
Incorporating Guidance and Rewards into a Handheld-Device User Experience

Robert Fabricant

frogdesign
96 Spring Street
New York, NY 10012 USA
robert.fabricant@frogdesign.com

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Copyright © 2005 AIGA | The professional association for design.

Abstract

frogdesign worked for three years on the development of the StressEraser, a handheld medical device for the consumer market. This product uses biofeedback to encourage deep breathing patterns that reduce stress and promote general health. The goal of this product is to become part of the user's daily routine. User research demonstrated the need for positive rewards and clear guidance to introduce users to the experience and reinforce regular patterns of behavior. frogdesign combined insights from exercise equipment and computer games in the development of the overall experience design. In so doing we achieved a novel approach that is a significant departure from the typical interface design for handheld devices, such as cellphones and digital cameras, which provide little guidance in their operation. By contrast, the StressEraser guides the user through a sequence of activities, providing strong encouragement to introduce and support the overall experience.

Keywords

Bio Feedback, Concept Design, Experience Strategy, Games, Guided Tour, Handheld Devices and Mobile Computing, Health Care, Health, Industrial Design,

Information Architecture, Interaction Design, Input, Interdisciplinary Design, Product Design, Prototyping, User-Centered Design / Human-Centered Design, User Experience, User Interface Design, User Research.

Project/problem statement

The migration of microprocessors into consumer devices creates many opportunities for designers to introduce specialized user experiences for common tasks, such as heating your coffee or paying for your groceries. Bill Buxton has written about the need to move beyond the dominant Windows-Icons-Menus-Pointer (WIMP) computing model and to create solutions that encompass new forms of physical input with specialized user interfaces to meet the needs of specific tasks. He correctly observes that, "In design there is a tradeoff between weak general and strong specific" systems [1]. He has described this trend as 'Divergence' [2]. Divergence is a reality for many consumers, who sport cell phones, data devices, digital cameras and MP3 players that all employ different graphical user interfaces and control surfaces.

In November 2001, frogdesign began working with Helicor, a technology startup, on a new type of consumer medical device, the StressEraser. This product relies on biofeedback to improve a user's breathing patterns and help him/her manage stress. The StressEraser differs significantly from a typical heart rate monitors (like the Polar line of wrist based heart rate monitors) in that it measures the change in heart rate, or pulse, over time. The up-and-down movement of a pulse rate is caused by the activity of one nerve in the body, the vagus nerve, that extends from your brainstem out to various parts of the body. The vagus

nerve is the primary pacifying nerve of the body. Vagus nerve activity comes and goes in waves. When it comes, the heart rate drops. When it goes, the heart rate returns to its baseline. This wave of vagus nerve activity causes the pulse rate to cycle down and up in waves with regular, deep breathing. When plotted over time the change in heart rate (heart rate variability or HRV) exhibits a smooth, sinusoidal pattern for a subject in optimal health, such as a professional athlete (**Figure 1**). Studies have shown that HRV is an important indicator of longevity in people who have suffered heart disease, diabetes and other ailments [3].

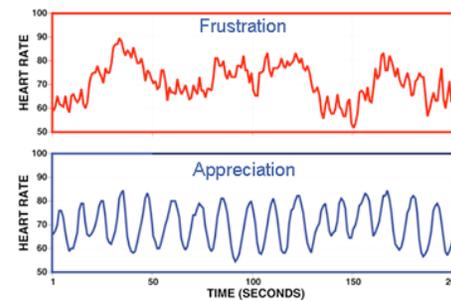


Figure 1. Sample HRV Graphs: the lower (blue) graph shows the regular, sinusoidal pattern that is indicative of low stress and general fitness.

The specialized nature of the StressEraser encompasses input hardware input as well as interaction and screen design. To operate the StressEraser, the user places his/her finger in a clip at the top of the device. This clip uses an IR sensor to capture pulse data and convert it into an HRV graph.

The overall goal is to develop a strong bond with users so that this product will become part of their daily routine and something they would recommend to

friends. The experience has to feel simple and natural or the product will not succeed at its primary goal, reducing stress. As Donald Norman puts it: "The primary notion behind the information appliance is clear: simplicity. Design the tool to fit the task so well that it becomes part of the task, feeling like a natural extension of the work, a natural extension of the person".[4]



Figure 2. Product design for the StressEraser developed by Helicor and frogdesign.

The proliferation of computing devices, or information appliances, has largely fallen short of this aspiration. The migration of computing power into consumer devices has created huge cognitive burdens, as user interface standards are nonexistent even across the most common devices, such as cell phones: "Unfortunately (our locus of) attention remains finite while the number and complexity of tools continues to increase. In what has become a problem for almost all

design disciplines, the foreground is full."[5] Our initial interviews with physicians and trainers as well as potential users, revealed universal skepticism to the very notion of a handheld device as a 'stress-reducer'. A number of efforts have been focused on reducing this cognitive load, within both academia and the computing and telecommunications industries. Most of these solutions have focused on the discovery and synchronization of data across multiple devices, but not the common representation of that data.

In *Less Is More*, Bill Buxton looks to network communications, the ability to share common data objects, as the best solution to relieving this cognitive load [6]. Even when wireless data interchange standards are in place, such as Bluetooth or JINI, user interfaces continue to diverge. There have been attempts to develop self-organizing GUI systems that can migrate across a range of devices and organize tasks in a common manner. Two relevant examples are the Personal Universal Controller or 'PUC' [7] and Automatic Interface Generators [8]. But none of these approaches have achieved anything close to the critical mass required to succeed. And in each case, they introduce a generalized approach to interaction and representation that can be very limiting. The standards they propose consist of generic collections of buttons and panes for managing single screen interactions. A good example of this kind of GUI generation can be found on large, touch-screen universal remote controls, like the Philips Pronto line. It is difficult to model more complex tasks and specialized user experiences within the restricted language of these GUI systems.

This generalized approach runs completely counter to the idea of a 'strong specific' system, like the

StessEraser. One of the strengths of a strong specific system is that it is specialized, so that valid assumptions can be made about the users goals when they engage with the product. This opens the door to more explicit feedback and guidance during the operation of the device. Rich feedback, in the form of coaching and rewards, can reduce the learning curve and increase adoption rates for this kind of device. This approach is missing from most handheld devices, such as digital cameras, which provide little explicit guidance in their operation. These tools are passive: they rely on the user to discover and learn how to operate their many functions. And they provide no explicit rewards to the user that invests the time to learn about their operation. For this project we looked to exercise equipment and game design for more appropriate analogies.

Background

This product was designed by a multi-disciplinary team working closely with an entrepreneur who had little prior experience with product development. The frog team oversaw all aspects of the design, from industrial design, mechanical design and electrical engineering to user interface design and user validation. The initial experience strategy was developed in late 2001 and early 2002, and our design and engineering support continued through mid 2004. The lead contributors to the project were:

- Robert Fabricant, User Interface Design, frogdesign
- Gary Natsume, Product Design, frogdesign
- Robert Curtis, Mechanical Engineering, frogdesign
- Eric Freitag, Project Manager Helicor
- Adam Forbes, founder and CEO, Helicor

Helicor is a start-up company that was created to develop products for managing stress and promoting HRV as a key health indicator. The StressEraser is currently being manufactured for a release date in fall 2005.

Challenge

The biggest challenge that we faced was the lack of awareness regarding HRV. Our user research showed a great deal of public awareness regarding heart rate monitors and a strong association with athletic performance. But few interviewees, even personal trainers and yoga instructors, understood the concept of HRV and it's significance as a stress indicator. Additionally, our preliminary research indicated that the likely audience for breathing and bio feedback tools is very suspicious of technology. They are much more receptive to holistic and alternative medicine than digital devices.

This lack of public awareness regarding HRV had a direct impact on the marketing strategy for the product. The client shifted from a direct to consumer strategy to an emphasis on sales through physicians so that the first product would qualify for coverage under major insurance plans. Physicians were the only segment with any awareness of HRV. This change in marketing strategy introduced a number of new requirements regarding FDA approval that effected the experience design. The client was planning on marketing the product as a 'stress reliever', targeting key segments, such as mobile professionals and those with specific anxieties (like Insomnia or Aviaphobia). FDA standards strongly regulate the claims a medical

product can make. Initial designs that provided a direct representation of specific stress level reductions, had to be scrapped.

Solution

A. Process (methods, tools, procedures, influences):

With little prior knowledge of HRV and little market definition, the frog team conducted several rounds of user interviews to shape the overall experience strategy. Informal research revealed that most end users relied on an expert, or mentor, to introduce them to new health practices. We conducted a round of interviews that focused on the influencers of end-user behavior. We interviewed eight professionals ranging from cardiologists to chiropractors to personal trainers. While many of these professionals were skeptical of the ability of a device to replace any element of their direct hands-on involvement with their clients, some hopeful trends did emerge. Much of their work is focused on helping their clients to listen to their bodies. While some segments, such as yoga practitioners, may be sensitive to these physical signals, many potential users, particularly those in high pressure jobs, need a great deal of assistance. As one Chiropractor put it: The StressEraser “would be a great tool for people who have a harder time feeling what’s going on in their body. It gives people a way to ‘see’ the result of an exercise or activity in their body”.

This was confirmed by follow-up interviews with our target market: “The things that reduce my stress, like yoga, take 2+ hours out of my day, so I don’t have time for that. I would definitely get a stress monitoring device, if I new it didn’t take too time out of my day for

the breathing exercises.”

The client was strongly attached to a negative marketing strategy around managing stress in crisis situations. We found that the typical person with stress management issues requires a great deal of positive as well as negative reinforcement to change their health habits. While users are bombarded with negative reinforcement, positive influences, in the form of mentors and coaches, are much less available. We developed a series of user scenarios to help position the product in a more positive light (**Figure 3**).

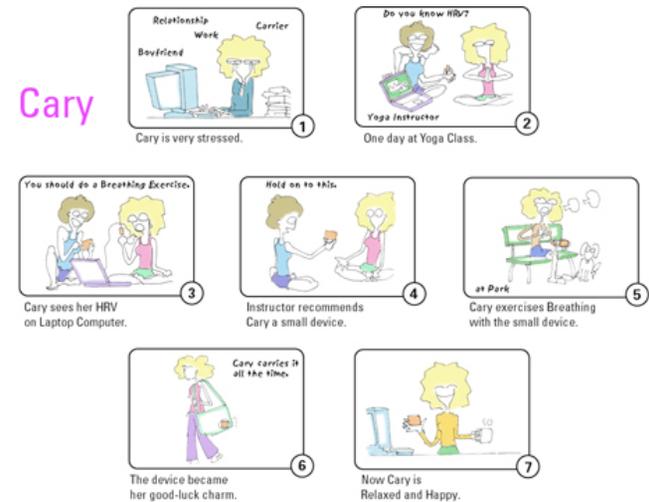


Figure 3. Sample user scenario for the StressEraser

Out of these insights emerged a strong overall model for the experience (the coach or guide), and a much better understanding of the most receptive audience for our product. The metaphor of a coach or guide became

the primary vision for the project. The biggest challenge was to fulfill these user expectations in a small, handheld device with a 165 x 68 pixel, two-bit display and limited audio output.

Frogdesign performed a thorough competitive scan of existing products related to biofeedback and heart rate monitoring. We looked at everything from heart rate monitors, like the Polar wrist-based exercise products to the Freeze-Framer™ from Heartmath. While some of the computer-based products, like the Freeze-Framer™, provide rich visualizations to support different breathing exercises, none of the handheld products provide much in the way of guidance and rewards. To understand how to apply this model to a more limited display we looked instead to exercise equipment and video games. We were able to identify several key elements that made these activities habit-forming:

- [1] No prior knowledge is required. The system is trained to the user through a set of simple steps that calibrate the experience at the beginning of the process.
- [2] The process moves along in a guided, linear manner with clearly defined stages.
- [3] Rewards and encouragement are provided contextually, to reinforce positive behavior.
- [4] Rewards are provided on multiple timescales to maintain interest and attachment.

We took particular inspiration from game designers. Good games provide rewards not just as an end-goal, but as a way of establishing patterns of behavior: “Watch the rhythms emerge, and how the player and the game interact. It will become clear that the game is

really an entrainment engine. The job of the gamewright therefore, is to reinforce patterns, and dampen dissonance”[9].

B. Solution details:

It took a number of attempts to apply this model to the StressEraser product experience. Over the course of almost two years we refined and tested various aspects of the design with end users through a variety of simulations, some screen-based and some on actual prototype hardware. The first few iterations of the design focused on the graphical representation of the HRV graph and the breath pacer metronome.

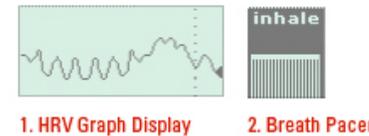


Figure 4. Two key elements of the user interface are the graphical display of HRV data over time and the Breath Pacer that guides the user through different breathing exercises.

We tested a number of different variants of these displays with groups 6-8 participants. While these tests allowed us to optimize the display and behavior of these primary elements, they also confirmed the need for more guidance and encouragement before, during and after a breathing session.

Based on this feedback we introduced an initial calibration sequence. This sequence served a number of purposes:

- [1] Introduce the primary elements of the user interface.

- [2] Educate the user regarding HRV and its connection to stress
- [3] Demonstrate the principles of biofeedback that establish a connection between physical actions (such as breathing) and the display.
- [4] Calibrate the system to the breathing capacity of the individual user.

This is a strategy used frequently in exercise equipment. An analogous approach can be found in Yourself!Fitness, from responDESIGN, an exercise program that was recently released on the Xbox gaming platform.



Figure 5. The overall interaction model divides the experience into three stages of engagement.

The final design of the user interface guides the user through three stages of engagement while providing a strong sense of context and clear rewards at each stage (**Figure 5**). The first stage is a linear, step by step introduction to the breathing process that calibrates the device (**Figure 7**). The linear structure is reinforced by a step indicator in the upper right corner of the screen. The second stage is a live breathing session that is guided by a 5:00 session timer. The system provides explicit 'coaching' in the form of periodic messages that reinforce optimal breathing patterns. Additional guidance is provided in the form of a persistent metronome, the Breath Pacer. This pacer is represented on-screen as well as through two forms of ambient feedback: LED's and audio cues, to free the

user from the screen-based GUI (**Figure 6**). These alternate mechanisms allow the user to concentrate on breathing and not on controls or menus in the UI.



Figure 6. Ambient Feedback: the breathe button under the screen glows to reinforce optimal breathing, allowing the user to stay in a synchronized state without relying on the LCD screen.

For our first round of user testing we used the Freeze-Framer to introduce the basic biofeedback principles before presenting our initial designs. During these tests we noticed that some level of synchronization or entrainment was easy to achieve within a single session for many users. While this provided immediate positive reinforcement of the StressEraser experience it also created a challenge in managing user perceptions. To become habit-forming we needed to provide rewards beyond this initial positive reinforcement: "Goals and control can be provided and created at multiple scales, from quick low level goals such as 'get over the bridge in front of you' to long-term, higher level goals such as 'get all the red coins in the world.'" [9] For the next version of the design, we introduced more immersive visualizations as level variants [10] within the five minute session (**Figure 8**).

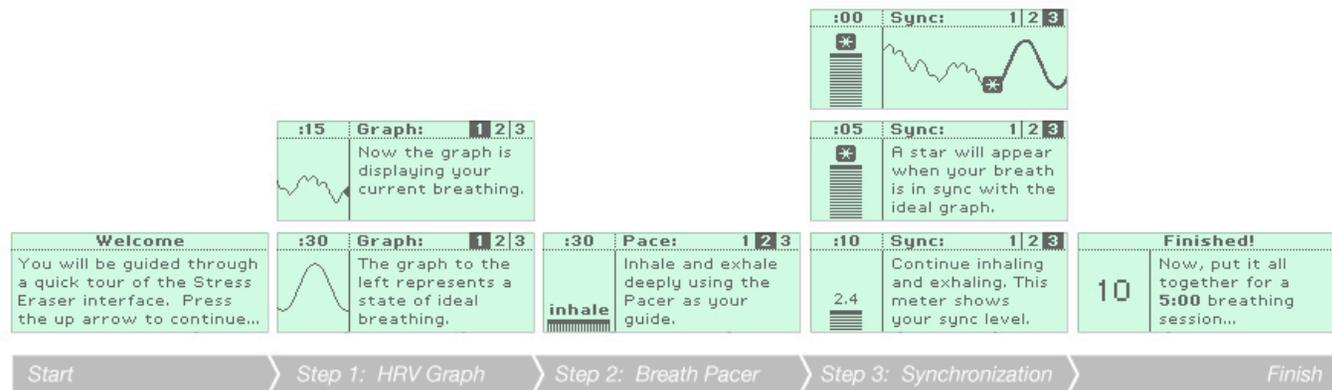


Figure 7. Stage 1: Introduction & Calibration. The first-time user is presented with a guided introduction to the device. This tour walks through each individual element of the breathing process. These elements, such as the HRV graph, respond to the user's physical state through data that is captured by a sensor in the finger clip. The user can move back and forward within the tour, exploring each element in turn until he/she is ready to begin a timed session. This process is linear, with a persistent indication of the user's location within the process. The tour can be skipped by pressing the 'breathe' button to initiate a breathing session. The introduction serves another important purpose: allowing the device to calibrate to the users breathing capacity.

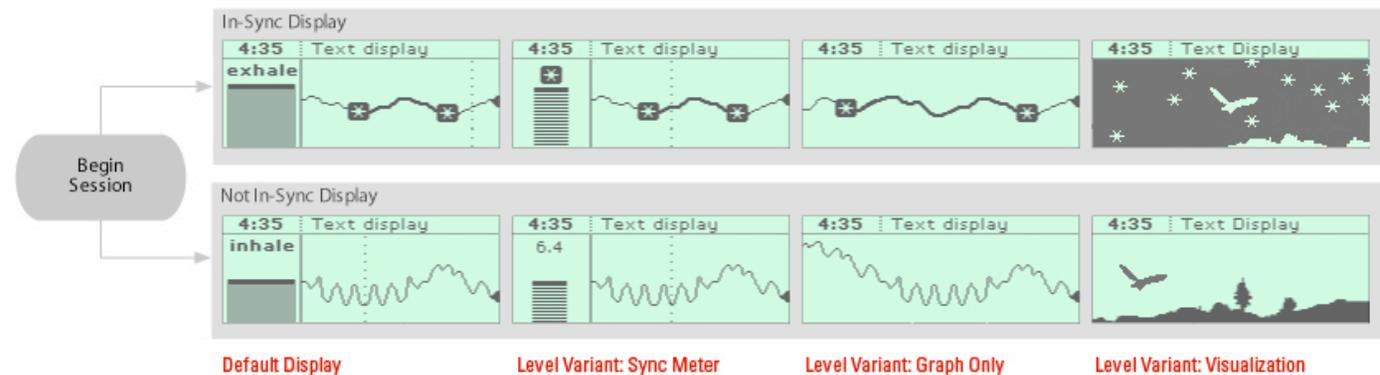


Figure 8. Stage 2: Breathing Session. Breathing sessions are guided as well, but they are driven by time and not a step by step process. Each session begins with a countdown and then displays the user's live HRV data in the form of a graph. Optimal breathing patterns are reinforced through a pacer as well as text that displays encouraging messages. During a session, the user can navigate easily between several visualizations of their HRV data.

We also introduced an iconic representation of synchronization similar to the tokens of power that are collected in computer games like Zelda (**Figure 9**). The various stages of the experience are unified by this common token. In subsequent rounds of testing we allowed users to take prototype devices home to see how the StressEraser would fit into their actual routine. It was only through this kind of extended, contextual use that we were able to validate the reward system in the design.



Figure 9. Synchronization is represented as a token or symbol (a star) that is consistent throughout the user experience.

C. Results (measured against goals)

This product has not been released to market so it is too early to assess the results for end users. Initial trials with friends and family have been encouraging: "It is for me a meditation for dummies device. I love it....I have found heaven in this device. I am calmer more and more during the day....The device has become a true friend." And "[The StressEraser] makes me fall into a sort of meditative state....it is comforting

to know that it is there when I do need it." We have since incorporated the notion of guided experiences and rewards into a number of programs for other clients, including manufacturers of cell phones and digital cameras.

There have been a number of other health-related products that have recently come on the market based on similar design principles: Yourself!Fitness and The Journey to WildDivine, a CD-ROM based biofeedback and meditation tool. In both cases the coach metaphor has been expressed as a literal character within the experience. While this approach may be entirely appropriate for the yoga and exercise market, our research suggested that it would undercut the credibility of a medical product, like the StressEraser.

References

- [1] Buxton, William. Less Is More (More or Less). Buxton Design, Toronto Ontario. Page 17.
- [2] Buxton, William. Less Is More (More or Less). Buxton Design, Toronto Ontario. Page 1.
- [3] Takase, B., Noritake, M., Uehata, A., Maruyama, T., Nagayoshi, H., Nishioka, T., Heart Rate Variability in Patients with Diabetes Mellitus, Ischemic Heart Disease, and Congestive Heart Failure. National Defense Medical College, Saitama, Japan. 1992
- [4] Norman, Donald. The Invisible Computer...
- [5] McCullough, Malcom. Digital Ground
- [6] Buxton, William. Less Is More (More or Less). Buxton Design, Toronto Ontario. Page 19.
- [7] Harris, T., B., Higgins, Hughes, J., Nichols, J., Myers, M., Pignol, M., Rosenfeld, R. Generating Remote Control Interfaces for Complex

Appliances. School of Computer Science,
Carnegies Mellon University. Pittsburgh, PA.

- [8] Harris, T., B., Higgins, Hughes, J., Litwack,
K., Nichols, J., Myers, M., Rosenfeld, R. Personal
Universal Controllers: Controlling Complex
Appliances With GUIs and Speech. School of
Computer Science, Carnegies Mellon University.
Pittsburgh, PA.
- [9] Moriarty, Brian in Salen, Katie & Zimmerman, Eric.
Rules of Play. Cambridge Massachusetts. The MIT
Press. 2004. Page 341.

[10] Church, Doug. Formal Abstract Design Tools.
www.gamasutra.com.

- [11] Salen, Katie & Zimmerman, Eric. Rules of Play.
Cambridge Massachusetts. The MIT Press. 2004.
Page 323.

Acknowledgements

I would like to thank David Merkoski, Eric Freitag and
Adam Forbes for their keen insights throughout this
project.