

Control Compatibility and Feedback: A White Paper

**Prepared by:
Interface Analysis Associates
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Interface Analysis Associates
1135 S. De Anza Boulevard
San Joes, CA 95129
Tel 408.342.9055
Fax 408.342.9059
www.interface-analysis.com

**INTERFACE ANALYSIS ASSOCIATES: CONTROL COMPATIBILITY AND
FEEDBACK
AN EDITORIAL BY ANTHONY D. ANDRE, Ph.D.**

When I was first introduced to the Duraswitch control concept, and their product line, I was ecstatic, to say the least. Two of my most recent consulting projects, not to mention many projects over the last few years, dealt heavily with the issue of membrane controls. One of the projects involved the design of a control interface to be used within an automotive manufacturing setting. Due to both environmental and cost factors, membrane controls were dictated by the client. Concerned about the lack of tactile feedback provided by these controls, we (the interface designers) struggled to add LED indicators, backlit status icons, and multiple-layer metal snap domes in order provide adequate feedback to the operator. Needless to say, the cost and complexity of our final design approached, if not exceeded, that of conventional controls.

The other project involved the evaluation of a wireless keyboard; a keyboard that had costs tens of thousands to design and develop. The keyboard used a rubber dome membrane keypad, with minimal travel and little tactile feedback. The evaluation showed, and the research participants commented, that the keyboard was difficult to use. Our recommendation, and the subsequent action of the client, was to replace this keyboard in favor of one that provided better feedback.

These are just two examples of the problem faced by product designers and human factors professionals every day; that is, how to achieve the benefits of membrane controls without compromising on control compatibility (i.e., control type) and feedback.

Compatibility and the Car Radio

Notwithstanding my professional interest on this topic, my strong feelings about the value of, and need for, compatibility and feedback attributes of conventional controls come from a more personal perspective. Indeed, I needn't look any further than my own automobile to see how these issues affect me on a daily basis. From 1992 through 1995 I owned a 1968 Mercury Montego, complete with an original AM radio. What the picture to the right does not show are the two large, round mechanical knobs used to control the radio volume and tuning.

The performance difference afforded by conventional vs. membrane controls is exemplified by a comparison of this and many current automobile stereo volume controls. Whereas in the past one could quickly and easily turn down the stereo volume by rotating a knob in a single motion, that same task today may require upwards of 20 discrete presses of a membrane push-button - a laborious and slow procedure I perform every day in my 1992 Mercury Sable, shown to the right.

Feedback and the Cellular Phone

And just as membrane controls are ubiquitous in today's machines and products, the issues of compatibility and feedback--whether applied to a cellular phone, a microwave, or a calculator-- are of universal importance to lay persons and human

factors professionals alike. It is no coincidence, then, that I refer to these issues often in my magazine column (see Andre and Segal, 1993 & 1994, October).

Take, for example, the cellular phone. While I don't recommend driving while talking on a cellular phone, the fact is that it is legal (for now) in the United States and many people partake in this activity. From a variety of perspective, one can argue that interacting with a phone while driving is a difficult task. I have argued (Andre and Segal 1994, October) that this task is made even more difficult by the increasingly popular trend of minimizing both the size and travel of the number keypad, through the use of flatter and flatter membrane ("flush") controls. This design has two important, and negative, consequences:

First, the flush design makes it difficult to find specific numbers through feel and without looking. Remember that there is a huge cost for looking away from the road and towards the phone!

Second, and perhaps more important, the lack of tactile feedback requires the user to attend to the visual display in order to confirm that the correct number was pressed, and pressed only once. Again, any (control) design that increases the driver's need to look at the phone is a bad one.

Here, unlike the automobile radio control example, it is not the choice (or compatibility) of the control type that is in question (push buttons, in this case), but rather the behavior and feedback characteristics inherent in its design. What's most intriguing and exciting about the Duraswitch innovation is that it addresses both of these issues: It allows for various control types (knobs, toggles, levers, etc.) to be used within the context of membrane control panels, and it provides greater feedback for "conventional" membrane push buttons.

The Ergonomics of Membrane Controls

As a consultant and lecturer in the field of workplace and industrial ergonomics, I am particularly sensitive to the physical, physiological and bio-mechanical consequences of our interaction with various artifacts. The current, and growing, epidemic of repetitive stress injuries (RSIs) demonstrates the devastating consequences of repetitive movements to the shoulders, arms and wrists. Soon to be added to this list, I predict, is the index finger.

Think about all of the products that you interact with every day and you soon realize that many, if not the majority of them employ flat membrane (flush) controls, as shown in the photo to the right. Recall that we often activate (push on) flat membrane controls with more force than is necessary (Sind, 1990), a consequence of their reduced tactile feedback. And since these controls are often used where continuous controls are more suited (e.g., automotive radios), we find ourselves unknowingly subjecting the tip of our index finger to repetitive isometric exertion. If the Duraswitch technology enables designers and manufacturers to implement the proper controls, with the proper feedback characteristics, thereby limiting the amount and force of movement required to activate a control or reach a desired control setting, I truly feel that it will help avert this potential RSI epidemic.

Final Words

The world is abound by membrane controls, and the trend will only continue in the near future. Membrane controls, as they have been most commonly implemented in a variety of products and settings, often deprive users of certain, critical aspects of compatibility and feedback. Clearly, the Duraswitch technology, which permits designers and manufacturers to implement, and most importantly consumers to interact with, controls that are both compatible in form and movement, and provide tactile and kinesthetic feedback, must be considered significant forward progress in the evolution of modem control systems; a conclusion that is apparent when either a scientific or a common sense analysis of control issues is undertaken.

It is refreshing to see a product that directly addresses the negative attributes of membrane controls, so clearly visible to, and experienced by, nearly all who interact with them. I personally look forward to the day when I can add Duraswitch controls to my repertoire of user-centered interface tools!

ABOUT THE AUTHOR

ANTHONY D. ANDRE received his Ph.D. in Human Factors and Ergonomics from the University of Illinois in 1991. He was then hired as Principal Scientist of Western Aerospace Labs, through which he served as a Primary Investigator and Head of the Control/Display Laboratory in NASA's Flight Deck Management and Human Factors Division until 1996. He currently consults to NASA as a Senior Research Associate through a grant to the San Jose State University Foundation.

In 1993, he founded Interface Analysis Associates (IAA), a highly successful human factors/ergonomics consulting firm specializing in the design and analysis of software/hardware user interfaces, high-tech consumer products, computer input devices and ergonomic products, office environments and aerospace systems. Dr. Andre has consulted to many high-tech companies and organizations such as Bay Area Rapid Transit (BART), Cidco, Inc., IDEO Product Development, Ingersoll-Rand, Kodak Imagination Works, Logitech, Inc., National Aeronautics and Space Administration (NASA), O'Hare and Tampa International Airports, Richmond CA Police Department, Shell Oil Co., Spectravision/On Command, Sun Microsystems, Inc., Tandem Computers and UK Defense Research and Evaluation Agency. IAA was recently honored with a Gold Award from the Industrial Designers Society of America (IDSA).

As part of the Human Factors and Ergonomics Graduate Program at San Jose State University, Dr. Andre is an Adjunct Professor in the departments of Psychology and Industrial/Systems Engineering. He teaches graduate seminars and courses on ergonomics, engineering psychology, research methods and human cognition.

Dr. Andre was recently honored by the American Psychological Association (APA), Division of Applied Experimental and Engineering Psychologists, as the first recipient of the Earl Alluisi Award for Early Career Achievement. He is also a Contributing Editor of Ergonomics in Design, a National Speaker for the Human Factors and Ergonomics Society (HFES), Member and Professional Development/Education Chair of the HFES National Program Committee, Member of the HFES Education Committee, Member of the HFES Public Relations Committee, Director of the HFES Bay Area Chapter, and a Member of the Board of directors of the Silicon Valley Ergonomics Institute.

Dr. Andre is the author of over 80 publications, is cited in several major textbooks and newspaper articles, and has presented numerous invited addresses, panel presentations and technical lectures on various human factors and ergonomics topics. His workshops on user interface design and workplace ergonomics have been attended by representatives of such leading organizations as Apple Computers, Bank of America, Chevron Oil, Fiskars, GM, Hewlett Packard, Intel Corp., NEC, Sun Microsystems, Thomson Multimedia/RCA, and UCLA.