Human Factors Design Considerations of Alarm Clocks

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ABSTRACT

Advances in technology have allowed computers and peripherals to become more affordable and useable. Technology is also trickling down and being integrated into other consumer products such as those found in the home, such as alarm clocks. Two studies examined the desirability of various features that have or could be incorporated into alarm clocks. In Study 1, 378 people evaluated the importance of various features that have or could be incorporated into alarm clocks. They were also asked to report other features not listed. Study 2 was similar except a larger list of potential features was included. Both studies indicated that there are several features considered more important (e.g., digital face, independent buttons to set hours and minutes, low price) than others (e.g., traditional analog clock face, cassette player). Also, feature importance differed depending on gender and undergraduate/non-student groups. Factor analyses revealed that ergonomic aspects were being considered with respect to feature desirability. Implications for human factors/ergonomics issues are discussed including specific suggestions for alarm clock designs and other electronic consumer products.

INTRODUCTION

Technological advancements have made computers and other products more affordable and user friendly. Technology is now being incorporated into more products used by consumers in the home. In the last several decades, the basic alarm clock has undergone considerable change. It no longer just gives the time and awakens us in the morning. Relatively inexpensive alarm clocks now have new features with capabilities derived from advances in affordable technology. As technology becomes increasingly part of our lives, it can be anticipated that additional features may be incorporated into alarm clocks in the future. Conceivably alarm clock could also display such information as personalized stock quotes and voice recognition capabilities. Although technology has allowed manufacturers to incorporate numerous new features to basic alarm clocks, there may also be some negative effects – the technology may 'overwhelm' users, particularly if the features are not easy to use or are not intuitive. Thus, human factors considerations should be addressed with respect to alarm clocks.

Since the advent of the digital timepieces, there have been very few published studies involving design considerations of alarm clocks (e.g., Voute, Kanis, and Marinissen, 1993). Previous research (Voute et al., 1993) has suggested that there are several fundamental design features considered most important in alarm

clocks. These include their physical stability such that they will not easily tip over, buttons at prominent positions, and ability to set the alarm and time in both clockwise and counter-clockwise directions. However, no published research has addressed people's preferences for many kinds of newer clock features now available or potentially available in the marketplace. Thus, an interesting question was asked: What are the characteristics of alarm clocks that are most critical and desirable to consumers?

Two studies are described in this article. Study 1 investigated the perceived importance of various features for alarm clocks that are both currently available or may be available in the future. Additionally, open-end questions asked participants to suggest features not listed and a dollar amount they were willing to pay for an alarm clock with these features. Study 2 was similar except that a larger list of features was included. The additional items comprised features suggested both by the experimenters and the participants in Study 1.

Study 1

Method

Participants. A survey was distributed to 378 individuals from various locales in North Carolina. Mean age was 26 (*SD*=11) with 230 males and 148 females responding. The mean age for the students was 21 years (*SD*=3.9, N=251) and for the non-students was 34 years (*SD*=14.14, N=129). The survey data was

collected by undergraduate students taking a psychology ergonomics class in association with the Cognitive Ergonomics Laboratory at North Carolina State University.

Materials and Procedure. The items concerning alarm clocks were a section of a larger survey that contained items on various topics such as car safety issues, cell phone use, road rage, etc. In the alarm clock section, participants were asked to rate the importance of 15 features for an alarm clock on a 9-point Likert-type scale ranging from 0 to 8 with the even points having the following word anchors: 0 (not at all important), 2 (somewhat important), 4 (important), 6 (very important) and 8 (extremely important). The features rated in Study 1 are listed in the left column of Table 1. After the list of features, there were three open-ended questions that asked: (a) "What is the maximum price that you would pay for an alarm clock that has the features you consider important; (b) What other features not listed above would you like to have in an alarm clock; and (c) Based on your experience, list all of the aspects/features of alarm clocks that you do not like."

Results

Mean importance ratings and standard deviations (*SD*) for each of the 15 items were tabulated and are shown in order from highest to lowest in Table 1. Repeated-measures analysis of variance (ANOVA) was conducted on these data. Comparisons among the means using Fisher's Least Significant Difference of .34 at $p=.05$ revealed that most of the comparisons among features were significant (i.e., having a mean difference greater than .34).

As can be seen in the table, the five most desirable features were digital numerals, followed by buzzer/radio alarm option, independent digits (separate buttons for hour and minutes), price, and large snooze button. The

five lowest rated features were rotary clock face, followed by cassette player, CD player, digital tuner, and adjustable illumination. The mean maximum price participants were willing to pay was $32.36 ($SD=37.01$); the median was $25.00.

Demographic Differences

Comparisons were made with respect to the demographic categories of gender and undergraduate student vs. non-student status. Only significant comparisons are mentioned ($p<.05$). Non-students ($M=5.08$) reported a greater preference for an AM/FM radio than students ($M=4.35$). Students ($M=6.67$) preferred a digital face more than non-students ($M=5.86$). Non-students ($M=3.93$) rated adjustable illumination of greater importance than students ($M=3.07$). Also, non-students ($M=$34.18$) reported being willing to pay a much higher price than students ($M=$21.23$).

Females ($M=3.90$) reported that size and shape to be of greater importance than males ($M=3.17$). Males ($M=$32.71$) reported being willing to pay somewhat (but significantly) more for a clock than females ($M=$31.27$).

Factor Analysis

A principal components factor analysis was conducted using participant ratings of the 15 clock features. The resulting structure suggested an involvement of four factors. One factor had high factor weights for adjustable illumination, easy-to-see buttons and controls, and buttons of various shapes. Together, these features appear to relate to the ergonomic aspects of seeing and using an alarm clock. A second factor had high factor weights for CD player and cassette player, which involve additional, recorded sound media.

Table 1

Mean importance ratings and standard deviation (SD) for the 15 alarm clock features in Study 1

Features	Mean	(SD)		Mean	(SD)
Digital face (digital numerals)	6.39	1.90	with identifying them in the dark)	4.42	2.41
Buzzer and/or Radio alarm option	5.83	2.48	An alarm that increases in sound intensity if		
Independent digits (separate buttons for			not deactivated	3.82	2.69
the hour and the minutes).	5.42	2.04	Shape/Size	3.43	2.58
Price	5.29	2.26	Adjustable Illumination	3.37	2.50
Large snooze button	4.95	2.62	Digital tuner	3.21	2.45
AM/FM radio	4.61	2.69	CD player	1.91	2.24
Buttons and controls that are easy to see			Cassette Player	1.26	1.76
(in the dark as well as when it is light	4.59	2.40	Clock face (rotary face with hour and		
Buttons of various shapes and sizes (to help			minute hand)	1.22	1.89

A third factor had high factor weights for AM/FM radio and buzzer/radio option which concerned the most basic sound media for the alarm function. The last factor had high factor weights for large snooze button and an alarm with increasing sound intensity, both of which are concerned with waking up.

Discussion

In the list provided, participants rated certain features of alarm clocks more important than others. These results have applicability for design. In its simplest implementation, the higher rated features should probably be included in alarm clocks beyond the essential time piece mechanism.

While some features were rated lower in importance than others, the lower rated features may still hold some desirability to some groups of consumers. Indeed, analyses that included participant demographic categories demonstrated some preference differences. For example, non-students (who tended to be older than the undergraduate students) gave higher importance ratings to AM/FM radio and adjustable illumination features than the students did. Also, non-students (and males) were more willing to pay a higher price for an alarm clock than the undergraduate students (and females). Apparently, females were more interested in the aesthetics, as reflected in the high ratings of size and shape than males. Thus, these findings would suggest that there are different market niches that could be addressed by manufacturers by selecting certain subsets of features in the alarm clocks that they market.

In the principal components factor analysis, four factors were revealed and two of these concerned aspects of physical and perceptual human factors/ergonomics (HF/E) in the operation in the dark and in waking up (involving touch, vision, and audition). These factors suggest that people consider the ergonomic aspects when choosing an alarm clock. The implication is that manufacturers should consider human factors/ergonomic aspects in the product designs of alarm clocks.

Study 2

In Study 1, only 15 categories of features and demographic categories were investigated. Alarm clocks available today and in the future may incorporate a set of features from a larger pool of potential features and characteristics. Study 2 evaluates a larger set of features that could be potentially incorporated in alarm clocks.

Method

Participants. A survey was distributed to 306 individuals from various locales in North Carolina. Mean age was 25 (SD=10) with 170 males and 136 females responding. The mean age for the students was 21 years (SD=2.5, N=222) and for the non-students was 37 years (SD=12.8, N=84).

Materials and Procedure. As in Study 1, Study 2's items concerning alarm clocks were a subsection of a larger survey that contained items on various topics. Participants were asked to rate the level of importance of the 39 features listed on the same 9-point rating scale described in Study 1. The sets of items were based on those rated in Study 1, and features suggested by the authors and the participants in Study 1. Features used in Study 2 are listed in the left column of Table 2.

Results

Mean ratings of importance (and SD) for each of the 39 items was tabulated and are shown ordered from highest to lowest in Table 2. Repeated-measures ANOVA was conducted on the participants' ratings of the listed 39 features, Fisher's Least Significant Difference at p=.05 is .32. As can be seen in the table, the five most desirable features were ease of use, easy way to verify alarm is set, battery backup, low price, and large controls. The five lowest rated features were cube shape, self recorded voice alarm, combination digital and rotary clock face, rectangle shape, and rotary clock face. The maximum price participants were willing to pay for an alarm clock was a mean of $33.52 ($SD$=24.85); the median was $25.00.

Gender Differences
Comparisons were made with respect to price and demographic categories. Males (M=5.67) reported that low price was of higher importance than females (M=5.01), p=.007. Females reported that ease of use (M=6.48), glow-in-the-dark controls (M=4.20) and digital display (M=4.85) were of higher importance than males (Ms=5.75, 3.58, and 4.29, respectively, ps<.05). Females (M=$36.82) reported being willing to pay a higher price for an alarm clock than males (M= $30.87), p<.05.

Table 2

Mean importance ratings and standard deviation (SD) for the 39 alarm clock features in Study 2

Features	Mean	(SD)	Features	Mean	(SD)
Ease of Use (easy to set time and alarm)	6.08	.11	Automatic dimmer display that decreases in brightness in dark, & brightens in light	2.58	.13
Easy way to verify alarm is set properly	5.96	.11	Radio preset buttons (ability to program several AM/FM stations)	2.54	.13
Battery back-up (ability to keep time when power is lost)	5.71	.14	Date display (ability to display month, day, year)	2.49	.12
Low price	5.38	.12	Exterior color (for example, white, black, beige, transparent)	2.45	.13
Large/easy to find controls (e.g., snooze button)	5.30	.12	Ability to fold into smaller unit for travel	2.37	.12
Individual hour- and minute- settings (or resetting) buttons	5.17	.12	Weather-band radio (ability to listen to weather reports)	2.31	.13
Stereo AM/FM	4.66	.15	Soothing sound (plays continuous sound to fall asleep & covers up distracting sounds)	2.22	.13
Snooze timers (ability to set how long the radio or other sound alarm to stays on)	4.65	.15	Analog dial tuner (traditional scroll wheel knob)	1.85	.11
Large display	4.60	.13	White noise generator (produce 'hiss sound' to help mask annoying sounds)	1.74	.12
Having only a digital display of the time	4.52	.13	Large size	1.70	.10
Multiple alarm settings (wake up to either buzzer, AM/FM, cassette, or CD player)	4.43	.14	Calendar display (ability to display calendar of month)	1.66	.10
Forward/reverse fast time settings	4.23	.14	Cassette player	1.65	.11
Automatic time set or reset (self-setting time)	4.01	.14	Changeable display color (ability to change the color to green or to red, etc.)	1.45	.11
Glow –in-the-dark controls	3.85	.14	Having only a clock-face display of the time	1.43	.11
Individualized-shaped controls (that are easy to differentiate from other controls by touch)	3.75	.14	Rectangle shape	1.42	.11
Digital button tuner	3.54	.14	Having both digital and clock-face display	1.35	.11
Dual alarm settings (2 alarms for 2 users)	3.31	.15	Self recorded voice alarm (wake up to voice recordings)	1.33	.11
CD player	3.00	.14	Cube shape	1.11	.09
Small size	2.95	.13			
Multi-bright settings (ability to set more than one brightness level of display)	2.94	.14			
An alarm that gradually increases in loudness	2.78	.14			

Undergraduate Students vs. Non-student Differences

Undergraduate students (*M*=3.64) reported that glow-in-the-dark controls to be of lower importance compared to non-students (*M*=4.44), *p*<.05. Undergraduate students (*M*=1.80) reported that large-sized alarm clocks to be of higher importance than non-students (*M*=1.32), *p*<.05. Students (*M*=3.83) reported that automatic time setting is of lower importance than non-students (*M*=4.48), *p*<.05. Students (*M*=5.57) reported that low price to be of higher importance than non-students (*M*=4.88), *p*<.01).

Factor Analysis

A principal components factor analysis was conducted using participant ratings of the 39 alarm-clock features. The results suggested an involvement of six factors. One factor had high factor weights for changeable display, automatic dimmer, date display, radio preset buttons, weather-band radio, and soothing sound generator. Together, these features appear to relate to ergonomic aspects of seeing/hearing and using

an alarm clock. Also as a group (with the exception of radio-preset buttons), these are relatively advanced features that few alarm clock designs presently incorporate. A second factor had high factor weights for large/easy to find controls, individual hour- and minute-settings, easy to set time and alarm, and an easy way to verify that the alarm is set properly. All of these features involve ergonomic aspects of operation. A third factor had high factor weights for ability to fold into a smaller unit for travel and small size, both of which concern the portability of the alarm clock. The fourth factor had high factor weights for cube shape and rectangle shape, both of which concern the clock's geometry. The fifth factor had high factor weights for stereo AM/FM and CD player, both of which concern recorded sound media. The last factor had high factor weights for dual alarm settings and forward/reverse fast time settings, which are features that concern adjustments of the time and alarm.

Discussion

Like Study 1, participants in Study 2 rated various potential features of alarm clocks. Study 2, however, incorporates a larger set of features than Study 1. The results show that some features of alarm clocks are considered more important than others. There were also several differences noted for gender and undergraduate student/non-student differences categories. Again, these findings would suggest that there are different market niches that could be addressed by manufacturers. Moreover, the principal component factor analyses revealed six factors where two dealt with the perceptual and performance human factor/ergonomic aspects of the alarm clock.

General Discussion

This research examined features in alarm clocks that are potentially important to consumers. Study 1 examined 15 features and Study 2 examined 39 features. While there was a relatively strong preference for a low price in both studies, other features were evident as being highly desirable. These included large and easy to find controls, individual hour/minute settings, AM/FM radio, and digital display. It would make sense that manufacturers consider incorporating these and other highly rated features in the products they produce. The results also showed that there were features that were commonly given low ratings of importance among participants such as cassette player, having only a clock face, and a cube shape. Manufacturers should consider dropping these features since consumers do not consider them important. Alarm clocks with these low-rated features may not purchased because they add unnecessarily to the cost. Thus, it would behoove manufacturers to incorporate the most highly rated features in alarm clocks relative to less highly rated features.

The demographic analyses hinted at differing opinions among groups of consumers. These results suggest that there might be distinct market niches for particular clusters of features. That is, certain types of alarm clocks may be purchased by different groups of consumers. A manufacturer that wishes to secure a larger market share should consider what features might best go together and then market the clocks with those feature clusters to capture different groups of consumers.

The principal component factor analyses yielded four factors for the 15 features in Study 1 and six factors for the 39 features in Study 2. Three of the factors in both studies yielded similar factor dimensions. These factors were the ergonomic aspects of seeing/hearing and using an alarm clock, the recorded sound media, and the alarm function.

Perhaps the most important findings of the study is that people consider human factors/ergonomics aspects to be important as features of alarm clocks. Both studies showed that features that facilitate human use and satisfaction were rated highly. Evidence of human factors/ergonomics considerations was also found in the factor analyses. These results indicate that manufacturers should consider the human interface with respect to the products that they produce. The human factors/ ergonomics aspects may be as important or more important than the actual feature functions included in the product.

Of the features present in both studies, most showed relatively consistent ratings. There were, however, a few inconsistencies in the results between the two studies. CD player was rated higher in Study 1 than Study 2, and the feature multi-bright settings of display, was lower in Study 1 than Study 2.

Future investigations could examine features not tested in the present research. For example, there are options in most current alarm clocks to choose the sound media (radio or buzzer) to wake up to, but are these sounds the most desirable and effective? By having participants rate different kinds of alarm sounds, manufacturers could determine which kinds of sounds to incorporate in their alarm clocks instead of a generic alarm. Also, there is the potential problem that alarm clocks can awaken not just the intended user but also others nearby. Would it be beneficial to include alarms that have a more directional projection (e.g., using high frequency sound aimed directly to one portion of the bed)? These and other issues could be investigated in future research.

As a person's level of sophistication in technology increases, production of 'smarter' products is inevitable. Therefore, consideration of basic human factors/ergonomics and the need to assess usability is necessary for alarm clocks, as well as other kinds of products used by consumers in their homes. This will be increasingly true in the future as more consumer products incorporate technologically advanced features (Woodson, Tillman, and Tillman, 1992).

REFERENCES

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