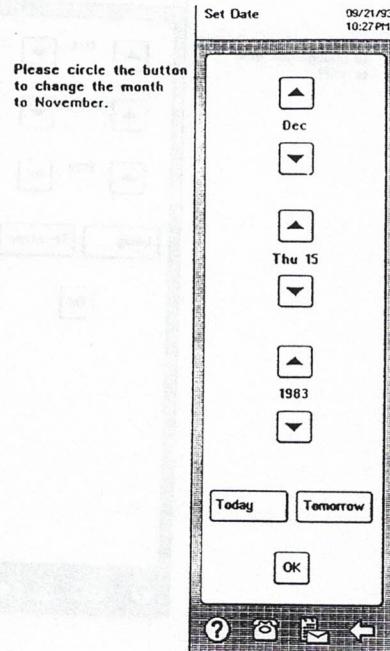
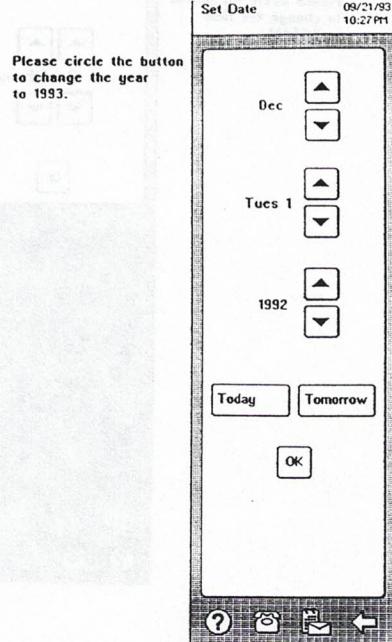
4. Do you consider yourself knowledgeable in

- Computer applications
- Operating systems
- Both computer applications and operating systems
- Neither computer applications nor operating systems

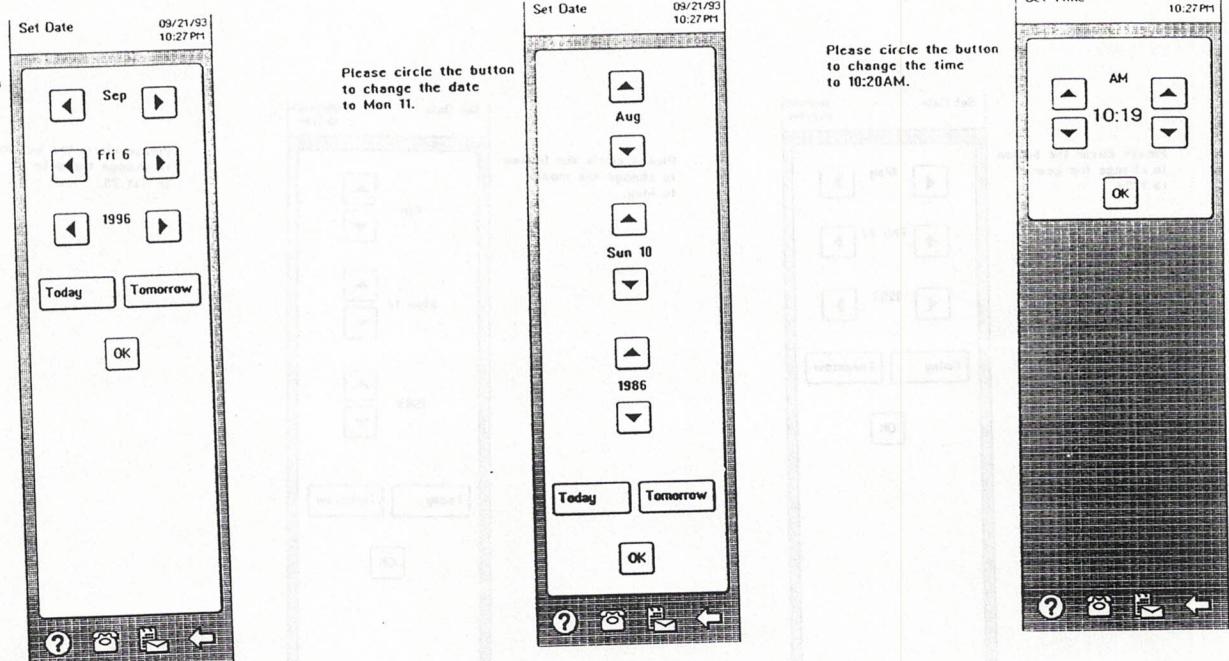
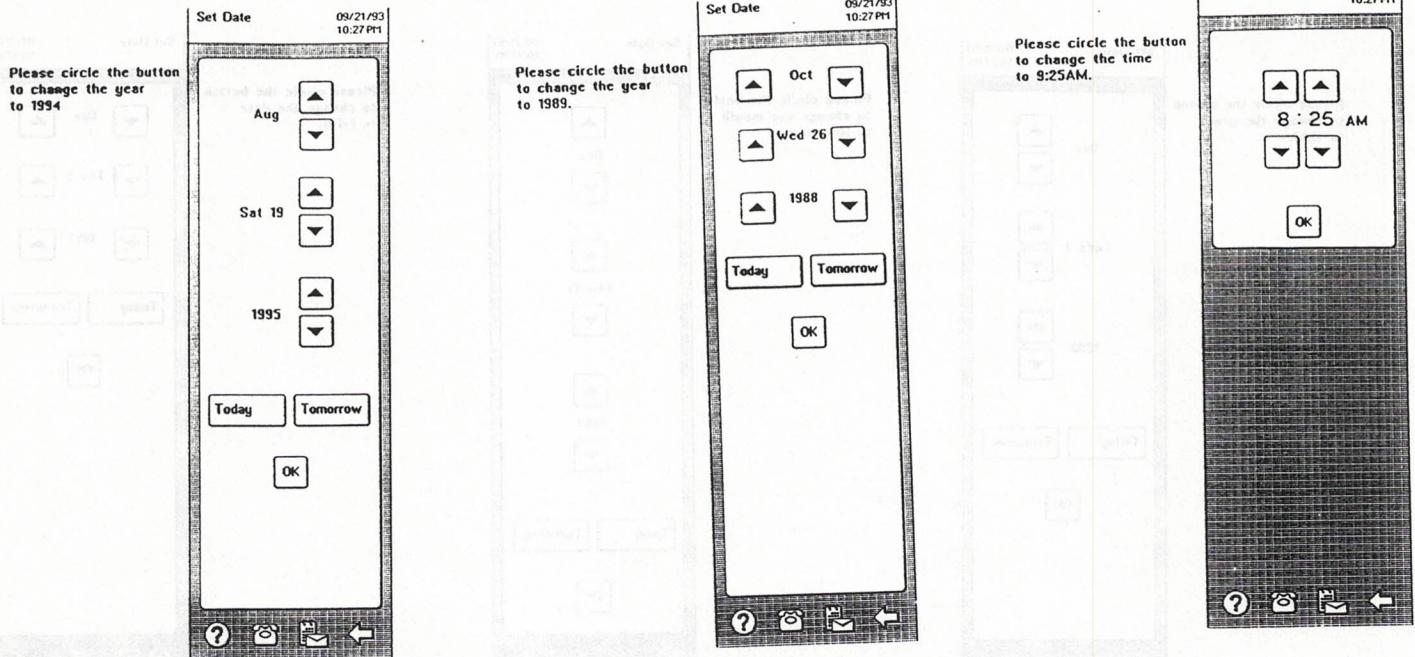
5. With which computer systems/operating systems are you familiar?

6. With which personal organizers (especially time and date organization, either as a separate device or as a computer program) are you familiar?

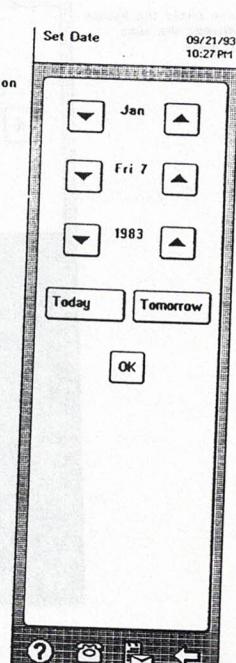
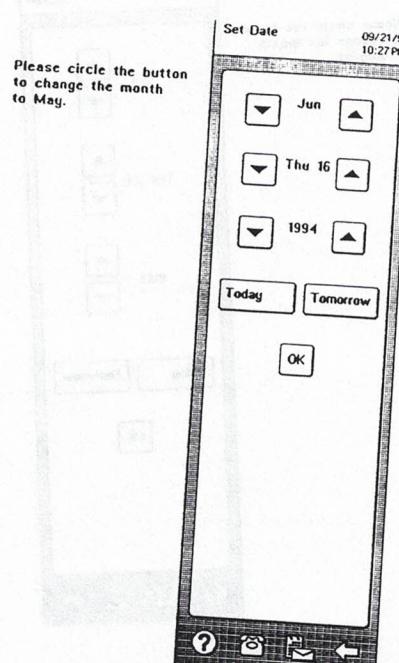
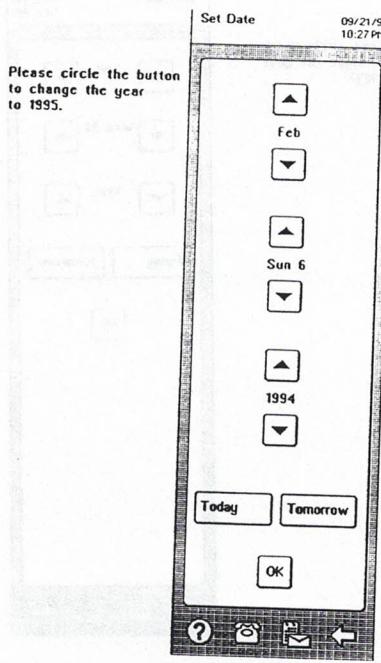
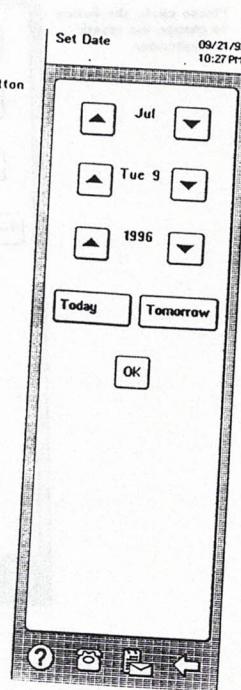
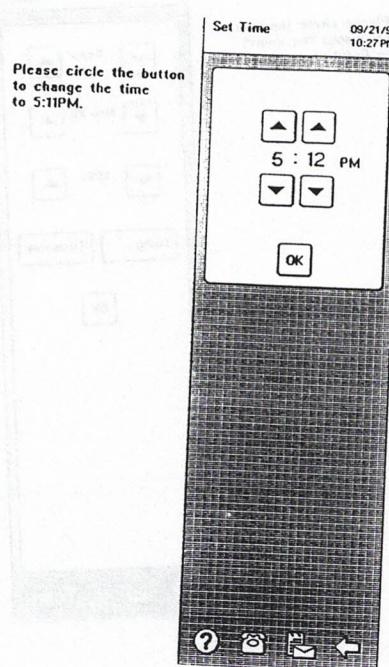
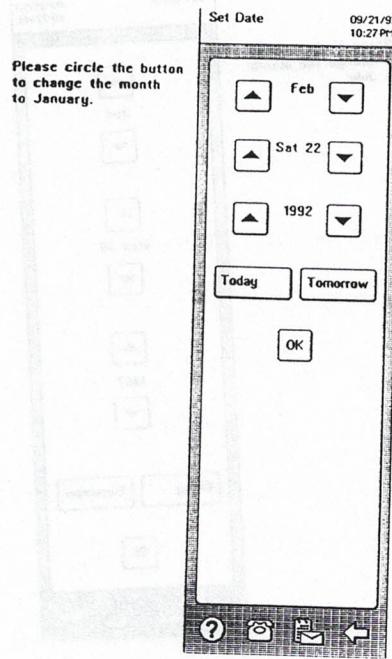
# Unclassified



## Unclassified

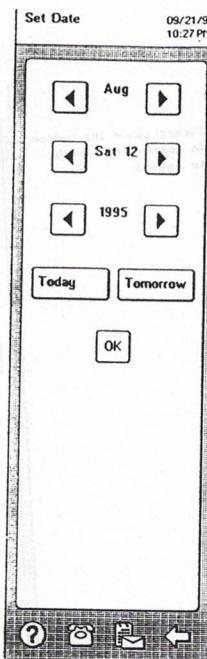


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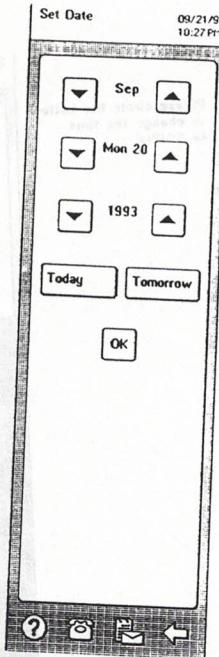


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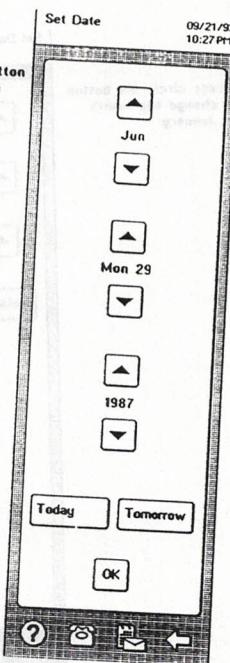
Please circle the button to change the month to September.



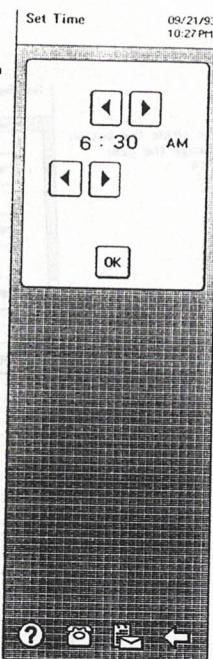
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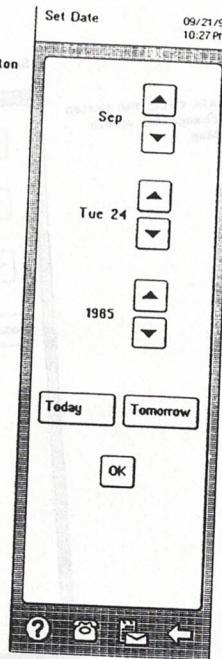
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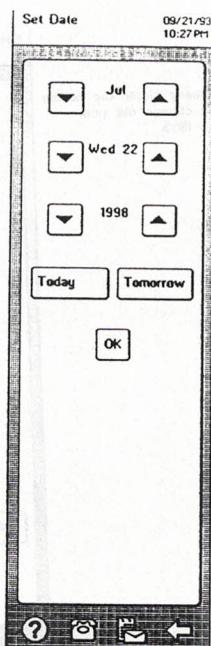
Please circle the button to change the time to 7:30AM.



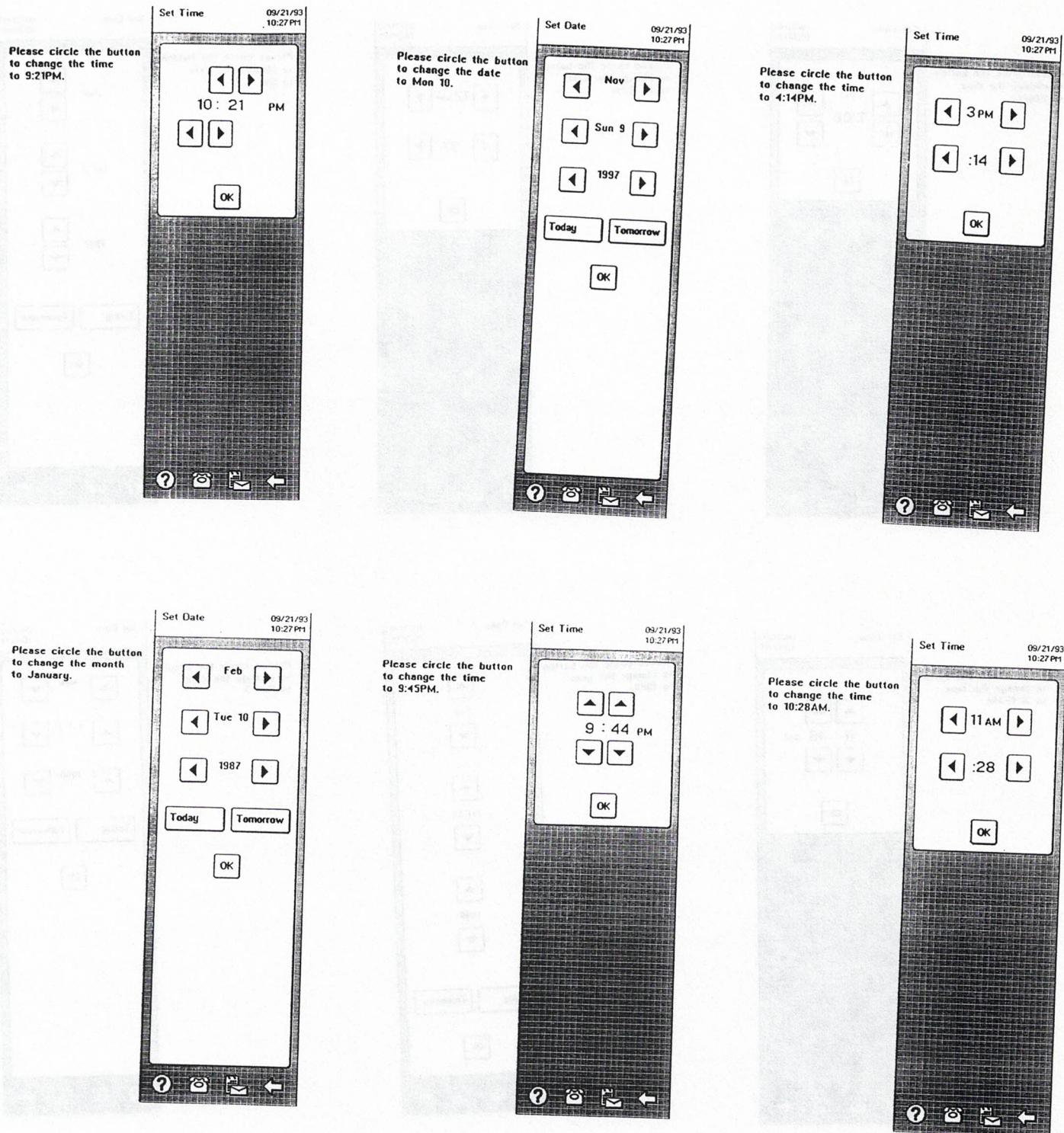
Please circle the button to change the month to August.



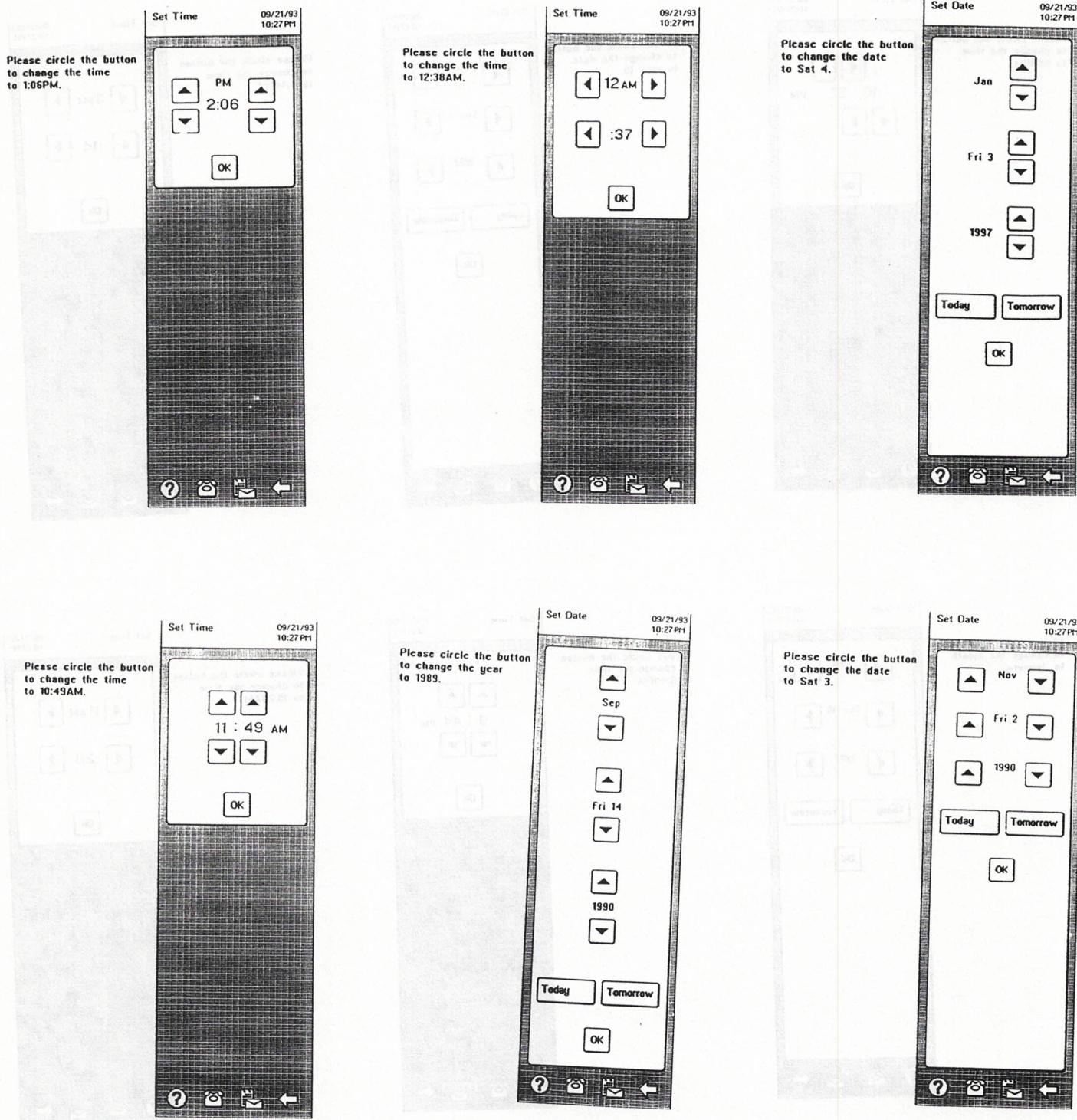
Please circle the button to change the year to 1997.



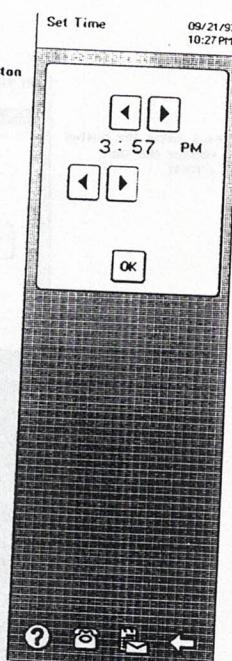
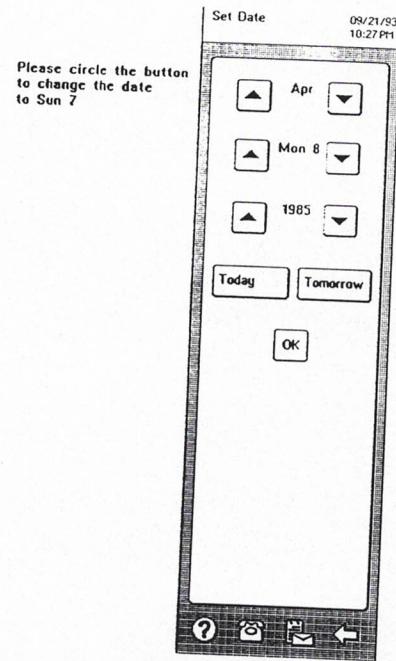
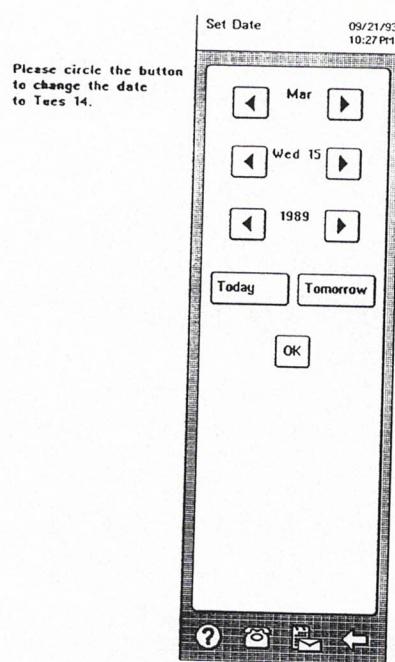
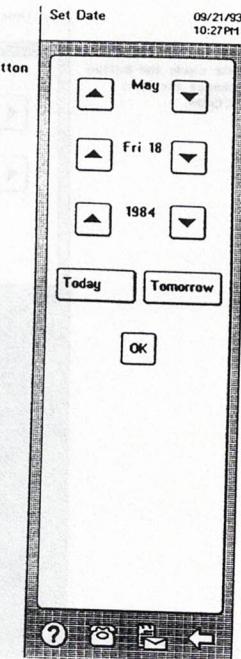
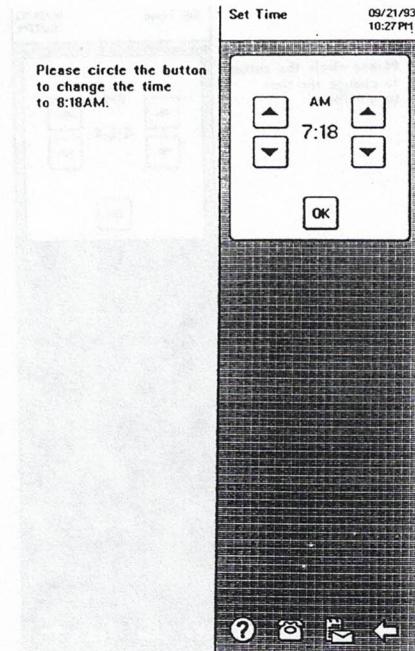
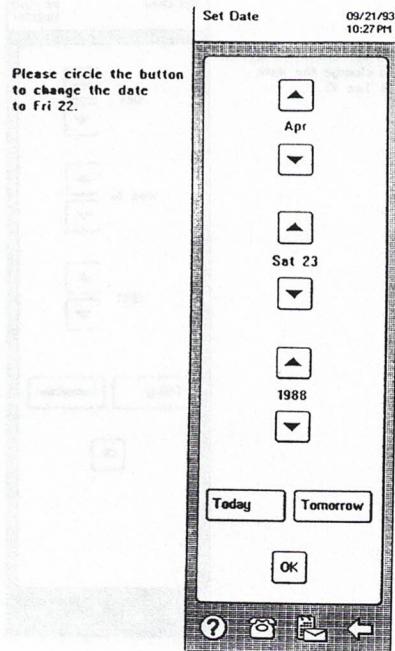
## Unclassified



Unclassified



# Unclassified



## Unclassified

