# Designing Controls for People

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What is a human factors approach for the design of home controls? Basically, human factors engineering or ergonomics is a process of designing machines to fit human capabilities and needs, rather than the alternative, which is putting the responsibility on the user to make the accommodation to the machine.

This presentation will highlight some of the human factors issues in the design of home controls, based on our experience at Honeywell, Inc., a leading supplier of home and building controls worldwide. Honeywell Home and Building Control designs and builds innovative home controls with support from the human factors staff at the Honeywell Technology Center. There is continuing corporate recognition that the user interface of a thermostat, a security panel, or other home control has a very important influence on a homeowner's satisfaction with our products.

For the user interface designer at least, the surface features of a home control are critically important, because it is there that the user-device interaction takes place. Practically speaking, most users will never learn much more than the appearance and operation of the control panel. Few users will want to understand how the transistors, resistors, algorithms, or communication protocols are integrated to create a home controller. And while homeowners expect their controller to meet general capabilities such as reliability, precision, and system compatibility, "easy to use" is one of the most important features it can have. An unsatisfactory user interface can make everything good about a home control irrelevant. Moreover, the user's reaction to their home control can influence their satisfaction with their entire HVAC system.

Critical pieces of information for the human factors designer are knowledge of the users and an understanding of their needs and their capabilities. Of course, no user group is homogeneous; we expect diversity. Generally, home control devices such as thermostats have a very diverse set of users, much like telephones or kitchen appliances, since almost all modern homes have one. In addition, homes themselves are occupied year-round in a variety of climates, and the people in those homes span all ages and backgrounds. (Of course, there are other users including distributors, contractors, and installers, since most homeowners do not select their home controls like other consumer products, nor do they complete their own installations.)

The diversity within any local market is magnified when we enter a national market and eventually global markets. The remarkable global differences in tradition and culture, climate, heating and cooling systems, and not least language, create enormous design challenges for home controls around the world. These global differences can seem overwhelming, until we recognize that, fundamentally, we are all human beings with many similar needs and capabilities. By recognizing these shared characteristics, user interface designers can help make controls for global markets with improved ease-of-use and which contribute to overall customer satisfaction.

First among these shared human characteristics is our need for a comfortable environment. Typically, we are not aware of the internal climate in a home unless there is some deviation from standard conditions, when we become uncomfortable. There is a substantial body of literature that maps the relationship between human comfort and the physical environment, including factors such as radiant heat, air temperature, air movement, air moisture, as well as human variables such as activity level and clothing (Fanger, P. *Thermal Comfort*, 1982). Our modern home controllers do not offer us the option of monitoring and controlling all of these factors, but continuting developments in sensors and control algorithms are sure to help us control more of them in the future. User interface design will need to keep pace with these developments, so that we can control not just temperature but overall comfort.

Traditional human factors research is built on a understanding of human sensory, perceptual, and motor characteristics. For example, within a range, most of us can read text of a certain size, recognize symbols, press buttons of a given size and configuration. In addition to these basic sensory and motor capabilities, perceptual capabilities can help us understand complex visual displays. The layout of a home control panel can take advantage of our human perceptual tendency to group and organize information, including the well-known Gestalt principles of visual organization. Good human factors design practice includes the creative use of color, shape, grouping, and terminology to clarify and differentiate functions. (Note: the human factors discipline is increasingly concerned about those individuals who have visual and other disabilities, and we are continuing to look for new controller designs that accommodate their special needs.)

Layered on top of our human sensory and perceptual abilities is our dynamic interaction with home controls--how do we learn and how do we understand? This area, including perceptual learning and cognitive design, is very active with research in the broader discipline of user-computer interaction (Norman, D. *The Psychology of Everyday Things*, 1988). It is also the most challenging, because this is where the cultural and language dif-

ferences make a significant impact. Yet some general human capabilities such as memory are generally stable and predictable across groups.

In fact, in the design of more complex controls such as programmable thermostats and security systems, the frequency of use is a very important factor. From our surveys of customers, we have learned through customer surveys and interviews that home thermostats are used infrequently. In addition, people have a legendary reluctance to read and save operating instructions. Even a very well-designed interface can be daunting if use is so infrequent that users remain perpetual novices. The solution can be creating "help" functions in a number of ways. A basic type of help function includes prompting the user for responses, since infrequent users do not remember very well which keys are active, especially when operating relatively sophisticated controllers or security systems. For example, the TotalHome™ display prompts the user for "OK or Cancel" at each necessary step in operation. Another help technique is "on-line help," similar to what is provided in PC software programs. More sophisticated versions of on-line help are context-sensitive help that attempts to predict relevant help messages for the user, and adaptive help, that tracks the user's changing familiarization with the system to optimize the help information. While the display capabilities of simple home controls are currently limited, there will be more use of this technique in the future as displays can carry more information and are more flexible.

Another consideration of for human factors is the social dimension. In our research, we have received anectodotal reports that many households have a "designated thermostat operator." One reason for this, apparently, is to avoid family duels over what the proper setpoint should be. Some families fear the time when the children are tall enough to reach the controller, and they would like to have password protection! We must also recognize, however, that people in the home want to designate someone to use the control because of a perception that sophisticated programmable controllers are complicated, much like VCRs. This perception can be changed in the long term by better design and more informative displays.

User interface designers are eager to incorporate new technology into home controls. In the past decade, we have witnessed the advent of technologies such as:

- Personal computers in many homes,
- Miniaturization of hardware components,
- High performance flat panel displays,
- Widespread communication networks.

These developments will undoubtedly create many opportunities in the future for better controls from the human perspective: Easier to read, simpler to operate, and more capable

controls. While the same technology may be also used for entertainment in other products (i.e., video games), we recognize that there is not much entertainment value in a home control. In fact, one can argue that the best home control recedes into the background in a room and does not call attention to itself through its design or user interface. Fundamentally, the best design gives the homeowner a secure feeling that it will do the job it was designed to do, to make the occupants comfortable.