# COMPARING HUMAN FACTORS IN THE DESIGN OF COMMON OBJECTS IN GUATEMALA VERSUS THE UNITED STATES

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requirements for the Bachelor of Science Degree in Psychology
by

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# CHAPTER 1
## Introduction

"When you have trouble with things... it's not your fault. Don't blame yourself; blame the designer" (Norman, 2002a, p. x). This mantra from one of the most widely cited writers in the field epitomizes the concept of human factors. Similar to the way good customer service involves the representative taking responsibility for the customer's problem, good human factors requires the designer of an object, whether it be a pencil or an airplane cockpit, to take responsibility for minimizing any difficulties the user may have. A focus on human factors is becoming increasingly important. For example, King (1999) worked with disabled people using assistive devices. He found that bad design caused people to get frustrated with trying to use the devices and give up the treatment. Bad human factors has also been cited as one of the causes for the 1979 accident at the Three Mile Island nuclear plant (Allman, 1988).

Studying human factors from a cross-cultural perspective can provide some valuable insight. One important component of human factors is anthropometry, which involves using data on human measurements of body size and function for the design of objects. The designer incorporates data taken from the target population to design the product to fit the users. Considering anthropometry from another culture involves different body measurements, different physical capacities, and sometimes different work practices. Daftuar (1998), for example, notes that Indians tend to prefer to work from a squatting posture, which Westerners rarely ever do. Often, third-world countries end up recycling old products that were designed for a target population in Asia, the U.S., or Europe. Electrical outlets in Guatemala are specifically designed to allow both American and European electrical devices to function. Daftuar (1998) also pointed out that at the

time of his study, India was using a system of old British road signs when Britain had switched to an international system. Although most U.S. objects are understandably designed for U.S. populations and most British objects are designed for British populations, it is also important to take into consideration the populations of less-developed countries that will use the products as hand-me-downs in the future. Another reason to look at another country's approach to human factors is that it can provide the designer with fresh ideas. Even in a creative field such as human factors, the design can gravitate toward tried and true standards to which the people have become accustomed. There is some resistance when a new solution is proposed. Imagine the confusion that would occur if someone introduced a screw that had to be tightened by turning counter-clockwise and loosened by turning clockwise, for example. When tired conventions stand in the way of developing a more effective design, looking at the designs of another country can provide fresh ideas.

For this study, twelve simple Guatemalan objects were selected. A deliberate attempt was made to steer away from complex objects or objects of high technology because, first of all, high-tech objects would be difficult to find in Guatemala due to the country's poverty, and second, most of the high-tech objects that exist in Guatemala are recycled technology of other countries, so any difference between those objects and the current objects in the U.S. would reflect more of a difference in the times than a difference in approach to design. Photos and detailed notes were taken on the twelve Guatemalan objects, twelve corresponding American objects were also found, and similar notes and photos were taken of them. Using the photos and notes from the twelve pairs of objects, experts objectively rated each U.S. object and each Guatemalan object

on select components of human factors. Later, two groups of subjects were selected: a Latin-American group and an "other" group. Each group was asked for each object whether they would have found the U.S. version or the Guatemalan version easier to use.

The goals of the study were to note differences between U.S. and Guatemalan design and, by comparing the preference data from the two groups of subjects with the objective expert rankings of human factors, to see how people's preferences correlated with objective assessments. In other words, do people objectively prefer what works best or do they prefer another design for some other reason, perhaps because it is more familiar to them?

# CHAPTER 2
# Literature Review

The goals of this literature review are: 1) to define the concept of human factors and establish criteria for assessing the design of objects with respect to human factors, and 2) to provide examples of issues that affect international differences in human factors design.

## What is Human Factors?

Human factors is a frame of reference that focuses the design of objects on how the user will use the product. Put another way, "Human factors focuses on how human beings interact with the devices we use in play, education, work, and daily living" (King, 1999, p. 39). Unfortunately, human factors is often overlooked. "Far too many items in the world are designed, constructed, and forced upon us with no understanding-or even care-for how we will use them" (Norman, 2002a, p. vii). When someone is struggling to figure out how to set the time on a VCR, which way to open a door, or which knob to use to control a stove burner, he usually blames himself for any mistakes. He says to himself, "I must be an idiot because I turned on the wrong stove burner." However, advocates of human factors focus their attention and, if there is a problem, also focus the blame on the design rather than the user. In the introduction to his liberating book, The Design of Everyday Things, Donald Norman writes, "When you have trouble with things... it's not your fault. Don't blame yourself; blame the designer" (Norman, 2002a, p. xl. The designer who is conscious of human factors would make the user's job easier by allowing him to set the time on the VCR without having to navigate through dozens of abstract

menus, by putting visual cues in the door (a handle to suggest pulling or a panel to lend itself to pushing) and by placing the knobs for the stove in an arrangement that mirrors the layout of the actual burners.

With our increasing dependence on technology, human factors considerations are becoming more and more important. Not only does disregard for human factors cause unnecessary inconvenience and frustration; it can also cost lives.

> For most people, problems with user-hostile products are just minor irritants. But for some hapless users, the confusions of technology have serious consequences. The 1979 accident at Pennsylvania's Three Mile Island nuclear power plant occurred after operators incorrectly interpreted the readings on the dials of their consoles. The Army's hand-held Stinger missile requires a complex 18-step operating procedure -- a daunting task for the ordinary soldier on a battlefield (Allman, 1988, ¶3).

Donald Norman also points out that user-centered design is even more important for high-stress situations, where emotion can play a role in the user's likelihood to make errors.

> Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks. This may seem strange, especially to people who have been trained in the cognitive sciences: affect changes how well we do cognitive tasks? Yup ... Now consider the implications or these findings upon design. A short summary is that good human-centered design practices are most essential for tasks or situations that are stressful: distractions, bottlenecks, and irritations need to be minimized. In pleasant, positive situations, people are much more likely to be tolerant of minor difficulties and irrelevancies (Norman, 2002b, ¶16-17).

Human factors is closely related to several disciplines. "Human factors" is basically synonymous with the term, "ergonomics".

> Human factors engineering, or its equivalent, human engineering, is a term used almost exclusively on the North American continent. Everywhere else, with the possible exception of the U.S.S.R., ergonomics is the term that most closely approximates its American counterpart. Although these two terms, human factors

> engineering and ergonomics, look and sound vastly different, the differences between the disciplines are more apparent than real (Chapanis, 1975, p. I).

Assan and Imbeau also suggest that the two terms are interchangeable in the title of their paper, "Who Belongs to Ergonomics? An examination of the human factors community" (Assan & Imbeau, 2003).

Human factors is considered a branch off of both engineering and psychology. "Human factors is distinctly different from psychology or engineering, although it makes use of contributions from both" (Meister, 1999, p. 13). There are subtle differences between the approaches to human factors from the psychology and the engineering perspectives.

Those who study the field of human factors from a psychology background tend to strive for a positive experience for an individual user and seek design solutions that simplify the thought process that the user must go through in order to use the product. In his book, Assistive Technology: Essential Human Factors, Thomas W. King, a special educator and speech-language pathologist, emphasized the importance of human factors in ensuring that disabled people are not discouraged by bad design to the point of ceasing to use the assistive devices that become a part of their lives.

> Despite our best clinical efforts to get people the assistive technology they need, and to help them learn to use it, the AT user and his or her family may give up or refuse to use it. We tend to regard this as a clinical failure of theirs or ours, often for reasons that we many not understand. But this rejection of tools, devices, and technologies may be more related to inattention to essential human factors in AT device design, selection, and use (King, 1999, p.3).

Those who come from a background in engineering focus more on improving group productivity and economic benefits. They also incorporate the concept of anthropometrics (literally "measurement of man"), which involves taking physical

measurements of people and taking the size of the users into consideration with design. David Meister, who comes from an engineering background, lays out the goal of human factors quite succinctly as increasing productivity, comfort, and safety (Meister. 1999). In his book, Designing for Humans: The Human Factor in Engineering, John Burgess clarifies,

> The orientation of human factors engineering... centers on ways in which machines and products can be most efficiently designed to suit the characteristics of human beings, their shapes and sizes, physiology and psychology, and how they sense, perceive and coordinate muscle control. The treatment of such factors has become an engineering specialization that focuses on how humans can best interact with machines (Burgess, 1986, p. xi).

There are multiple objectives in human factors. As King mentions,

> Human factors is always focused on increasing a user's effectiveness, efficiency, and convenience with a device or tool... Effectiveness is the ability of the device to accomplish the task for which it is intended in conjunction with the user. Efficiency measures accurate and successful uses versus error uses, plus rate of use, Convenience is defined as user ease in application of the device -- how much or little effort and discomfort across several domains (physical, cognitive, linguistic, etc.) is required of the user... Human factors is also particularly focused on maximizing the user's comfort with a device or system -- does it accomplish what they believe was intended of the device or system when they acquired it?... Human factors also focuses on reducing danger to the user and persons around them from the device, as well as the user's possible failure during use, and subsequent rejection of the system for future use (King, 1999, p. 41).

Basically, the functions of objects and how to perform those functions must be intuitive. One of Donald Norman's mantras is that "when instructions have to be pasted on something, it is badly designed" (Norman, 2002a, p. xii). The instructions for operating a device should be apparent in the design. Some of Nonnan's (2002a) concepts can assist in making the procedures obvious. First, objects should provide clear cognitive models which are the user's conceptual understandings of how the unseen components of

the device function. Norman uses the example of a typical home thermostat. Because the control for the thermostat is a sliding lever with temperature markings on it, one naturally assumes that cranking the lever to a higher temperature will make the heater function with more power than it would if the user set the lever to a temperature that is barely above the current temperature. However, this is not the case. A typical thermostat functions as a simple on/off switch, not an analog adjustment of high to low power: the heater turns on when the temperature is below the user-set threshold and turns off when it has reached the desired temperature. Another concept that can lead to intuitiveness is visibility. Often, power switches on a computer, printer, or garbage disposal are hidden away for aesthetic reasons. The concept of visibility, as the name suggests, requires that the functional parts of a device be made visible. Natural Mapping means designing controls in a way that is analogous either to the components that they operate or to the motions that they perform. With the ideal stove, if the burners are arranged in a square, the knobs should also be arranged in a square so that the front left knob controls the front left burner. If a switch controls an electric car window, moving the switch up should roll the window up, and vice versa. Affordances are clues built into an object that tell the user what to do. "Plates are for pushing. Knobs are for turning. Slots are lor inserting things into. Balls are for throwing or bouncing". In order to take advantage of affordances, one should put plates on doors that are to be pushed and pull handles on doors that are to be pulled. Physical constraints are limitations that restrict a handle from being turned the wrong way or prevent a floppy disk from being inserted sideways, backwards, or upside down. Feedback tells the user the status of the device. Feedback is usually visual or auditory, and sometimes tactile. Feedback lets the user know that his

input was received and prevents him from having to press the same button multiple times to make sure that the function was performed. Most buttons that one uses to call an elevator have feedback in the form of a light that turns on after the button has been pressed so that if another person intending to ride the elevator walks up later, he doesn't unnecessarily press the same button again. The buttons for the "press here to cross" pedestrian signals at intersections, however, do not have any feedback, so peoplc will often press them repeatedly in their uncertainty.

*Cultural Issues in Human Factors*

Cross-culturally there are many differences with regards to human factors. Moray points out some examples of cultural differences that have been found in human factors and argues that still marc research needs to be done in the subject.

> Although Chapanis (1975) drew attention to ethnic differences in human factors at the level of the ergonomics of human - machine interaction, the extent of such differences is not sufficiently stressed... Daftuar (1975) shows that the scripts of some languages seem to be inherently less legible than others; and Wyndham (1975) reports problems in the interpretation of graphical material used for warnings in different cultures. Moray (1999) gives some examples where stimulus response stereotypes differ widely even among technologically advanced countries; and Rochlin and yon Meier (1994) and Bourrier (1996,1999) showed that the organization and practice of maintenance outages in nuclear power plants differs widely not only between France and the USA, but also even at different plants within the two countries. These latter studies have important implications for the question of HRO design. How is one to interpret the general statements made about human-centred design with such confidence when so little cross-cultural research has been done (Moray, 2000)?

The standard for North American light switches, which so many Americans have come to expect, is actually not a worldwide standard. In fact, it is cven contrary to the standard used in most of the world.

> It is well known that in North America a switch is 'on' when it is in the 'up' position, whereas in most of the world it is 'on' in the 'down' position.

> In an emergency, when rapidly switching power on or off in a combination of equipment from different sources, one can expect mistakes to be made. (One may add the fact that in Japan, switches move horizontally, so that 'right' is 'on' and 'left' is 'off', which while not leading to confusion with a North American or European stereotype, means that the state of a Japanese switch is completely ambiguous to a Western person confronted by it for the first time) (Moray, 2000).

Despite the fact that Americans have different body sizes, different ways of thinking, different work practices, and different established standards, American products intended for American users are often forced on the rest of the world, and the users have to adjust accordingly. Wyndham states, "Although the buttock-leg length of the Bantu is 6cm shorter than that of the European, the seat-pedal distances in most heavy-duty trucks in South Africa are built on European dimensions" (Wyndham, 1975, p. 119). As an example of different work practices, Daftuar reports, "As mentioned earlier, Indians prefer to work in a squatting posture… The data in Table 2 arc difficult to relate to anthropometric data in Western human engineering guides, because the working posture illustrated in Figure 10 does not occur in the West" (Daftuar, 1975, p. 98). Fang and Rau compared how Americans and Chinese used the Yahoo! Portal website, which was designed for an American audience and translated into Chinese for the Chinese users. The Americans used the site in English as it originally was. They reported,

> The results indicated that cultural differences have significant impact on most questions regarding information organization and general satisfaction. The Chinese participants generally rated the site lower… Yahoo! Portal site was initially developed for the US audience. Because the directories were created by US developers, it is clear that they would beller fit the cognitive style and thought processes of the US people than those of the Chinese… The above results suggested that eultural differences have significant impaet on task performance for some tasks. The Chinese participants generally used more steps and more trials to perform the tasks than did the US participants… Because of the cultural differences in the cognitive style and thought processes between the Chinese and the US people and the fact that Yahoo! Portal site was

> designed for US audience, the Chinese participants would have had significant disadvantages in using Yahoo! to find information (Fang & Rau, 2003).

Even the goals and the importance of human factors differ widely across cultures. Daftuar illustrates that the concept of efficiency (one of the goals of human factors) in India is very different from that in the U.S.

> The extended family often forces an enterprising man to spend whatever he has saved on supporting others rather than on investment in businces expansion. In traditional India the efficiency of a man is judged not by economic achievements alone but also by the effectiveness with which he maintains his extended family. As a result, job satisfaction in India is generally more directly related to a worker's satisfaction with his home environment than it is in the case of his counterparts in the West (Daftuar, 1975, p. 96).

In many less·developed countries, less concern is given to human factors. The technology used in these cases is sometimes the old technology from other countries that those other countries have since replaced.

> Indian road signs are, in general, old British road signs. Although the United Kingdom in the meantime switched to international road signs many years ago, Indian road signs have remained unchanged. Indeed, Indian designers have paid no attention to the problem… Since our sample consistcd of students who did not drive, the percentages of correct interpretations of our road signs were naturally smaller than those obtained in comparable studies in the West. In fact, correct interpretations of the Indian road signs varied from zero to 75.5 percent with a mean of 39.9 percent. Sign 24 was not understood by any subject, and no single traffic sign was correctly understood by all the subjects. Some road signs were even found to convey meanings opposite to those actually intended (Daftuar, 1975, p. 97.98).

However, since less industrially developed countries rely more heavily on manual labor, the need for human factors there is great, arguably greater than in those countries that are more developed. Special attention mllst be given to the specific attributes of the

population in question rather than designing for the people of the U.S. and implementing the design in another continent.

> Most industries in developing countries are labor-intensive. Because, in general, they lack the capital for highly automated machinery, factory operatives are called upon to do more physical work than in the industrially more advanced countries. It is therefore of great importance for industrialists in developing countries to have information about the capacities for physical effort that characterize indigenous populations. With such information, work standards can be set in accordance with the physical work capacities of the workmen (Wyndham, 1975, p. 115).

> The above results need to be borne in mind in considering the employment of the rural Bantu when he first enters the urban area. Because he is unskilled, he has to take a job as a manual laborer. Yet, as this study reveals, only a small percentage of rural males are capable of heavy manual work. If these men are not to be overtaxed, two steps are necessary. First, the work standard expected from these men should be modified. This applies particularly to the wholly unrealistic work-study standards that are based on Europeans who have higher maximum oxygen intakes. Second, ergonomic principles should be used where possible to lessen the work loads on the men (Wyndham, 1975, p. 121).

Lim also highlights the need for human ractors for manual laborers, which are mainly minority populations with specific anthropometric considerations, in the U.S.

> For some 100,000 sewing machine operators in the United States, common chores like lifting groceries, bathing, or performing their jobs is excruciating... Some of the findings in the report were alarming: 25 percent of those surveyed have trouble doing everyday tasks, 31 percent have trouble bathing and dressing themselves, 54 percent have trouble doing housework and 56 percent have sleeping problems. Moreover, garment workers work six days a week at an average of 48 hours per week. Most of these workers earn $6.32 an hour -- just seven cents over minimum wage (Lim, 2002, ¶5).

In conclusion, we have seen that although some cross-cultural research has been done on the subject of human faclors, there remains much to be done. Standards that Americans accept as commonplace sometimes differ widely in the rest of the world. Populations in other countries and continents have different

physical and cognitive characteristics and different work practices. Approaches to human factors and even the goals of the concept also differ from one country to the next. Despite these international differences, select industrialized nations tend to force their products on other populations, which can be problematic.

# CHAPTER 3
# Methodology

## Object Selection

Initially, twelve everyday Guatemalan objects such as doorknobs, window curtains, and elevator control panels were selected. The objects were chosen for being simple to analyze and distinct from their counterparts in the U.S. Typical corresponding U.S. versions of the Guatemalan objects were found. Both sets of objects were photographed and tested, and notes were taken on their ease of use. Some objects fit the rating criteria better than others, so the final number of objects was reduced to nine pairs of objects that worked well with the criteria.

## Materials

The photos and some written notes were put into a list of objects. This list was first used to develop the expert ratings and later handed out to subjects to assess their preferences. Two versions of the list were developed in order to reduce biases. Version A placed all the Guatemalan objects first, and version B placed all the U.S. objects first. See the appendix for a copy of the list of objects.

## Criteria

Five criteria were used in developing the expert ratings. They were: natural mapping, affordances, constraints, feedback, and overall design. The first four were taken from *The Design of Everyday Things* (Norman, 2002a). Below is what was looked for in each criterion.

- Natural mapping - if there are controls, are they arranged in a relationship that spatially represents the components they control? Does moving a control in one direction result in moving a component in the same direction?
- Affordances - if there are buttons to be pushed or levers to be pulled, is it obvious by the design what the user should do?
- Constraints - Are there constraints that prevent the user from inserting something the wrong way or moving a control that has no function?
- Feedback - Does the device tell the user its state? Does it confirm the user's input when he/she presses a button?
- Overall design - General sense of how intuitive and how functional the object is.

The expert ratings took the form of a 5-point Likert-type scale, with 1 being the lowest rating and 5 being the highest.

Expert Ratings

Two Cal Poly students who have completed the course, IME 320 - Human Factors Engineering, collaborated to come up with expert ratings for each of the objects. They first established and explained the criteria. Then, they used version A of the questionnaire (Guatemalan objects first, followed by U.S. objects) to assess each object based on the criteria.

## Participants and Data Collection

Subjects were chosen from several convenient locations and split into two groups: Latin-American and "other". Each subject was given the Informed Consent Form, an answer sheet, and one of two versions of the list of objects. As previously stated, the list of objects either arranged the objects Guatemalan objects first, followed by U.S. objects (version A) or U.S. objects first, followed by Guatemalan objects (version B). A coin was flipped for each subject to determine which version he or she received. Participants were first asked if they would assist in a senior project by filling out a quick survey. They were then instructed to view the nine pairs of objects and rate which pair they thought was better designed. In total, ten Latin-American subjects and twelve "other" subjects responded. Below is the breakdown of the number of subjects from each group who responded according to the times and places of data collection.

Table I

*Data Collection Summary*

| **Date / Time** | **Place** | **Latin-American respondents** | **"other" respondents** |
|---|---|---|---|
| Thu, 3/10/05, 1:30 PM | Cal Poly University Union | 1 | 2 |
| Fri, 3/11/05, 3:30 PM | Bus en route to Fresno | 2 | 3 |
| Wed, 3/16/05, 4:07 PM | Cal Poly computer lab | 1 | 1 |
| Wed, 3/16/05, 8:00 PM | Student apartment | 0 | 1 |
| Wed, 3/16/05, 9:00 PM | Outside shops | 3 | 4 |
| Thu, 3/17/05, 9:00 AM | Outside supermarket | 2 | 1 |
| Thu, 3/17/05, 10:01 AM | Greyhound station | 1 | 0 |
| | **Total:** | **10** | **12** |

# CHAPTER 4
## Findings

There are two categories of findings: expert ratings and subject responses.

### Expert Ratings

Notes from the expert ratings are below. "+" indicates a positive aspect. "-" indicates a negative aspect. "+/-" indicates a mixed aspect. Scores range from 1 (lowest) to 5 (highest).

1. GUA Address Book
   - Natural Mapping: 2
     - \- Date layout has no order: month on top, date on side, day on bottom
     - \- Week appears to start on Monday
     - \- User has to push a button down to lift the lid up
     - \+ Alphabet is natural
   - Affordances: 5
     - \+ Sliders all afford sliding
     - \+ Button affords pushing
   - Constraints: 3
     - \- No constraint to prevent two dates from being shown
     - \+ Can't change letter when book is open
   - Feedback: 5
     - \+ Numbers, days, and letters light up
   - Overall: 3

US Address Book
   - Natural Mapping: 5
     - \+ Go down to go down in the alphabet
   - Affordances: 4
     - \+ Push-down bar is natural
     - \- Letter pointer looks as if it should be pulled
   - Constraints: 3
     - \+ Only one set of letters to slide
     - \- Can slide indicator when open
   - Feedback: 4
     - \+ Slider clicks in position
     - \- Lights behind letters might be more accurate, better for the vision-impaired
   - Overall: 4

2. GUA ATM

Natural Mapping: 2.5

- "Enter" should be bigger and at bottom or top, not middle.
- Slots not organized
- Cash slot should be higher
+ Keys are good

Affordances: 4

+ Keys afford pressing
+ Slots afford insertion
+ Cash slot affords reaching
- No braille

Constraints: 5

+ Cash slot closes when not in use, too small to stick fingers inside
+ Stops card if inserted incorrectly
- Nothing to prevent user from touching the screen

Feedback: 4

- No auditory beep (for vision-impaired)

Overall: 4

US ATM

Natural Mapping: 4

- Keypad doesn't match computer keypad
+ All slots are on right

Affordances: 5

+ Braille

Constraints: 5

+ Slots close when not in use
+ Stops card if inserted incorrectly

Feedback: 5

+ Audible beeps
+ Green light tells you what to do next

Overall: 5

3. GUA Calendar

Natural Mapping: 3

+ Normal day layout
- Prev month and next month are both under current month
- Moon indicators are not with their dates

Affordances: 3

- Not clear how to tear off month

Constraints: N/A

Feedback: N/A

Overall: 3

US Calendar

Natural Mapping: 5
+ Days are good
+ Gives you view of all the months at bottom
Affordances: 5
+ Spiral binding
Constraints: N/A
Feedback: N/A
Overall: 4
- Elapsed day / remaining day is not clear

4. GUA Curtain
Natural Mapping: 2
- If string moves around, it could be hard to tell which side to pull
- Pull string seems backwards
Affordances: 2
- Loop is not a good affordance
Constraints: 4
+ String stops when it's supposed to
- Nothing stops user from yanking curtain
Feedback: 5
+ Obvious visible feedback
Overall: 3

US Blinds
Natural Mapping: 3
- Two controls are on different sides
Affordances: 3
+ Bar affords rotating
+ Thimble affords pulling
- Not clear which way to lock, unlock
Constraints: 5
+ Can't pull the blinds down by hand
Feedback: 5
+ Obvious visible feedback
Overall: 4

5. GUA Door Handle
Natural Mapping: 4
+ Rotations are natural
- Outside key controls both deadbolt and latch
- Could locate keyhole closer to deadbolt (for inside)
Affordances: 4
+ Bar affords pulling to the left
- Have to pull door open with tiny bar
Constraints: 5

+/- Locks automatically
+ Have to pull finger hook to pull door open

Fcedback: 3
+ Audible door click
- Locked/unlocked both look the same

Overall: 3
- Can't go out without locking
- Keyhole operates different things inside and outside

US Door Locks

Natural Mapping: 5
- Rotations are all natural
+ Separate mechanisms for each lock

Affordances: 5
+ Levers should be tumed
+ Knobs afford turning

Constraints: 5
+ Knob is close, first thing you grab

Feedback: 4
+ Clicking sound
+ Look Different locked/unlocked
- Locy/unlock = vertical/horizontal not quite intuitive

Overall: 4

6. GUA Elevator

Natural Mapping: 2
- Buttons are arranged in a rectangle
- Max capacity sign is inbetween buttons
+ Control buttons are separated from floor buttons

Affordances: 5
+ Button indentation

Constraints: 5
+ Buttons can only be pushed

Feedback: 4
+ Button light - thin
+ Braille

Overall: 3

US Elevator

Natural Mapping: 3
- Rectangle floor display
+ Keyholes are out of the way
- Button labels are subtle

Affordances: 4
+ Buttons are flat, can only push
+ Stop button has a pull groove

Constraints: 5
+ All you can do is push buttons
Feedback: 5
+ Whole button lights up
Overall: 4

7. GUA light switch
Natural Mapping: 3
+ Some okay mapping: stairway light is below
- Nothing differentiates two top lights
+/- So/so rectangle symbols
Affordances: 3
+ Flat surface affords pushing
- Groove down the center would be nice
Constraints: 5

Feedback: 3
+/- Subtle visual clue of whether switch is on/off
+ Tactile: user can feel the slant
Overall: 3

US light switch
Natural Mapping 3
+ Left and right switch map to left and right lights
+ Up is on; down is off
- Very subtle distinction between single switch and double switch

Affordances: 4
+ Shape is narrow, affords flipping
Constraints: 5
+ Narrow switch shape won't let user push
Feedback: 4
+ More visually obvious on/off
Overall: 3.5

8. GUA Payphone
Natural Mapping: 5
+ Button layout is good
+ LCD at eye level
+ Function buttons separated from numbers
+ Phone is on left, natural for right handers
Affordances: 5
+ Buttons are clear to push
+ Card slot affords card
Constraints: 3
- Phone on hook doesn't block numbers

- LCD screen is not protected from smashing

Feedback: 5

+ LCD screen shows numbers and instructions
+ Beeps to tell you if you left your card
- No braille

Overall: 5

US Payphone

Natural Mapping: 3

+ Natural coin drop
- Volume is not natural
- Cluttered surface with ads
+ Coin release is where it should be

Affordances: 5

+ Coin slot looks like a coin slot
+ Coin release lever looks like a lever
+ Flat surface in coin return should be pushed

Constraints: 3

+ Phone on hook prevents user from pressing buttons
- Coin slot is always open
- Nothing to prevent people from inserting dangerous objects into coin return

Feedback: 2

- No LCD, nothing visual
+ Good audio feedback with keys, different tone for each key
- Coin drop into lock box sounds same as into coin return
+ Can't see into coin return

Overall: 3

9. GUA Windows

Natural Mapping: 2

+ Good location of turning device right next to windows
- Rotation defies convention, also not mapped naturally to window rotation

Affordances: 5

+ Obvious to twist, not pull or push

Constraints: 5

+ Handle locks when closed

Feedback: 5

+ All visual

Overall: 3

US Windows

Natural Mapping: 4

+ Natural sliding motion

+ Lock motion is natural
- Move lock in opposite direction of pane to lock/unlock

Affordances: 3

- Not obvious to slide

Constraints: 1

- Lock moves whether window is closed or not

Feedback: 2

- Can't tell whether it's locked or unlocked
- Not obvious whether it's fully open or fully closed

Overall: 2

The table below (Table 2) summarizes the expert ratings. Again, 1 is the lowest possible rating, and 5 is the highest.

Table 2

*Expert Ratings*

| **Object** | **Component** | **Guatemalan Rating** | **U.S. Rating** |
|---|---|---|---|
| 1. Address Book | Natural Mapping | 2 | 5 |
| | Affordances | 5 | 4 |
| | Constraints | 3 | 3 |
| | Feedback | 5 | 4 |
| | Overall | 3 | 4 |
| 2. ATM | Natural Mapping | 2.5 | 4 |
| | Affordances | 4 | 5 |
| | Constraints | 5 | 5 |
| | Feedback | 4 | 5 |
| | Overall | 4 | 5 |
| 3. Calendar | Natural Mapping | 3 | 5 |
| | Affordances | 3 | 5 |
| | Constraints | N/A | N/A |
| | Feedback | N/A | N/A |
| | Overall | 3 | 4 |
| 4. Curtain / Blinds | Natural Mapping | 2 | 3 |
| | Affordances | 2 | 3 |
| | Constraints | 4 | 5 |
| | Feedback | 5 | 5 |
| | Overall | 3 | 4 |

| Object | Component | Guatemalan Rating | U.S. Rating |
|---|---|---|---|
| 5. Door Handle | Natural Mapping | 4 | 5 |
| | Affordances | 4 | 5 |
| | Constraints | 5 | 5 |
| | Feedback | 3 | 4 |
| | Overall | 3 | 4 |
| 6. Elevator | Natural Mapping | 2 | 3 |
| | Affordances | 5 | 4 |
| | Constraints | 5 | 5 |
| | Feedback | 4 | 5 |
| | Overall | 3 | 4 |
| 7. Light Switch | Natural Mapping | 3 | 3 |
| | Affordances | 3 | 4 |
| | Constraints | 5 | 5 |
| | Feedback | 3 | 4 |
| | Overall | 3 | 3.5 |
| 8. Payphone | Natural Mapping | 5 | 3 |
| | Affordances | 5 | 5 |
| | Constraints | 3 | 3 |
| | Feedback | 5 | 2 |
| | Overall | 5 | 3 |
| 9. Windows | Natural Mapping | 2 | 4 |
| | Affordances | 5 | 3 |
| | Constraints | 5 | 1 |
| | Feedback | 5 | 2 |
| | Overall | 3 | 2 |

Since Guatemala is a less wealthy country than the United States, one would expect that less attention is given to human factors in Guatemala compared to the U.S. Accordingly, most of the U.S. objects received a higher rating than the Guatemalan objects. One outstanding exception to this tendency was the payphones. The dominating Guatemalan payphone company, Telgua has enough of a capacity to support excellent human factors in the design of their payphones. Even in the most run-down of

locations in Guatemala, the majority of all payphones haveLCD screens, which is a great improvement over payphones in the U.S.

There were also a couple of smaller points that some of the Guatemalan products included but the U.S. counterparts lacked. Both the U.S. and the Guatemalan address books have a sliding control that, if moved while the unit is open, will get off track. Whether intentional or not, only the Guatemalan product has a physical constraint to prevent the user from sliding the control while the unit is open. The slider on the Guatemalan address book is only visible on the top of the address book when it is closed. The U.S. address book has the slider on the side, and it is visible and moveable both when the unit is open and when it is closed.

As another example of good Guatemalan design, the Guatemalan ATM has a keypad that is arranged the same way the standard keypad on a computer keyboard is, whereas the keypad on the U.S. version is flipped vertically. One could argue that, although the U.S. keypad doesn't conform to the standard of the computer keyboard, it does match the standard of telephone keypads. However, having the ATM keys conform to a telephone layout is not as natural as having them conform to a computer keypad because one uses the telephone keypad in a vertical orientation, whereas one uses both the ATM keys and the computer keyboard in a horizontal orientation.

Finally, the Guatemalan light switches provided some information more clearly than did the U.S. light switches. The Guatemalan switches had a black rectangle on the side that turns the light on, and in the case of the double switch that shares control of a hallway light with another switch on the opposite end, the switch had a rectangle on both ends, distinguishing it from the single switch. The U.S. single switches had a tiny "on"

and “off” hidden for aesthetic reasons, and the double switches had no indicators at all. The Guatemalan symbol for "on" is much more visible and therefore an improvement over the U.S. light switch, but it could be made more intuitive by making it a symbol of a light bulb rather than a seemingly arbitrary rectangle.

Subject Responses

Table 3 shows the combined results of the product preferences of both groups.

Table 3

*Combined Subject Responses*

| **Product Name** | **# Prefer U.S.** |
|---|---|
| Address Book | 16 (73%) |
| ATM | 17 (77%) |
| Calendar | 13 (59%) |
| Curtains/Blinds | 13 (59%) |
| Door Handle | 15 (68%) |
| Elevator | 14 (64%) |
| Light Switch | 13 (59%) |
| Payphone | 15 (68%) |
| Windows | 19 (86%) |
| Total | 135 (66%) |

As we see from Table 3, all of the U.S. products received the majority vote. The expert ratings corresponded with most of the subject responses, with the exception of the payphone and the windows.

Below are tables showing the product preferences (Guatemalan or U.S.) of the Latin-American group (Table 4) and the "other" group (Table 5).

Table 4

*Product Preferences of Latin-American Group*

| **Product Name** | **# Prefer Guatemalan** | **# Prefer U.S.** |
|---|---|---|
| Address Book | 3 (30%) | 7 (70%) |
| ATM | 3 (30%) | 7 (70%) |
| Calendar | 5 (50%) | 5 (50%) |
| Curtains / Blinds | 4 (40%) | 6 (60%) |
| Door Handle | 5 (50%) | 5 (50%) |
| Elevator | 4 (40%) | 6 (60%) |
| Light Switch | 5 (50%) | 5 (50%) |
| Payphone | 2 (20%) | 8 (80%) |
| Windows | 2 (20%) | 8 (80%) |
| Total | 33 (37%) | 57 (63%) |

Although none of the Guatemalan objects received majority votes from the Latin-American group, it is interesting to note that the door handle, the light switch, and the calendar were split 50/50.

Table 5

*Product Preferences of "Other" Group*

| **Product Name** | **# Prefer Guatemalan** | **# Prefer U.S.** |
|---|---|---|
| Address Book | 3 (25%) | 9 (75%) |
| ATM | 2 (17%) | 10 (83%) |
| Calendar | 4 (33%) | 8 (67%) |
| Curtains / Blinds | 5 (42%) | 7 (58%) |
| Door Handle | 2 (17%) | 10 (83%) |
| Elevator | 4 (33%) | 8 (67%) |
| Light Switch | 4 (33%) | 8 (67%) |
| Payphone | 5 (42%) | 7 (58%) |
| Windows | 1 (8%) | 11 (92%) |
| Total | 30 (28%) | 78 (72%) |

Comparing Table 5 with Table 4, we can see a general difference between the preferences of the Latin-American group and the "other" group. Overall, the Latin-Americans preferred the U.S. objects 63% of the time. The "other"s overall preferred U.S. objects 72% of the time.

Table 6 below shows an item-by-item comparison of the differences of the Latin American responses versus "other" responses. The percentages were found by subtracting the percentage of Latin-American respondents who preferred the Guatemalan version of an object from the percentage of "other" respondents who preferred the same Guatemalan version. A positive value indicates that more Latin-Americans preferred the Guatemalan object than did "other"s, and a negative value indicates that more "others" preferred the Guatemalan object than did Latin-Americans.

Table 6

*Group Differences in Percent who Prefer Guatemalan Products (Latin-American minus "Other")*

| **Product Name** | **Difference in % Prefer Guatemalan (Latin-American minus "Other")** |
|---|---|
| Address Book | 5% |
| ATM | 13% |
| Calendar | 17% |
| Curtains / Blinds | -2% |
| Door Handle | 33% |
| Elevator | 7% |
| Light Switch | 11% |
| Payphone | -22% |
| Windows | 12% |
| Total | 9% |

Overall, the 9% difference is not too striking, but it is interesting that the Latin-American group preferred the Guatemalan door handle 33% of the time more than the "other" group did. Also, there is a large difference in the payphone ratings, where the Latin-American group preferred the Gualemalan payphone 22% of the time less than did the "other" group.

# CHAPTER 5
# Discussion

## Conclusion

It seems that for the common participant, familiarity may be a stronger factor than considerations of human factors in preference for products. Despite the fact that the experts rated some of the Guatemalan products superior to the U.S. counterparts, neither the Latin-American nor the "other" group rated any of the Guatemalan products better than the U.S. ones. The most striking example of this is in the case of the payphones. The Guatemalan payphone received an expert rating of 5 against the U.S. version's 3, but 68% of all respondents preferred the U.S. version. After completing the questionnaires, several of the participants specifically stated that they tended to select the products with which they were more familiar, the U.S. versions.

Also, there was an interesting difference comparing the preferences of the Latin-American group with those of the "other" group. The Latin-American group overall preferred the U.S. products 63% of the time, compared to the "other" group's 72%. The Latin-American group was also the only group that preferred any of the individual U.S. products only 50% of the time. This happened three times. It is assumed that although all of the Latin-American group was most likely living in the U.S. there would be slightly more people in that group who have immigrated from a Latin-American country or who use products that are similar to the Guatemalan products studied. Although this assumption is a stretch, if we also assume that people tend to prefer what they are accustomed to, this may explain the slightly higher tendency of the Latin-American group to prefer the Guatemalan objects.

*Recommendations*

There are many ways that this study could have been vastly improved. Perhaps most importantly, the cross-cultural comparison would have been made much more strongly if the two groups of respondents were taken from Guatemala and the U.S. This would require selecting the U.S. objects beforehand and bringing them (or representations of them) to Guatemala, selecting the Guatemalan objects later, and then conducting the surveys first in Guatemala and second in the U.S.

Also, there is a great limitation involved in using pictures and written notes to represent the objects. One of the people asked to complete the survey actually refused to take it, saying, "It's not real". Ideally, one would have tangible objects and allow the subjects to actually experience using them.

Another concern was that most of the subjects did not take the surveys seriously. Attempts were made to make the survey fairly fast and easy to complete, but people understandably had no motivation to put any thought into the surveys. Perhaps if subjects were offered small rewards for participating, they would give more thoughtful responses.

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# APPENDIX A

Informed Consent Form
and
Answer Sheet

# COMPARING HUMAN FACTORS IN THE DESIGN OF COMMON OBJECTS IN GUATEMALA VERSUS THE UNITED STATES

## Informed Consent to Participate

This research project is being by Michael Eng of the Psychology and Child Development Department at Cal Poly. The purpose of this project is to gain a better understanding of people's preferences for differently designed objects.

You are being asked to take part in this survey by indicating your preference tor one of the options for each object presented. Participation will take approximately 10 minutes. Please be aware that your participation is strictly voluntary and you may discontinue your participation at any time without penalty. You may also omit any items you prefer not to answer.

Your responses will be provided anonymously to protect your privacy. The potential benefit of the study is a better understanding of people's preferences for design of objects.

If you have questions regarding this study or would like to be informed of the results when the study is completed, please feel free to contact Daniel Levi in the Psychology Department at 756-6159. If you have concerns regarding the manner in which this study is conducted, you may contact Steve Davis, chair of the Human Subjects Committee at 756-2754, sdavis@calpoly.edu or Susan Opava, dean of Research and Graduate Programs at 756-1508, sopava@calpoly.edu.

If you agree to voluntarily participate in this research project as described, please indicate your agreement by completing and returning the attached survey. Please retain this consent form for your records.

# APPENDIX B

Questionnaire: Version A (Guatemalan objects = A. U.S. Objects = B.)

# Survey: Comparing Human Factors Version: A

Instructions:

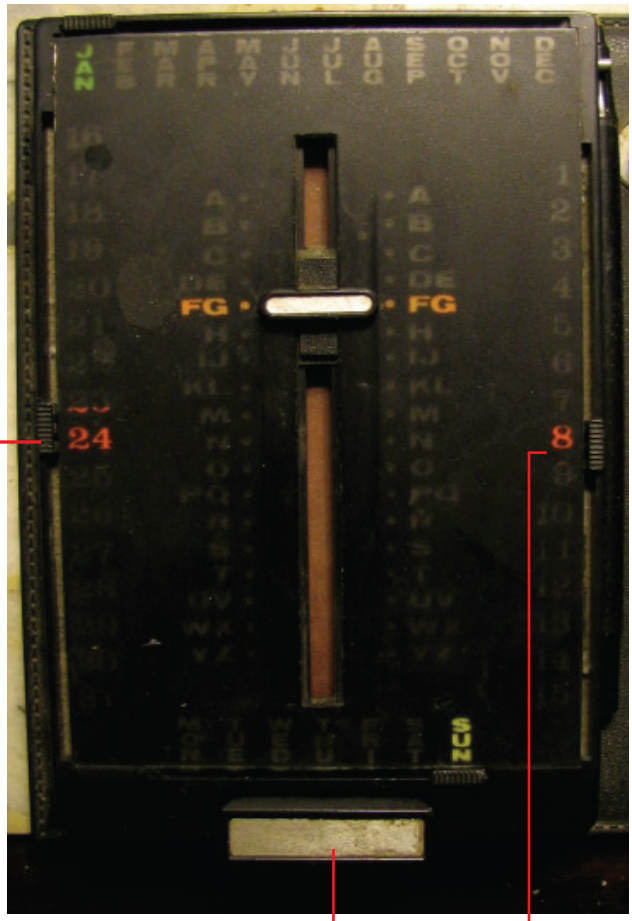
Do not write on this sheet. Mark your answers on the answer sheet provided.

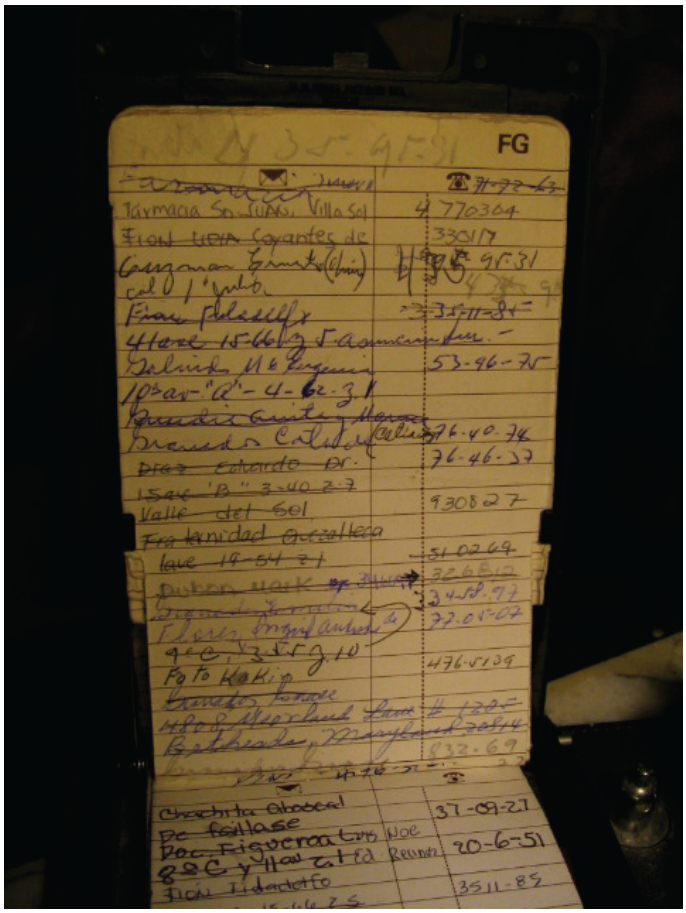
On the following pages, you will see pictures and written descriptions of nine pairs of ordinary objects. For each pair of objects, imagine that you have never seen anything like them before, and choose the one that you think better takes into consideration the user in the design. In other words, choose the object that makes more sense from the user's point of view.

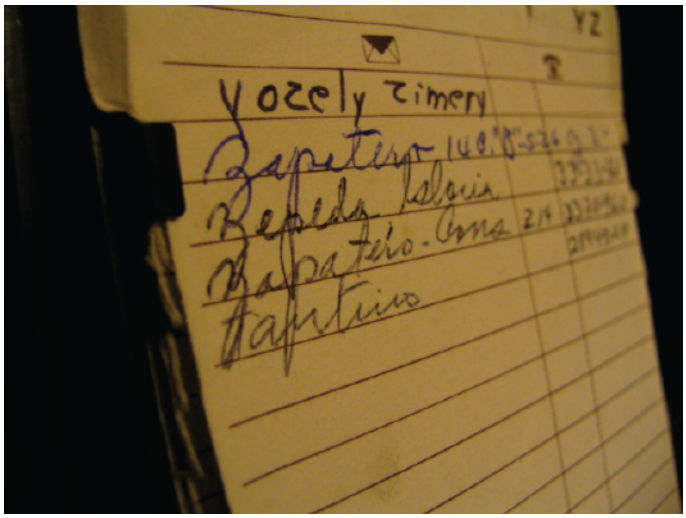
**A note on image quality:**
The original questionnaire had full-color images of respectable quality.
In reproducing this document, some images had to be retrieved from a scanned microfiche, which accounts for the degraded image quality in some cases.

# #1: Address Book

## Version A



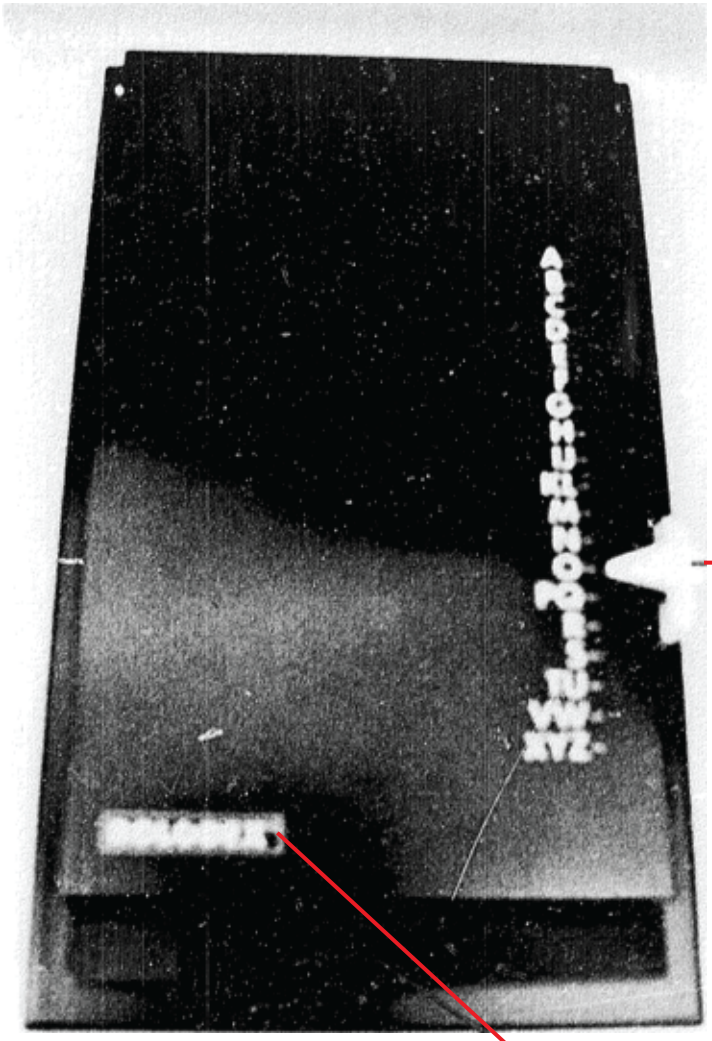



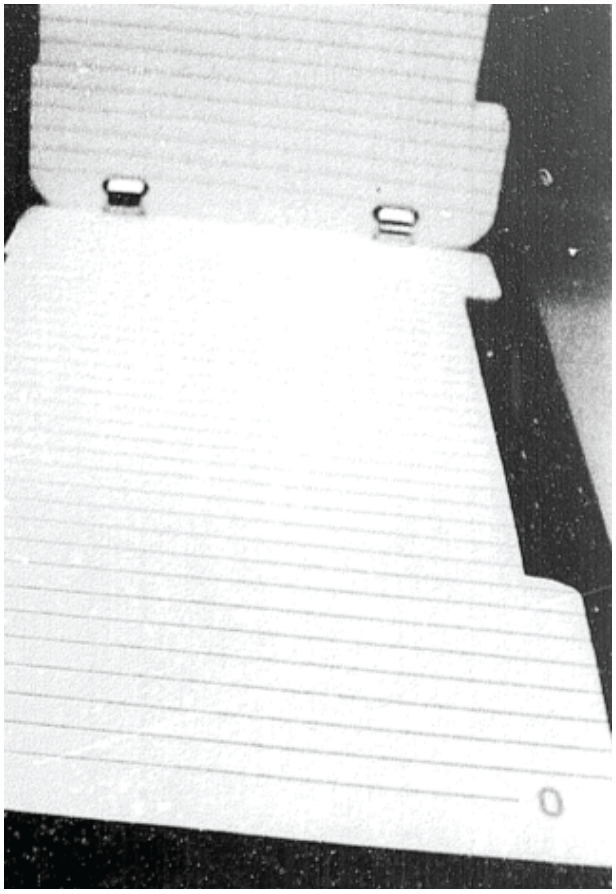

date: #16-31

Press to pop up book

date: #1-15

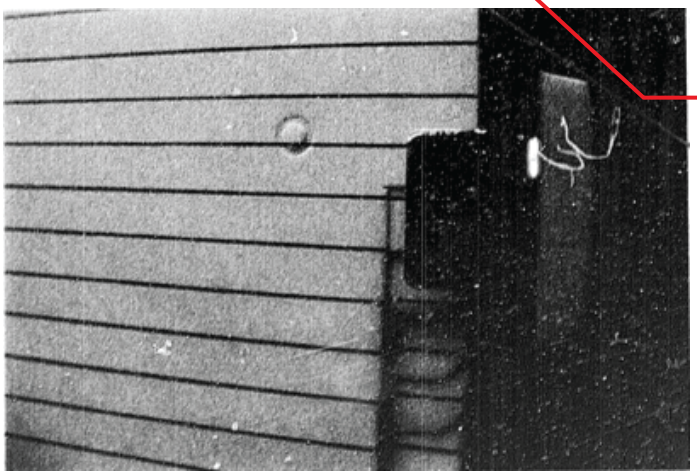
# Version B



Slide indicator to select page
(clicks in place with each letter)
(sliding when open can throw slider off track)

Press to pop up book



# #2: ATM

## Version A



### Keypad

7 8 9
4 5 6
1 2 3
0

### Features

Color coded keys

Standard keypad

No auditory beep with keypress, only visual display

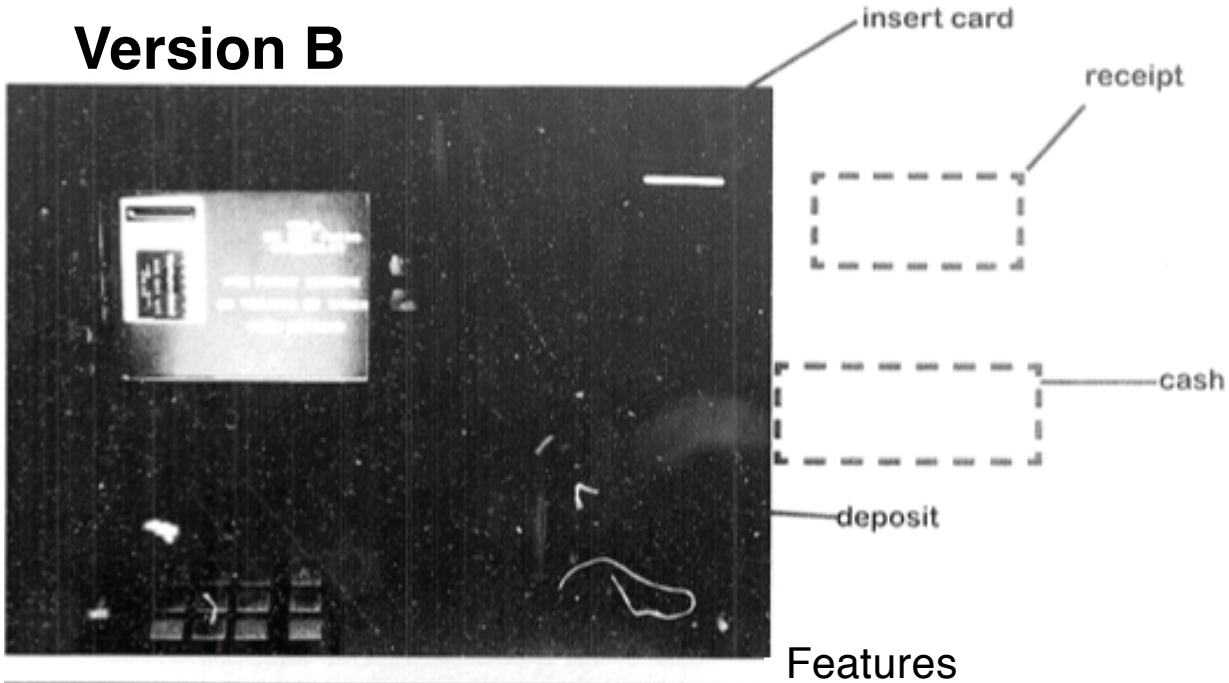
Stops card if inserted incorrectly

No braille

No labels

Does not accept deposits

# Version B




## Features

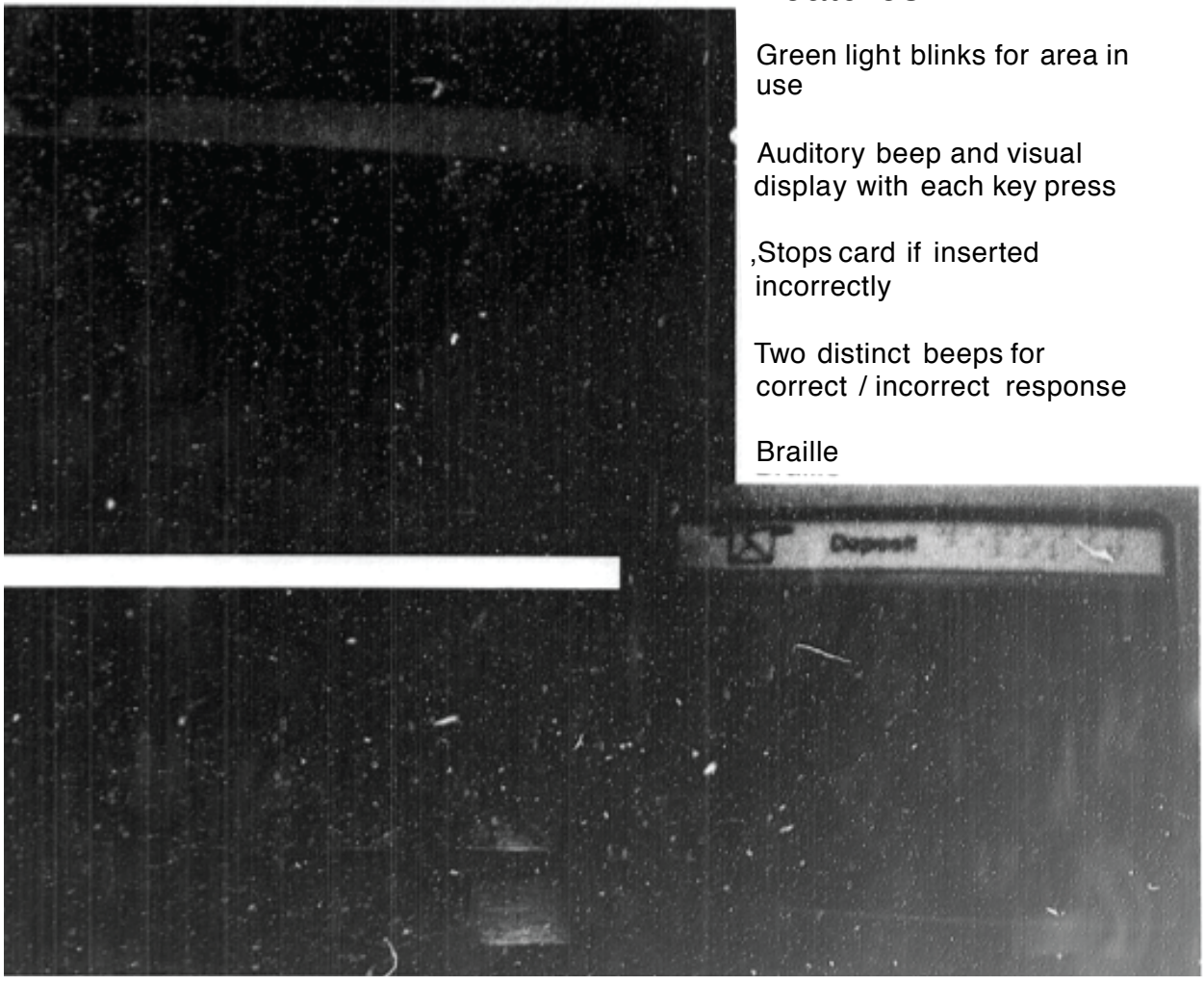
Green light blinks for area in use

Auditory beep and visual display with each key press

,Stops card if inserted incorrectly

Two distinct beeps for correct / incorrect response

Braille



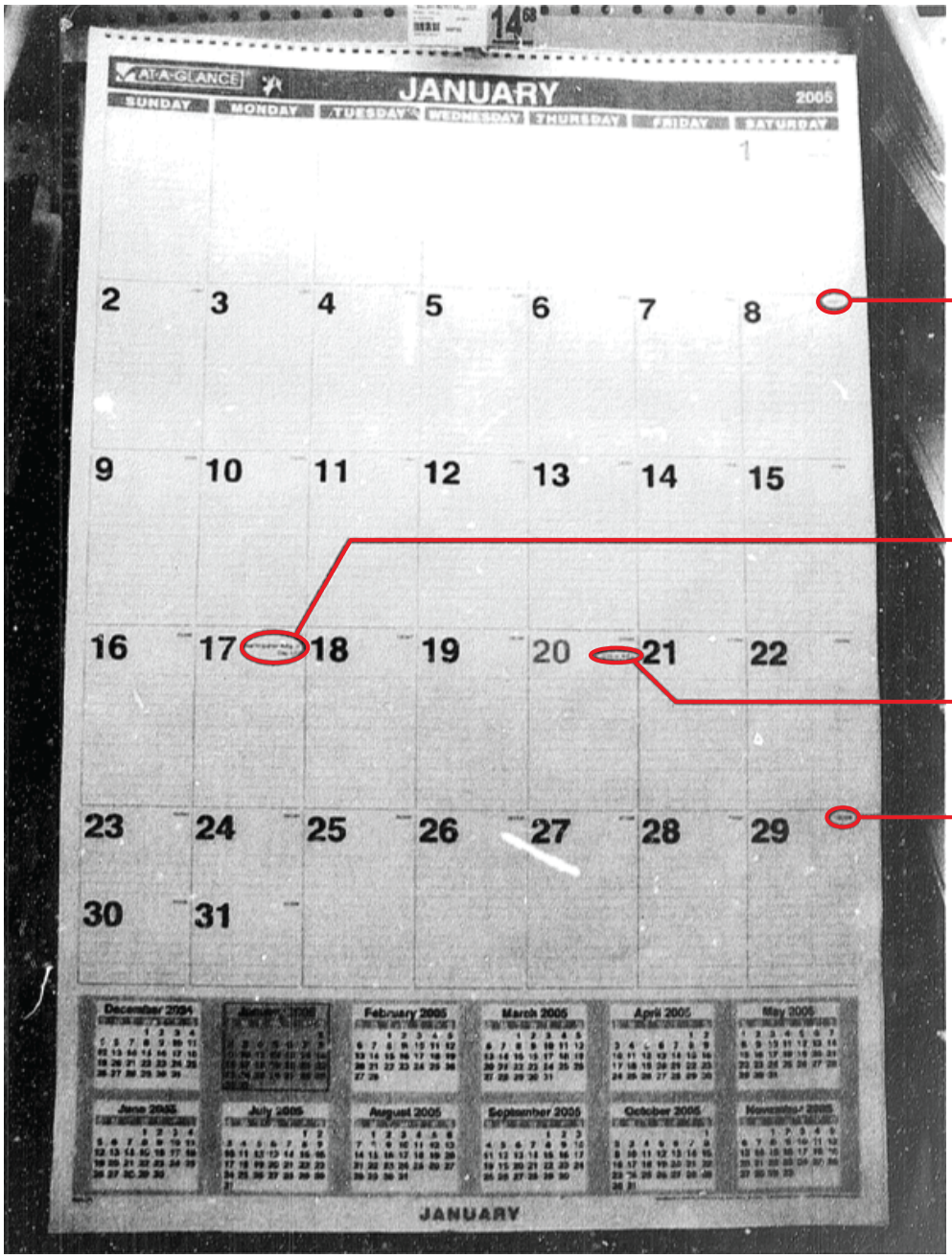
# #3: Calendar

## Version A


## Features

Each month must be torn off

# Version B




8/357

Martin Luther King Jr. Day (US)

Inauguration Day

29/336

## Features

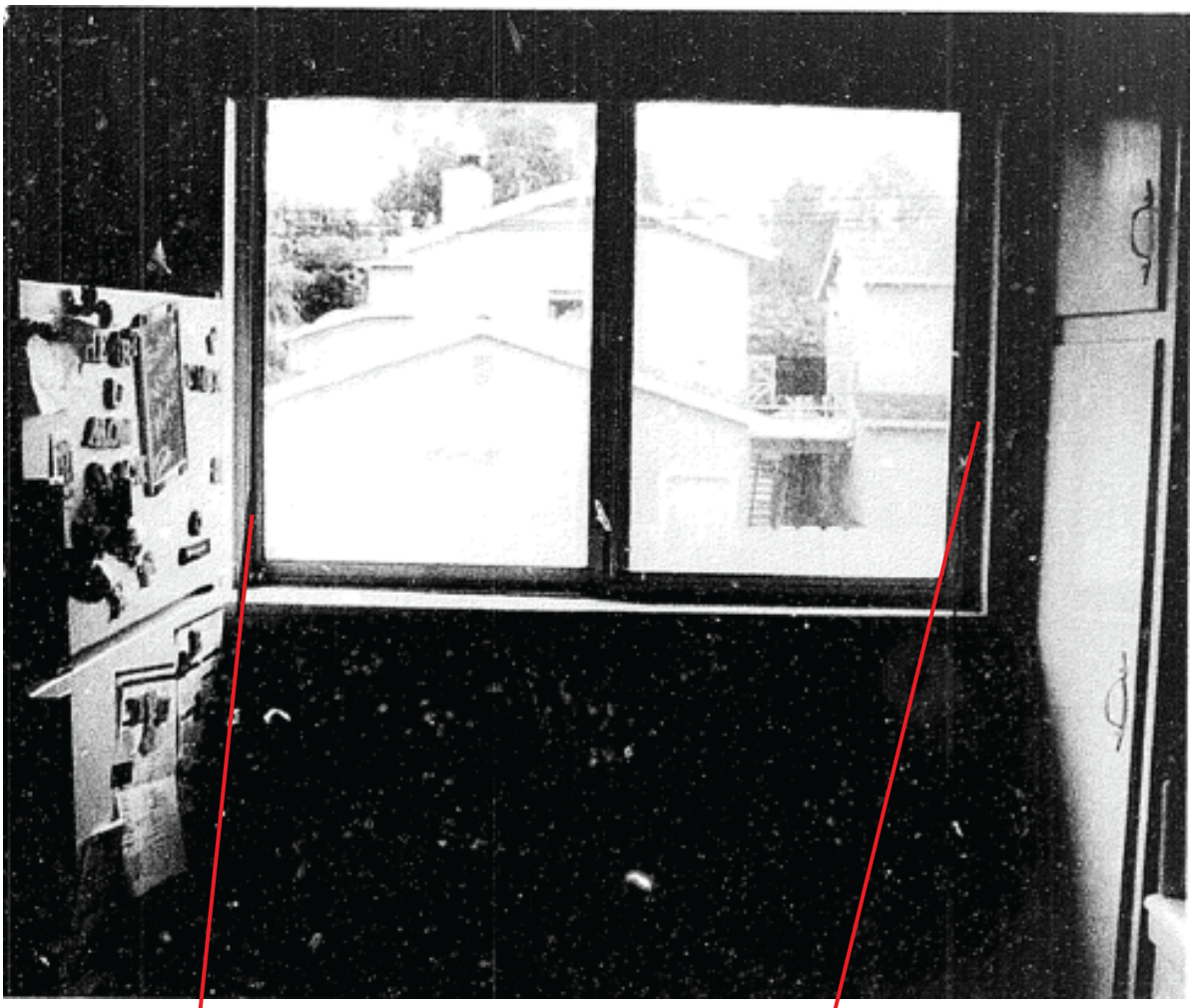
Each month can be flipped over spiral binding

# #4: Curtains / Blinds

## Version A


String stops when curtain gets to end

# Version B



Rotate handle

to rotate blinds

Move handle to release and lower blinds

Move handle to lock

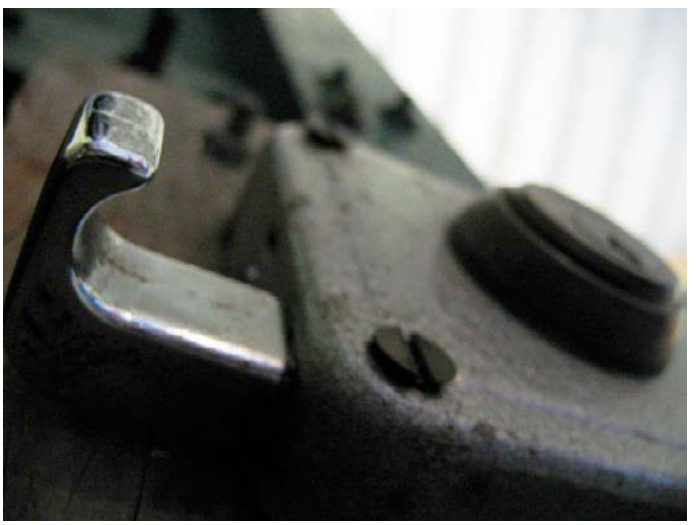
Pull handle to raise blinds

# #5: Door Handle

## Version A

Locks automatically

Outside entry requires key



### Inside

↻ Rotate key to unlock deadbolt

↺ Rotate key to lock deadbolt

← Pull handle to open latch

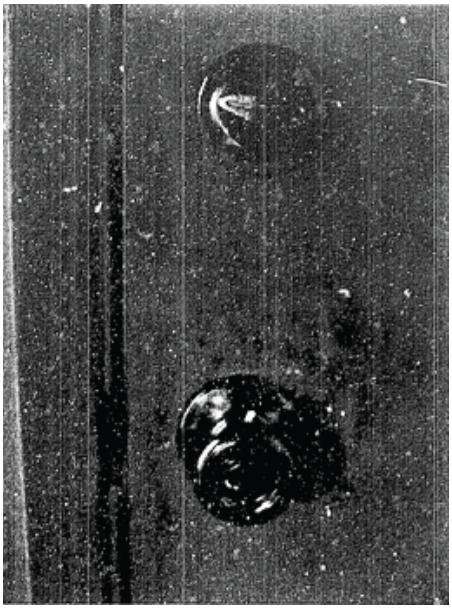
### Outside

↺ Rotate key to unlock deadbolt

↻ Rotate key to lock deadbolt

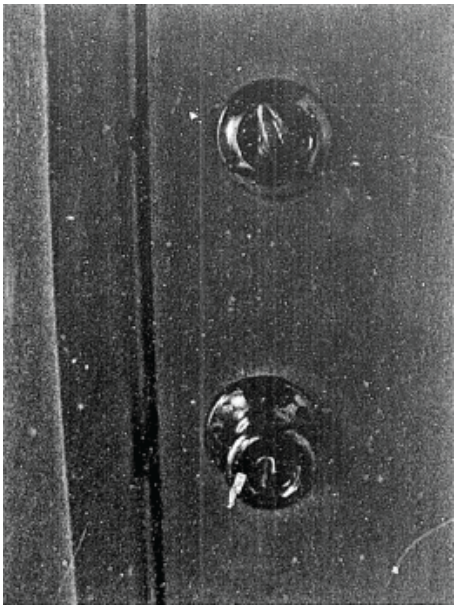
↺ Rotate key to open latch

# Version B



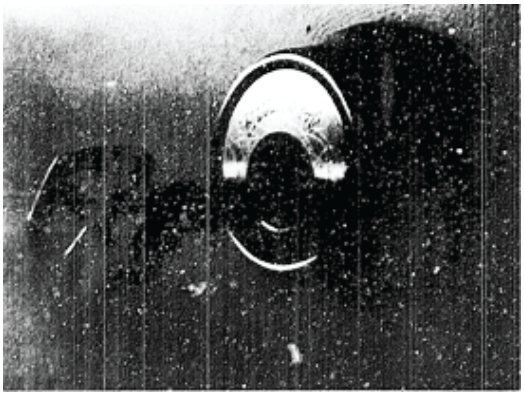
**Both unlocked**

↺ Rotate to lock



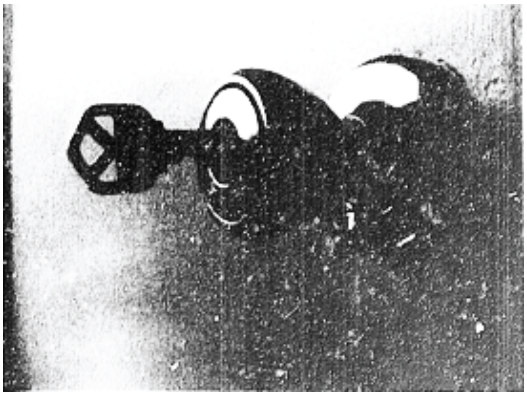
**Both locked**

↻ Rotate to unlock



↻ Rotate to lock

↺ Rotate to unlock



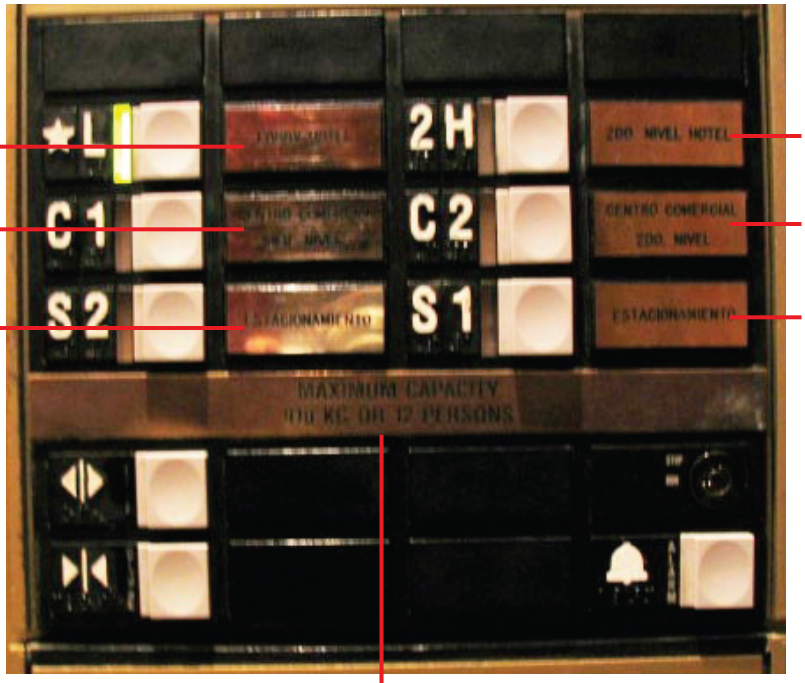
↻ Rotate to lock

↺ Rotate to unlatch

# #6: Elevator

## Version A

(braille included)




Hotel Lobby

Commercial Center
100 Level

Parking

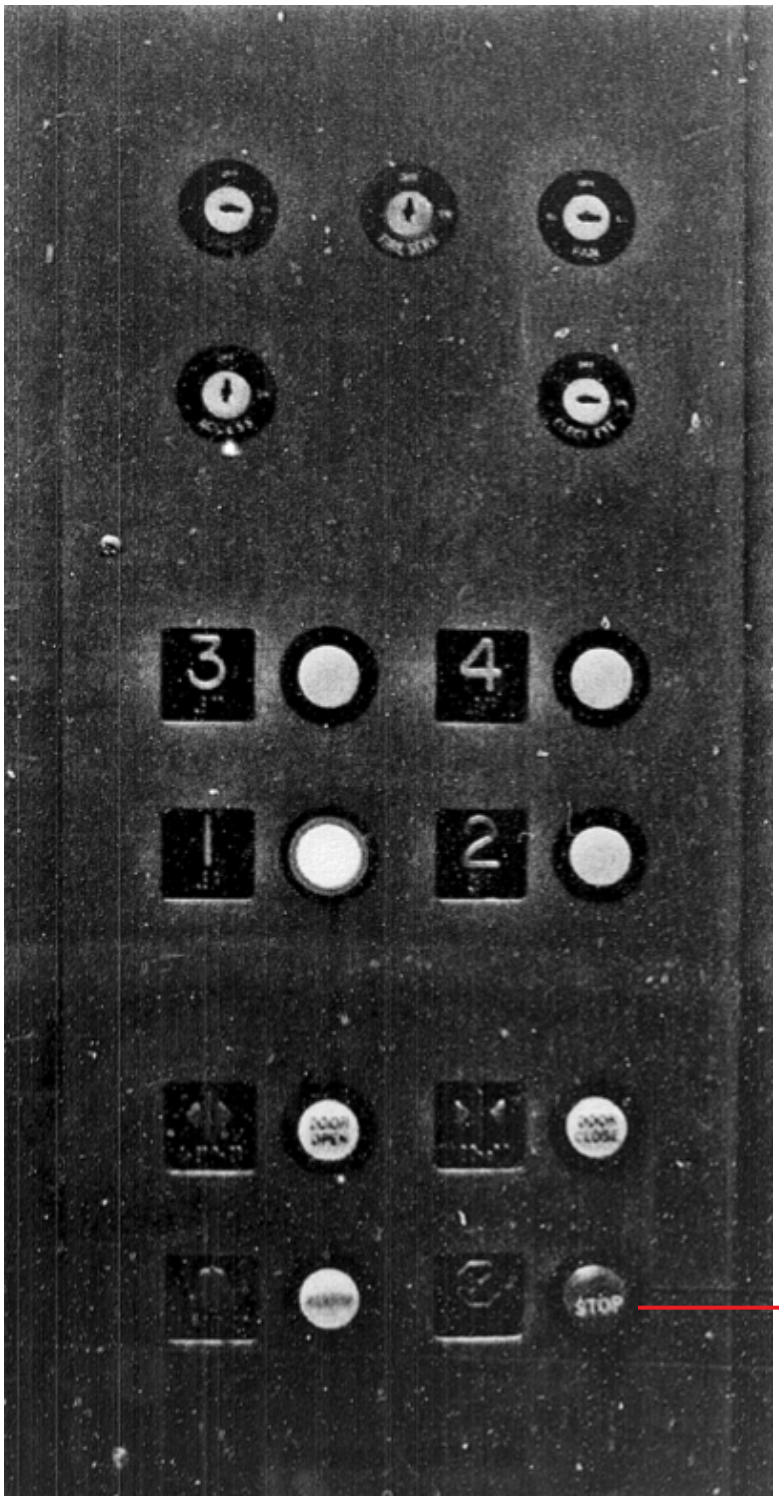
200 Level Hotel

Commercial Center
200 Level

Parking

Maximum Capacity
410 KG or 12 Persons

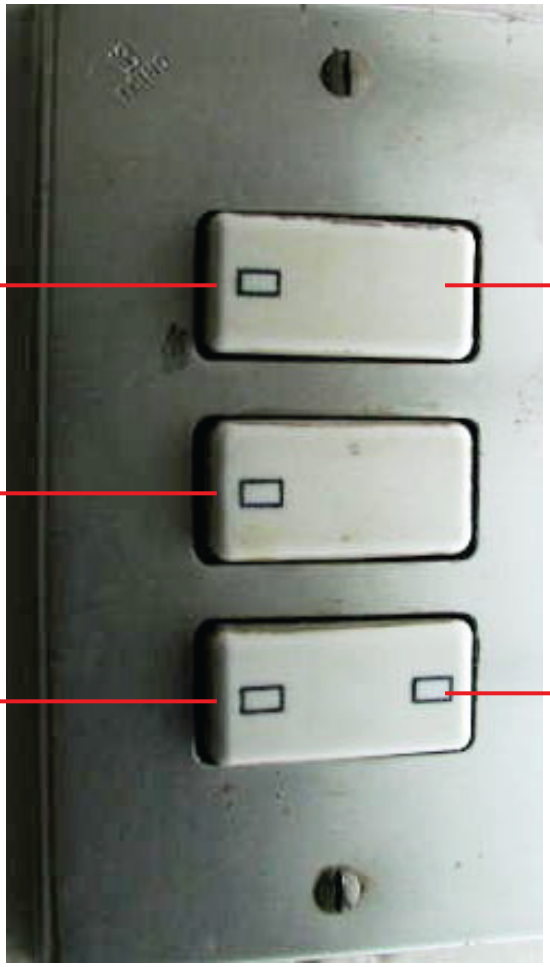
# Version B




Pull to stop

# #7: Light Switch

## Version A

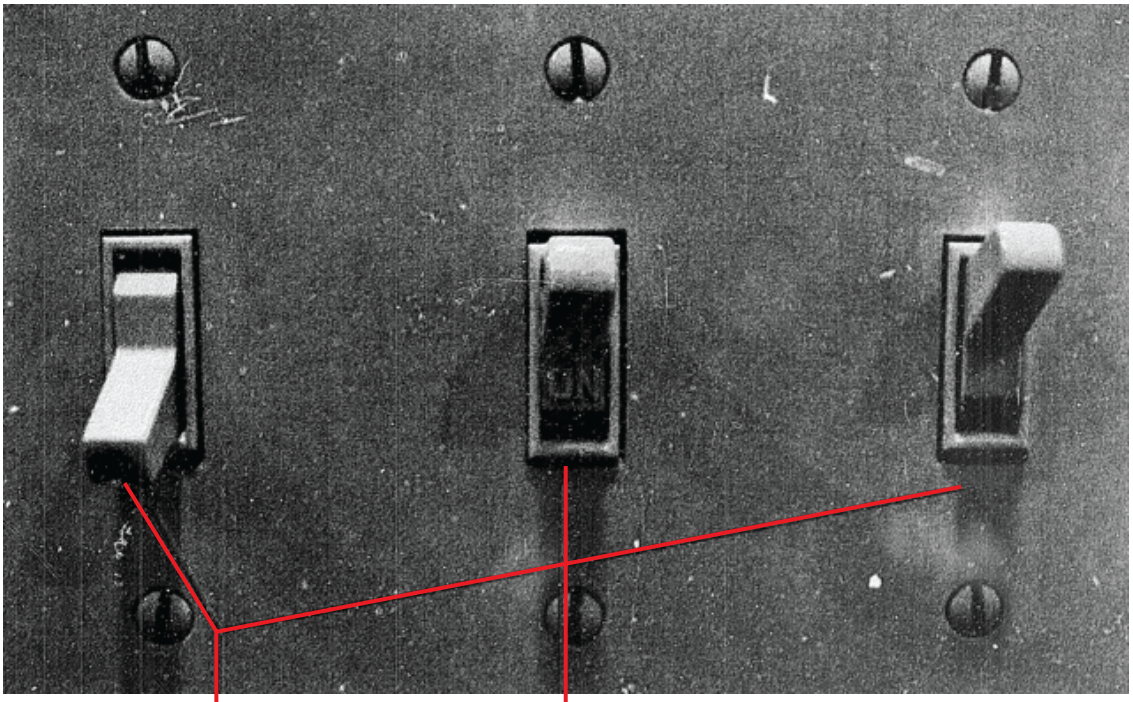


# Version B

Controls light downstairs to the left

Controls light nearby

Controls light in the hallway to the right




Toggle on l off, depending on position of the switch downstairs

Up = on
Down = off

# #8:Payphones

## Version A

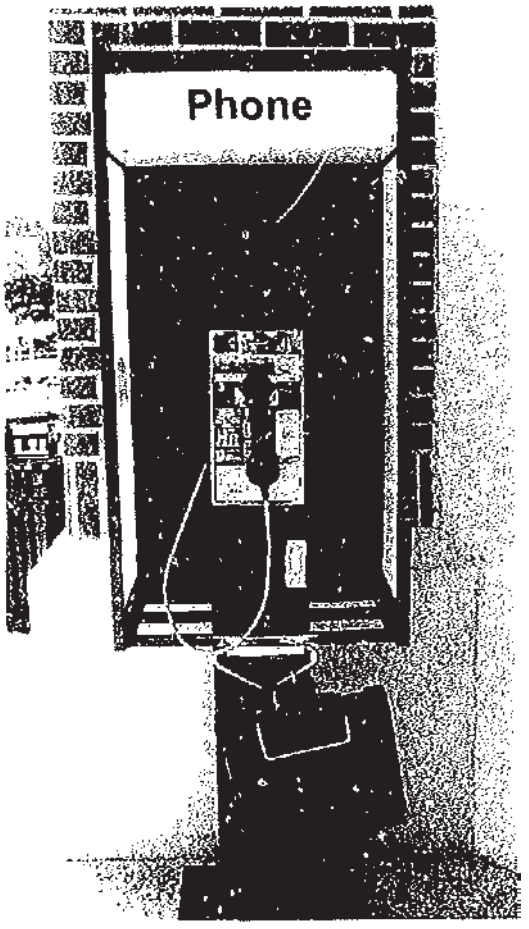


LCD screen displays number, gives instructions

Only accepts cards, but there is no card dispenser nearby

Beeps if card is left in slot

# Version B

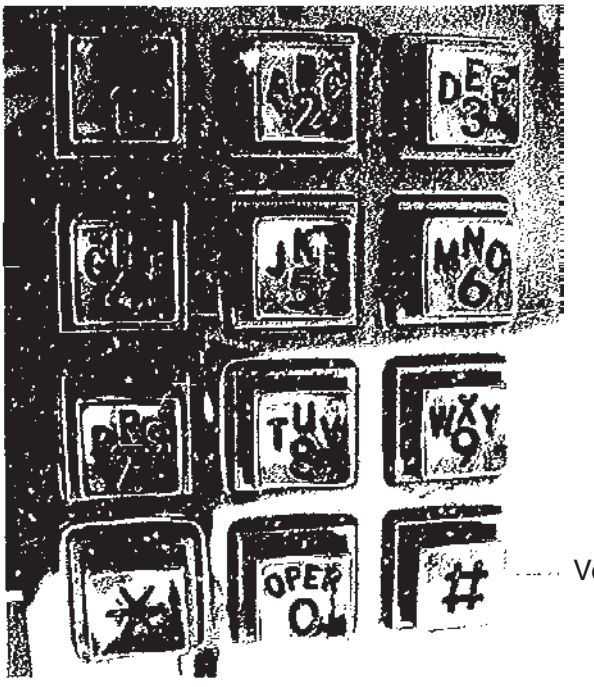




Beeps with each key press (different tone for each key)

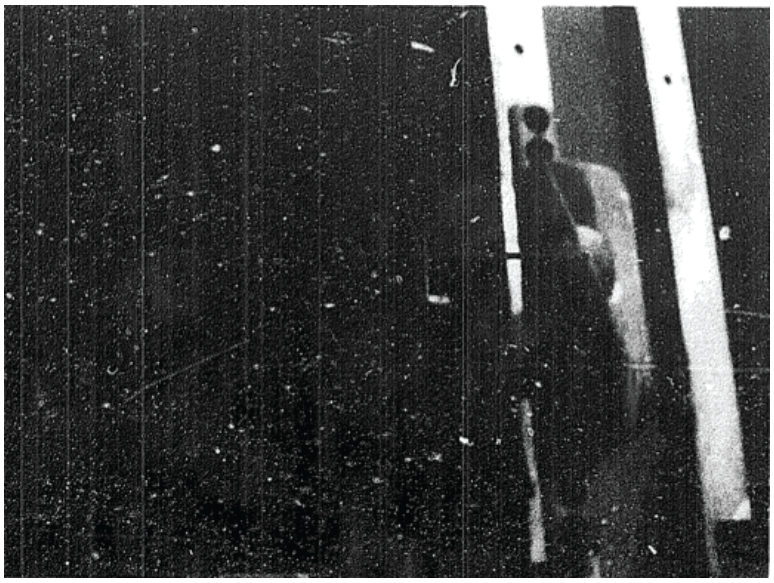
Audible sound of coins dropping whether change is given or not

No indication when person on other line hangs up, plays error message later



# #9: Windows

## Version A

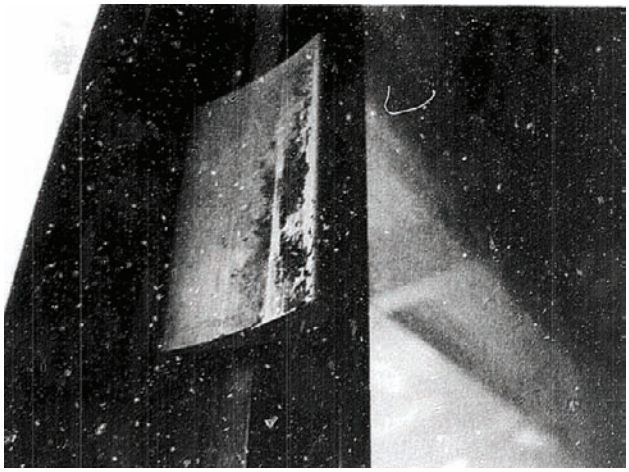


Rotatinghandle ↻ Opens window panes ↓

# Version B

Slide to open

Slide to close



Push to lock

Pull to unlock