The New Biotechnological Frontier: The Empath Watch

Specific Aim

The mission of the Company is to acquire, develop and market biosensor and emotion detection technologies and to integrate existing, profitable businesses, with a focus on healthcare, security, and transportation. The Company's core assets are related to biosensor wristwatches, biosensor turnstiles, emotion detection algorithms and related technologies, originally developed by David Bychkov, Exmovere LLC, Exmocare LLC, Exmogate LLC and BT2 International.

The wristwatches, called the Exmocare Telepath and Exmocare Empath respectively, are intended for mass production and sale to mature adults who need assistance with their daily living and could benefit from the Empath's ability to monitor their vital signs on a regular basis and the Telepath's ability to transmit those data by Bluetooth. In the case of the Telepath, the vital sign results will be monitored by security companies, phone companies, etc. These data will be assessed by the computers that receive the signals, and then that monitor/computer will determine what type of corrective action may be needed on a patient by patient basis.

The detection of human emotions from vital sign data collected by biosensors, either embedded or worn will be analyzed. These emotion detection algorithms can be used to detect like, dislike, stress, relaxation, anger, depression and a multitude of other human emotional states with at least 85% accuracy as compared to self reporting by test subjects.

This information will be used in the clinical setting to make timely decisions based on data received. This reduces unnecessary external patient testing while allowing health care clinicians to diagnose and treat in a more efficient and accurate manner while reducing overall costs to patients, insurance companies, and governmental agencies.

Research Design and Methods

Project title: The New Biotechnological Frontier: The Empath Watch

Research Area: Biotechnology and psycho-physiological monitoring technology.

Broad Challenge

In a society whose population ages as fast as the census can keep count, one common factor keeps popping up: Disease treatment and prevention. The geriatric population is living longer as the medical community gets wiser. Although fortunate for people benefiting from this knowledge base, it results in costing patients, insurance companies and governmental health agencies millions upon millions of dollars of unnecessary external testing and monitoring.

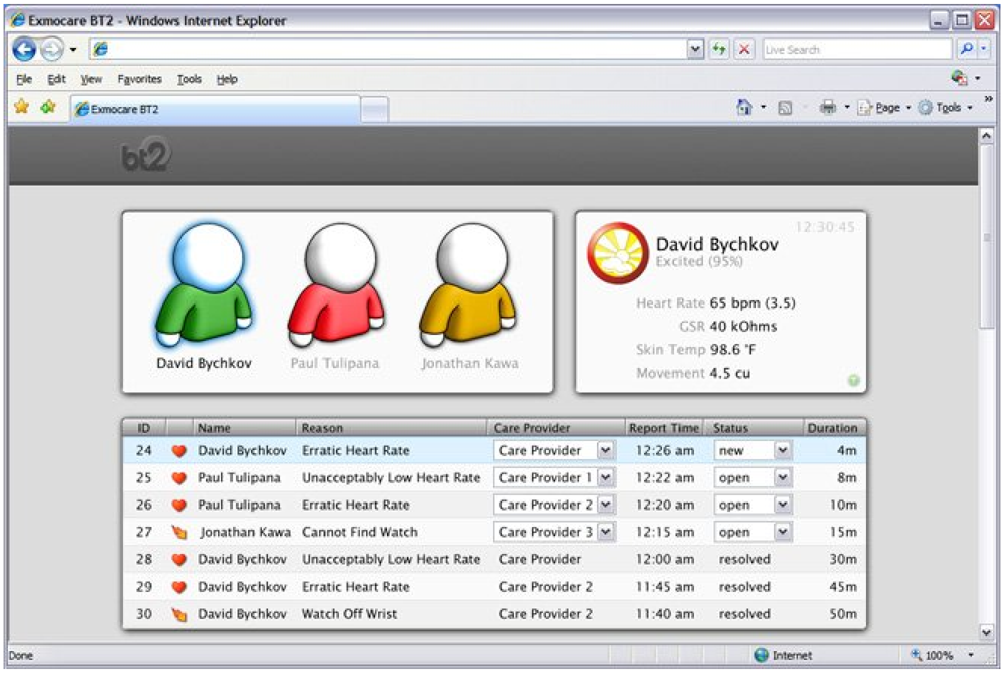
Peter Orszag, Director of the Congressional Budget Office, estimates that 5 percent of the nation's gross domestic product; $700 billion per year, goes to tests and procedures that do not actually improve health outcomes. By cutting just .25% from that cost, the resulting $175 billion savings can be passed down through various entities.

Specific Challenge

Information that direct care providers use in patient treatment is now gathered using external testing in various forms. The average cost of an electrocardiogram in 2009 is $129.00. Heart rate and heart rate variability are assessed using infrared signals to determine blood volume pulse by the Exmocare watch.

Many times stacked diagnostic criterion is used in formulating patient diagnosis, such as skin temperature and dryness. Both skin temperature and galvanic skin response can be measured by the Exmocare watch. Not only can the watch assess emotional state, but be programmed to send an alert when specific stacked criterion is met. In a patient with a history of cardiac disease, it is conceivable that the watch could alert caregivers and clinicians before the patient suffers an acute myocardial infarction.

By the time the patient arrives for treatment, most data needed will have been received, collected, and a plan of action initiated resulting in improved patient outcomes and monetary savings to all entities involved.



Challenge and Potential Impact

Finding unique ways to cut treatment time for patients while at the same time minimizing healthcare cost has been a goal of both the private consumer and the corporate insurance carrier for decades. The sciences of biotechnology and psychophysiology have now reached a point that the science fiction of just a few years ago is the reality in which we live today. This ground-breaking research fills the gap between what we inaccurately report as humans, and the reality biotechnology measures.

The potential impact in health care and health care related savings to patients and insurance companies can be measured by the number of early diagnoses made by clinicians that would be otherwise left untreated leading to more serious concerns. The ultimate goal is a health care delivery system; each component accepting responsibility for the quality and cost of the care it delivers while responding to powerful incentives to innovate in order to improve outcomes, patient satisfaction, and value for money.

By several measures, health care spending continues to rise at the fastest rate in our history. The National Coalition on Health Care reports:

- In 2007, total national health expenditures were expected to rise 6.9 percent — two times the rate of inflation.
- Total spending was $2.3 Trillion in 2007, or $7600 per person. Total health care spending represented 16 percent of the gross domestic product (GDP).
- U.S. health care spending is expected to increase at similar levels for the next decade reaching $4.2 trillion in 2016, or 20 percent of GDP.
- In 2007, employer health insurance premiums increased by 6.1 percent - two times the rate of inflation. The annual premium for an employer health plan covering a family of four averaged nearly $12,100. The annual premium for single coverage averaged over $4,400.

Experts agree that our health care system is riddled with inefficiencies, excessive administrative expenses, inflated prices, poor management, and inappropriate care, waste and fraud. These problems significantly increase the cost of medical care and health insurance for employers and workers and affect the security of families.

The potential impact this could reasonably bring in savings alone to the Medicare system could easily be in the trillions of dollars as evidenced by this report by the California Public Interest Research Group reporting on a single state:

> ‘Californians can save more than $1 billion each year by eliminating unnecessary medical treatments, using less-expensive but equally effective drugs and reducing other kinds of waste from the health care system.’

The geriatric population will derive greater benefits from the use of the Exmocare Empath watch than other demographic groups. Exmocare represents the absolute state of the art in command and control technologies for monitoring of elderly and infirm people in the home as well as in the car. Exmovere goal is version 2.0 of the version 2.0 Exmocare wristwatch, which we hope will feature infrared blood glucose monitoring and blood oxygenation monitoring. Exmocare is based on Bluetooth transmission, so it is a natural fit with current and future medical technologies.

Development Approach

The Exmocare *Empath* is the second-generation Exmocare watch, which makes substantial improvements on the current hardware. The vast majority of client and customer feedback has indicated that there are five (5) basic areas that, if addressed, would better equip the Exmocare watch for continued use in the wide variety of applications to which it has been applied:

- Form factor
- Power management
- User interface
- Configurability
- Unit Cost

Each of these areas, and many more, have been considered carefully by Exmocare’s internal development team, and solutions have been determined that meet all known criteria for the institutional and consumer-level success of the device.
The following are preliminary models created by the Empath’s lead designer, Nicholas Senske.

Materials

Material selection is a key design issue for any consumer product, especially one that must be worn at all times. A device like ours not only has to accommodate a state-of-the-art sensor suite, but it has to do so reliably and with style. We believe that the previous design only marginally fulfilled these requirements. Moreover, it did not *feel* high-tech and high-quality. With the Empath, we set out to address these shortcomings—to create something that not only worked beautifully, but looked the part.

Towards this end, we are evaluating several materials and processes for the watch housing and band. The selection criteria are as follows:

1. Durability

Since the device is intended to be worn 24 hours a day, the material we use must be non-porous, non-reactive, and resistant to all manner of impact events.

2. Product Appearance

The material should not look or feel “cheap”. It should feel solid and substantial. It should look sleek and shiny. It should also stay looking great: resisting scratches, staining, UV discoloration, etc.

3. Comfort

The material should be comfortable to wear for extended periods of time (this relates to issues of wear and thermal comfort below).

4. Electronic isolation

The housing should not interfere with the operation of the electronic components, especially the transmission needs of the device.

5. Thermal isolation

If possible, the housing and band should help to dissipate heat from the electronics without warming the skin noticeably.

6. Environmentally-responsible materials and design

All materials used must be non-toxic (no BFR's or PVC). Using recycled plastic is an inexpensive way to reduce the consumables our product requires with no impact on the material's quality or durability. Plastic pieces should be marked with the appropriate recycling indicators for future disassembly and reclamation.

From these criteria, we presently conceive the body of the Empath to be composed of a durable plastic or layers of plastic, similar to the design of many of today's popular consumer electronics. Our precedents for this are the Apple iPod and Gameboy DS Lite, both of which are lifestyle devices: items people carry with them all day long. These devices survive being shoved into pockets and backpacks and still come out looking stylish. Compared to a metal housing, plastic offers reduced development time and manufacturing costs and does not interfere with wireless signals.

We propose a two-layered body composed of a rigid colored plastic frame covered in a transparent wear-resistant layer. For the base layer, our best candidate is ABS plastic (the same material used in LEGOS) in white. ABS is extremely durable, has good electrical properties, and is non-toxic and recyclable. The shell will likely be some form of clear polycarbonate (PC), which has high impact and heat resistance as well as great clarity. In practice, this top coating appears to float and gather light into the color layer, making it appear to almost glow. With a sufficiently light base color, the appearance of scratches and other wear is minimized, although the presence of oils from fingerprints is more noticeable.

We see the top bezel as a matte finish colored ABS. Currently, this piece is both non-essential and very easy to replace, so it is possible we could offer many different colors and designs for easy customization.

The band must be flexible enough to accommodate adjustment and durable enough to weather daily activities and battery changing cycles. Additionally, it has the additional technical requirements of containing the GSR electrodes and possibly the batteries. Because of the demands of these components, a link-style band (metal or plastic) is out of the question. A solid, hard plastic band is ruled out because it has to bend. Therefore, we are strongly considering a molded resin process. The advantage of this is that the result is a sealed, single piece. The disadvantage is that bands most likely cannot be fixed, but must be replaced outright. This should be manageable if we can keep the manufacturing costs low and ensure that we use a resin material that is recyclable.

The Empath has been redesigned from the ground up, making use of all the accumulated knowledge from a year of working with the current Exmocare watch. These redesigns include:

1. Completely redesigned form factor

a. Much smaller form factor

i. 1.5” diameter circular form factor @ ~.5” height

ii. Form factor now comparable to many consumer wristwatches.

b. Detachable band contains rechargeable battery

i. Watch comes with two bands and form-fitted charger.

ii. Changing and charging the battery is substantially easier

2. Extremely sensitive clinical sensor components

a. Newest, smallest, top-of-the-line sensor components allow for more accurate readings and lower power consumption than ever before.

b. Intelligent analog to digital conversion reduces power consumption and provides the capability for real-time

3. Onboard logic and memory

a. All digital signal processing will now be performed onboard the watch, reducing the risk of transmission errors.

b. Critical alerts will be sent directly by text message to wearer-configured caregiver, eliminating need for software-based delivery method.

c. User storage (flash memory) onboard allows the watch to store 24 hours worth of data for transmission.

i. Combined with transfer authentication logic onboard, this eliminates the possibility of missing a reading altogether.

d. Intelligent readings collection logic and configurable “panic mode” onboard significantly reduces power consumption for the device.

i. 3c and 3d simultaneously eliminate the requirement of an additional internet-enabled device to be present at all times.

e. System ROM eliminates the need for regular internet connectivity by storing configuration settings onboard.

f. Additional emergency medical and identification information can be stored and accessed from Flash memory.

g. Use of the micro .NET framework allows easy firmware upgrades and substantially better hardware/software integration across the board.

4. Substantially improved communications array

a. ZigBee replaces Bluetooth, allowing increased transmission range and lower power consumption.

b. GSM/CDMA onboard allows instantaneous sending of SMS alerts in situations where wireless transmission is unavailable, eliminating the need for a Smart Phone or other GSM/CDMA-equipped device for the Exmocare watch to be "mobile".

c. USB connector on dongle allows users to flash firmware and configure their device from their Home PC directly.

5. Expanded Internal User Interface

a. The Empath will feature a full-color OLED screen and a smart two-button I/O, allowing the wearer to interface with it directly in the following ways:

i. Substantially more verbose "face" – including time display, battery level, connectivity level (if applicable) and full color graphics.

ii. "Alarm mode" will allow the wearer to set multiple alarms and schedule reminders (take medication, etc).

iii. Heart rate monitor will graphically display the wearer's current heart rate on the face of the watch.

iv. The wearer's emergency medical information (name, address, next of kin, blood type, etc) will all be able to be stored in the watch, and will be viewable directly from the interface, allowing EMTs, doctors, etc. to get valuable information directly from the device.

v. The watch wearer will be able, from the watch, to set date and time, emergency contact (for SMS alerts).

vi. Privacy/Airplane mode will allow the wearer to stop the watch communicating, making it safe for air travel and also providing a privacy filter.

In short, every facet of the watch will be redesigned with the most robust usage conditions possible in mind. A more beautiful design, lower power consumption, substantially better display, greatly increased ease of use, and a smaller, more comfortable form factor will be possible all for a unit cost of about 1/3 of the current cost.

Watch Design

In redesigning the Exmocare watch, we had two primary goals: First, to ensure that the process of gathering and processing sensor information was significantly more accurate in a clinical setting than with the current watch. Second, that the form factor "looked and felt" like a high-quality consumer-grade wristwatch. We have taken great care to design both the watch hardware itself and the form factor to meet both of these goals.

Component Information

The heart of the Empath is the sensor technology found inside. Without some of the most accurate sensors in the world, the Empath could not perform in the wide variety of contexts for which it is designed. With that in mind, we have taken care to verify that each individual sensor will perform in all settings where the Empath might be reasonably expected to be used. In other words, while the Empath is not designed to perform in a space shuttle launch or in a deep-sea diving situation, it will work under almost any other circumstances.

Sensor Array and Analog/Digital Converter

Redesigning the sensor array is our top priority. Better power consumption, signal to noise ratio, size, spacing, and weather protection are all required.

Heart rate and Heart rate variability in the Exmocare watch are assessed using infrared signals to determine blood volume pulse. The highest quality IR emitters and receivers are required.

Emitter: The Empath will be equipped with a Fairchild Semiconductor 1N6265 GaAs Infrared Emitting Diode. The 1N6265 is a high-performance, hermetically-sealed emitter with a low power consumption of 6mW.

Receivers: The Empath will also be equipped with three (3) Fairchild Semiconductor L14N1 or L14N2 Hermetic Silicon Phototransistors. Two receivers are required for the Exmocare heart rate detection algorithm, with one redundant receiver in case of the failure of a single component. The L14N1/2's are wide-reception phototransistors providing photodiode abilities in hermetically-sealed packaging and passivity during sleep.

Skin Temperature and **ΔST** are valuable resources for the interpretation of emotional states, as well as good guides for assessing physiological safety. The Empath will have two temperature sensors, one measuring skin temperature directly and one measuring ambient temperature as a mode of comparison.

Skin Temperature: The GE NTC12 chip Thermistor is a high-sensitivity 1206 size surface mount ceramic chip thermistor with an operating range of -50°C - 150°C. This thermistor is designed for medical monitoring applications, where the thermistor is touching the skin, in order to give us the highest possible amount of accuracy in a direct-contact situation.

Ambient Temperature: The GE BR32/42/55 Glass Encapsulated Bead Thermistor is a rugged hermetic thermistor with a normal operating range of -80°C - 105°C, ideal for safe ambient temperature sensing in even the harshest and wettest climates.

The accelerometer in the Empath plays two valuable roles. First, it transmits relative movement, giving us a glimpse of the wearers' physical activity. Second, it allows us to cancel motion and gravitational effects in the infrared signal interpretation according to the Beer-Lambert Law.

The Freescale Semiconductor ±1.5g - 6g Three Axis Low-g capacitive Micromachined Accelerometer (MMA7260QT) features signal conditioning, a 1-pole low pass filter, temperature compensation and g-Select which allows for the selection among 4 sensitivities, and a sleep mode that makes it ideal for low power consumption.

Galvanic Skin Response and **ΔGSR** are important for many reasons, including: Emotional interpretation, watch-off-wrist detection ability, and confirmation of alert status in panic mode. Returning GSR from the top of the wrist is spotty at best. For this reason, we have designed the Empath with the GSR leads on the wristband, making contact with the bottom of the wrist for much higher reliability (see schematic drawings for the watch band below).

The implementation of GSR will be determined based on input from the Empath prototype hardware design team. At this point, one option under consideration for the electrodes is a silver-chloride electrode patch.

Analog-to-Digital Converter: Finally, in order to provide as close to real-time signal processing as possible, we need the ability to receive data from each sensor at the same, high, sample rate. Our agreed-upon best sample rate is 500Hz (500 samples per second). Each of our chosen sensors is configurable to meet this need.

In order to feed all of this information quickly and accurately to our onboard digital signal processing algorithms, we have chosen the Texas Instruments ADS1258 16-Channel, 24-bit Analog-to-Digital Converter. The ADS1258 is a 16-channel (multiplexed), low-noise, 24-bit, delta-sigma (DS) analog-to-digital converter (ADC) that provides single-cycle settled data at channel scan rates from 1.8k to 23.7k samples per second (SPS) per channel. A flexible input multiplexer accepts combinations of eight differential or 16 single-ended inputs with a full-scale differential range of 5V or true bipolar range of ±2.5V when operating with a 5V reference. The fourth-order delta-sigma modulator is followed by a fifth-order sinc digital filter optimized for low-noise performance. Programmable sensor bias current sources can be used to bias sensors or verify sensor integrity.

CPU/Storage

The advent of onboard logic, powering of a color display, and increased storage requirements demand that the Empath become an embedded computer system. To this end, we will require a custom-designed board that will house:

1. An ARM920T core processor supporting the .NET Micro Framework.

2. An SDRAM device of at least 32MB.

3. Local storage/Burst Flash Memory large enough to house the application firmware, 24 hours of stored readings, and watch wearer data. (Probably, 8-12MB will be sufficient).

Final components will be chosen once the fabrication models for the final circuit board are complete. All components will be chosen for effective power management, size, and price.

We are currently developing our proof of concept watch on the Freescale Semiconductor i.MXS Development Kit.

Organic LED Display

An organic light-emitting diode (OLED) is a special type of light-emitting diode (LED) in which the emissive layer is comprised of a thin film of organic compounds will be included. One of the great benefits of an OLED display over the traditional LCD displays is that OLEDs do not require a backlight to function. This means that they draw far less power and, when powered from a battery, can operate longer on the same charge.

Our current choice for a low power consumption full color display is the Truly Semiconductors 1.2-inch 96RGB x96 65k full color organic light emitting display standard module (overall dimension of panel is 28.3 x 27.1 x 1.6mm). The power consumption is measured as 0.37W for 50cd/m2 for full screen white color as OLED power consumption is highly dependent on the image content and hence the exact power is expected much lower than value.

Communications Array

The Empath will require a rather extensive communications array on the order of allowing all required interface methods. Our chosen approach requires three distinct interfaces.

1. **USB 2.0** – The USB interface will be located on the charger, and will be used exclusively for two reasons.

a. To flash the firmware. Firmware upgrades must take place over a highly controlled transport layer to ensure no degradation of the data. This can also be used to configure an individual watch for use with the different Exmocare software suites.

b. Desktop application-based configuration. For users of the Empath who do not use Exmocare Home Plus, Enterprise or Clinical services for interacting with and configuring the watch, a simple desktop application will be provided to enter emergency medical information, an emergency SMS contact, and very brief alerts configuration through a standard PC keyboard interface. This could also be used in the future to “skin” the watch.

We will be able to use almost any out of the box USB 2.0 component, because the charger will be plugged directly into the wall, thus requiring no specifically stringent power requirements, and will not have the space constraints that exist inside the watch.

2. **ZigBee** – The ZigBee protocol is intended for use in embedded applications requiring low data rates and low power consumption. ZigBee's current focus is to define a general-purpose, inexpensive, self-organizing, mesh network that can be used for, among other things, embedded sensing and medical data collection. The resulting network will use very small amounts of power.

ZigBee can be configured to transmit data to a ZigBee-enabled personal computer or mobile device in clinical settings and in Home Plus and Enterprise settings in which the data transfer requirement for GSM is low:

a. The most common use situation is where large amounts of data need to be transferred to a PC in a clinical setting.

b. Additionally, when an Enterprise Provider installs limited-transfer GSM cards, they may impose the requirement of a ZigBee dongle attached to a PC for direct transfer to the Enterprise server.

It is possible that our ZigBee component will have to be specially designed for the Empath to ensure excellent integration and low power consumption and physical size requirements. However, we are currently investigating the Telegesis ZigBee ETRX line of integrated ZigBee solutions. These chipsets, at the relatively small size of 37.75x20.45mm for an integrated solution, may provide a feasible store-bought alternative for the Empath.

3. **GSM** – The GSM protocol is the most popular standard for mobile phone communication in the world. The GSM protocol will be used in situations where:

a. The panic cycle detects a critical situation or configured alert and sends an SMS message to the configured recipient.

b. The Enterprise Provider has configured readings to be uploaded to the server via GSM, in which case this will happen by default 48 times a day or else on the schedule set by the Enterprise Provider.

The current component we are considering for use in the watch is the ultra-small AD6548 Othello-G Single-chip direct conversion GSM/GPRS Transceiver by Analog Devices. Analog Devices Othello-G is a true quad-band design, with independent programmable-gain LNAs for 850, 900, 1800 and 1900 MHz frequency bands. Local oscillator (LO) generation for both transmit and receive bands is performed on chip with a fast-locking Fractional-N PLL synthesizer with integrated loop filters, TX and RX VCOs, and tank circuits. The AD6548 also includes an on-chip crystal oscillator and calibration system, eliminating the traditional external VCTCXO and reducing cost. The translation-loop transmitter architecture eliminates the need for external filtering in the transmitter signal path.

Confirmation of this component requires an NDA between Exmocare and Analog Devices, which is currently being secured.

Shielding EMI and RFI

The Empath, as a design requirement, has a sensitive array of sensors and a series of communications modules. Eliminating the electromagnetic interference (EMI) and Radio Frequency Interference (RFI) inside the watch is of critical importance to getting the highest quality data. One approach currently under consideration is to shield the sensor array with an iron boride (or some similar composite) casing strip.

Watch Design Information

We live in a world in which technology is forever being further miniaturized. The consistent challenge of hardware and object designers is to fit all the required technology into a package that is as small as possible while still being mindful of ergonomic constraints. With a unique design and careful placement of components, we are able to reduce the projected requirements for the size of the Exmocare watch **n%** even with its many new included components. The current watch size is consistent with consumer expectations for a watch – no smaller and *no larger*.

An additional constraint on the Empath is determining appropriate button size. By using the largest part of the bevel's real estate for the two watch buttons, we have ensured that it will be easy even for someone of limited manual dexterity to interact with the watch directly. Further, by using haptic and audio feedback when the buttons are clicked, and with the design of the watch's graphical user interface, we have attempted to reduce the risk of unintended configuration.

This care was also extended to the design of the watch band. The watch band must reserve the possibility for housing the battery, and thus must be designed to be detachable. Even if another power solution is chosen (see below), it will be important for cosmetic reasons to be able to switch bands. The Empath's band also holds the galvanic skin response sensors, in order to get the most accurate GSR from the bottom of the wrist as opposed to the top. The process of removing the strap will be carefully considered for ease of use by even our hypothetical user with limited manual dexterity.

Size Comparison

Our goal with the Empath was to attempt to remove roughly 50% of the size from the current Exmocare wristwatch, by way of designing the Empath to look and feel like a "normal" wristwatch.

The current Exmocare watch is:

85.725 mm (3.375 inches) in length (thumb to pinkie)

42.863 mm (1.6875 inches) in width (wrist to elbow)

33.338 mm (1.3125 inches) in depth

The projected (safe) dimensions for the Empath are:

34.29 mm (1.35 inches) in length

50.8 mm (2 inches) in width

15.24 mm (0.6 inches) in depth

What this means is that – *using the worst case for the Empath* – in the two ergonomically costly (that is, "bulk-inducing") dimensions (length along wrist and depth) we have removed over 55% of the size, at a cost of roughly 15% along the forearm. This size puts us within the rage of a normal (albeit "chunky") wristwatch.

Features include:

User Interface

Designing a user interface for a 1x1" viewable area presents a unique set of challenges. As of now, the Empath, by the very nature of its being a watch, is ergonomically restricted to one of the smallest interface areas of any consumer device on the market. The second design challenge that comes into play with the Empath is the limited number of expected inputs. As a rule, a digital watch is expected to have two to four buttons. Given the projected (limited) manual dexterity of the Empath's biggest target market combined with the physical size of the device, two large buttons is basically the only option.

1. **Robustness**: that is, reduction of the possibility of improper inputs, and subsequently tolerance of the same. A robust interface is necessary not only to protect the device, but to protect the wearer of the watch and any potential care-givers. A secondary requirement of robustness is that under no circumstances (based on user input at least) should the Empath present an error message or a confirmation dialogue. By severely limiting input constraints, the Empath can "feel" more like a watch and less like a computer.

2. **Consistency**: that is, there are a set of simple rules that apply to all interface elements. Consistency allows the watch-wearer to quickly develop general rules about how the Empath works. Along with a general *less is more* principle, this will allow the Empath to be a "caring" product, instead of an intimidating one.

a. Path control. By limiting the number of paths with which a user can access a certain function, the learning curve for the interface is made simpler. Under normal (PC, cell phone, etc) device interface constraints, the ability to provide more pathways to a function is valuable, insofar as the number of necessary "clicks" is reduced. However, the severely limited input situation of the Empath, users will resent branching paths and prefer a more watch-standard "wraparound" interface.

3. **Affordance**. Affordance the property that indicates how obvious a device's function is from its appearance. By studying, interpreting, and simplifying expected methods of HCI (Human-Computer Interaction) for a digital watch the Empath can provide functionality based on the watch-wearer's extant conditioning.

4. **Compatibility**. As you may have noticed, we have been hedging around compatibility – our guiding principle – throughout sections 1-3. There are three levels of compatibility to discuss:

a. Compatibility between what the user expects and what the user gets.

b. Compatibility between different products of the same type.

c. Compatibility between the device and its surroundings, and the devices with which it is expected to cooperate.

4c is the largely the domain of the physical and component design of the watch, which has been and will continue to be discussed by this document. 4b is what we have been alluding to with the references to the "expected" behavior of a digital watch. Now, granted, there is nothing that really compares with or sets expectations directly on the Empath. It is a unique product, at least for now. This means that 4a becomes the guiding compatibility principle of the Empath.

Button Mapping

Again, the key factor in the determination of the Empath's interface is compatibility with expectations. The design challenge in creating the input system for the watch is that the closest expectation we have to conform to is a digital watch. In addition to that we have a requirement in place that dictates that the buttons must be large (usability), must for the most part perform a single function (consistency), and must be differentiated spatially and with haptic input to get the maximum amount of usability in all situations.

Panic Mode

Perhaps the least used and simultaneously most important function of the button interfaces is for manual panic mode. Triggering panic mode must:

1. Be simple enough to perform in a crisis situation

2. Be unique enough that there is a low risk of accidentally triggering a panic alert

Given the restricted number of options, the best possible way to trigger a manual alert is to press both buttons simultaneously and continuously for a period of 3 seconds. This action is unique among normal watch functions, simple to perform given the size of the buttons, and the time requirement should eliminate the vast majority of accidental manual alerts from being sent.

UI Interaction

Under normal watch interaction, it is important for consistency reasons to assign each button a single static function through all possible interactions. For this reason, we have assigned one button (top-of-face, assuming that most right-handed people wear a watch on their left wrist, and thus assigning the more frequently used button to the more dexterous index finger) as the *move button* and the other (the bottom-of-face thumb button) as the *set button*.

The move button gets the user from one place to the next. This button is used to navigate between interface screens, and also to adjust the value under the “cursor” when the user is entering data into the watch.

The set button changes the mode from view to edit for an individual interface screen (when applicable), and also applies changes to a value current under the “cursor” and moves the “cursor” to the next position.

Graphical User Interface

Given an intelligently standardized mode of interaction or input, the remainder of the challenge for a fully constituted interface for the Empath is the graphical user interface (**GUI**). The design of the GUI will be focused on aesthetic and usability requirements. To clarify, what we mean by usability is:

1. **Learnability**: How easy is it for users to accomplish basic tasks the first time they encounter the design?
2. **Efficiency**: Once users have learned the design, how quickly can they perform tasks?
3. **Memorability**: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
4. **Errors**: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
5. **Satisfaction**: How pleasant is it to use the design?

Clearly, many of these things can only finalized in real targeted end-user testing for, but by applying good design principles to the GUI, we can anticipate many potential problems.

Conclusion

This new, ground-breaking technology is unlike anything known to date. The detection of human emotions from vital sign data collected by biosensors either embedded or worn is cutting-edge biotechnology of the future.

These emotion detection algorithms can be used to detect like, dislike, stress, relaxation, anger, depression and a multitude of other human emotional states with at least 85% accuracy rating in the initial stage can only improve.

In a society whose population ages as fast as the census can keep count, one common factor keeps popping up: Disease treatment and prevention. The geriatric population is living longer as the medical community gets wiser. Although fortunate for people benefiting from this knowledge base, it results in costing patients, insurance companies and governmental health agencies millions upon millions of dollars of unnecessary external testing and monitoring. Many times stacked diagnostic criterion is used in formulating patient diagnosis, such as skin temperature and dryness. Both skin temperature and galvanic skin response can be measured by the Exmocare watch. Not only can the watch assess emotional state, but be programmed to send an alert when specific stacked criterion is met. In a patient with a history of cardiac disease, it is conceivable that the watch could alert caregivers and clinicians before the patient suffers an acute myocardial infarction.

Finding unique ways to cut treatment time for patients while at the same time minimizing healthcare cost has been a goal of both the private consumer and the corporate insurance carrier for decades. The sciences of biotechnology and psychophysiology have now reached a point that the science fiction of just a few years ago is the reality in which we live today. This ground-breaking research fills the gap between what we inaccurately report as humans, and the reality biotechnology measures.

The potential impact in health care and health care related savings to patients and insurance companies can be measured by the number of early diagnoses made by clinicians that would be otherwise left untreated leading to more serious concerns. The ultimate goal is a health care delivery system; each component accepting responsibility for the quality and cost of the care it delivers while responding to powerful incentives to innovate in order to improve outcomes, patient satisfaction, and value for money.

Based on the criterion of durability, reliability, comfort, and appearance, the Exmocare watch is second-to-none in design and technology.

The national fiscal impact on the health care system will be the savings of hundreds upon hundreds of thousands of governmental dollars to the Medicare system alone.