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# Apple iPod Touch Relevance to Military Weather Applications

**by David Sauter**

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# Apple iPod Touch Relevance to Military Weather Applications

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**14. ABSTRACT**

Mobile computing devices can provide invaluable information to dismounted Soldiers on the battlefield when desktop or laptop computers are not readily available. This report summarizes the usefulness of Apple iPod Touch devices for providing weather and weather effects information to the lower echelons. Both connected (to a remote computer) and standalone (not connected) applications (apps) are investigated.

**15. SUBJECT TERMS**

mobile computing, handheld devices, weather effects

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# 1. Summary

Apple iPod Touch (and iPhone) devices provide a mobile, powerful, versatile, and relatively inexpensive computing platform that is potentially well-suited for use by the military. Applications ("apps") are relatively easy to develop and deploy for tailored military use. An additional benefit is that many of today's Soldiers are already familiar with the operation of the device so little training is required. On the downside, licensing and provisioning profile issues required for development and distribution are frustrating and create an inefficient and cumbersome environment for app evaluation. In addition, the apps developed can only be run on Apple devices as opposed to open source apps (e.g., for the Android devices) which have a large number of potential hosting platforms. This report will discuss the iPod Touch capabilities as relevant to the military for providing weather and weather impacts. An actual app that has been developed to provide heat stress guidance will be examined.

# 2. Introduction

There are situations in which Soldiers do not have access to computer workstations or even laptops but still require intelligence regarding weather and weather impacts on their missions. In these events, handheld computing devices may be able to provide critical information with only simple locally available inputs (negating the requirement for a network connection). While there are numerous mobile computing device platforms that could provide this information (e.g., personal digital assistants [PDAs], smartphones, Apple iPhones and iPod Touch devices, etc.), this report will focus on the Apple iPod Touch. Sauter[1] specifically discusses PDA capabilities and apps.

In 2009, the U.S. Army Research Laboratory (ARL) Battlefield Environment Division was requested to support the Army sponsored All American Bowl (AAB) high technology exhibit in San Antonio in January 2010. Although existing apps existed on the PDA (including the fielded Mobile Artillery Meteorological application ["app"]), it was felt that demonstrating an app on the fairly new and very popular Apple iPhone or iPod Touch would generate additional interest from both the military and the general public (the AAB exhibits were open to the public). Thus, the prototype Mobile Heat Stress Decision Aid (MHSDA) developed in conjunction with the U.S. Army Research Institute of Environmental Medicine (USARIEM) at Natick, MA, was selected as a test app to host on the Apple iPod Touch. The touch device is similar to the iPhone, except it lacks the cell phone and camera capabilities. Hosting on the iPod Touch would provide insight

[1] Sauter, D. *Portable Weather Intelligence for the Soldier*; ARL-TR-4502; U.S. Army Research Laboratory: White Sands Missile Range, NM, 2008.

as to the Apple development environment, graphical user interface (GUI), computing capabilities, etc., that were previously unknown and allow us to determine the potential of the device for military app.

## 3. Development Environment

In order to develop iPhone or iPod Touch apps (simply referred to as apps from here on), an Intel-based Macintosh (desktop or laptop) is required, running Leopard (OS X 10.4.11 or later). The development is then done via the iPhone Software Development Kit (SDK), downloaded for free once the user becomes a registered iPhone developer. The SDK includes Xcode, which is Apple's integrated development environment (IDE). Xcode features a compiler, debugger, text editor, and GUI builder. An actual iPhone or iPod Touch device is not needed for the development and testing (unless using one of the hardware-dependent features, such as the accelerometer or camera) as the SDK includes a simulator, which runs on the desktop or laptop. Programming for the devices is written in the Objective-C language which is an object-oriented language. Obviously, the final testing and deployment will require an actual iPhone or iPod Touch in addition to the purchase of an annual development license.

For development, two iPod Touch 32 GB (flash memory) devices (third generation) were procured, as well as a Macbook. The iPod Touch is a capable computing device for its size, which is evident by the following features:

- 3.5-in widescreen Multi-Touch display with 480 × 320 pixel resolution
- 2.4 × 0.3 ×4.3-in and 4-oz weight
- Bluetooth and Wi-Fi wireless communication
- Safari web browser
- Location-based services via Wi-Fi
- Integrated speaker
- Accelerometer
- 256 MB RAM and 800 MHz processor

Although the processor speed and amount of RAM available are certainly more than adequate for simple weather apps, there are considerations that must be accounted for when designing the software. The primary issue has to do with the screen size and the fact that all screen input is via a user's finger tips. Thus, in designing the GUI, care must be taken regarding the size of input fields. Also, output screens must not contain too much information or too small of a font.

One major drawback with the Apple development and deployment process for the iPod Touch is the requirement for obtaining a developer license and provisioning profile. Although the license is valid for a year ($100), the provisioning profile (necessary for deploying apps to the remote device) expires every 3 months, forcing one to request a new profile, download to the Macbook and then rebuild and deploy the apps to the iPod Touch. In terms of supporting app evaluation at remote sites, this is an unacceptable process as it necessitates the return of each device to the developer.

# 4. Considerations for Military Use

There are a number of advantages in developing and deploying apps on the Apple iPod Touch devices, as described in section 4.1. Disadvantages for apps on the Apple iPod Touch are mentioned in section 4.2.

## 4.1 Advantages

### 4.1.1 Low Cost

A new 32 GB iPod can be purchased for less than $300. Compared to mobile devices that may be custom designed and developed for military operations, this is a very reasonable cost. Although these devices may not be as ruggedized as other devices currently in use by the military, it would seem that the low cost per unit justifies their use. Due to their light weight and size, they logistically have a small footprint, and it seems logical that spares could be readily available.

### 4.1.2 Soldier Familiarity

It is likely that a significant percentage of Soldiers (especially new recruits) are familiar with the use of iPod Touch devices and their operation. This translates into reduced training costs. Also, being familiar with the devices means that the Warfighter is more likely to use the device and associated apps.

### 4.1.3 Large Storage Space

The iPod Touch can be purchased with up to 64 GB of memory and this amount will probably increase in the future. This amount of storage provides the capability to store large weather-related gridded databases, satellite imagery, and even video. Gridded weather or weather effects databases can be used to provide high resolution (both spatially and temporally) input data required by some weather-related apps.

## 4.2 Disadvantages

### 4.2.1 Lack of Secure and Long-range Wireless Communications

The effective range for Bluetooth communications is on the order of several meters while Wi-Fi (in an open environment) may be several hundred meters to up to a few kilometers. This is obviously not sufficient for military communications back to a remote server, which may be tens of (or more) kilometers away. Thus, receiving and transmitting critical information is a concern. This can be mitigated to some extent by developing apps that only require simple locally entered weather inputs (or possibly using one of the available high quality handheld weather sensors). Or, in the case of apps that require more complex input (e.g., high resolution gridded data) it may be possible to download an entire database of weather or weather effects information to the device while at the garrison or tactical operations center (TOC) for use during the day. Ideally, however, there will eventually be longer range secure wireless communication capabilities. Note that this is also a shortcoming of PDAs and Android smartphones without cellular service as well.

### 4.2.2 Built-in Rechargeable Battery

The iPod Touch has a built-in lithium-ion battery that cannot be replaced by the user, thus, spare batteries cannot be carried. This necessitates access to AC power or a secondary device with a USB port for recharging of the device after 5−10 hours of continuous use (dependant on what type of activity is being performed). Miniature fuel cells may provide a partial solution to remote charging in the near future. Also, if there is only sporadic use of the device, a single charge can last for many days of operations. In a tactical environment, however, it is likely unacceptable to be forced to send the device back to an Apple authorized dealer every time a battery needs to be replaced.

### 4.2.3 Apps Portability

Apps developed and hosted on the iPod Touch (and iPhone) are written in the C language and use graphics as provided for via the interface builder. Thus, these apps are not portable to other mobile devices, such as PDAs and smart phones, without rewriting at least portions of the code. In fairness, this is also true for non-Java apps written for PDAs. The Android IDE is Java-based so those apps should be more portable.

## 5. Prototype App

Attesting to the relative ease in learning the iPhone SDK, a prototype MHSDA was ported from a PDA implementation in 2−3 months. This involved a complete rewrite of the GUI from the Microsoft Foundation Classes (MFC) to the iPod using the interface builder. While not difficult, it did require the majority of the time due to starting from scratch with different GUI elements (to a certain extent) and the "callbacks" to the computational algorithms. Additional effort was required related to learning the IDE, making minor modifications to the C algorithms and the licensing and provisioning profile procedures. Fortunately, there were no issues in switching from the iPod simulator environment to the actual iPod Touches once the license was obtained.

The MHSDA app was developed initially to address the issue of heat stress injuries in the military. Carter[2] indicated that annually, there are over 200 injuries requiring hospitalization from heat stress resulting in an average of almost two deaths. Thus, the rationale is justified for developing such an app and making it available on a mobile device. Current plans are to initiate testing and evaluation in FY11 as the next step in the transition of the technology to the Warfighter. Figures 1−8 show the various input and output screens with a discussion of the various GUI elements and potential future enhancements.

### 5.1 Launch Screen

Figure 1 shows the initial screen that is displayed upon startup of the device. Each app is represented by an icon. Simply tapping the icon with your fingertip launches that app. The MHSDA app is the far right icon in the fourth row from the top. The bottom-most row represents the user's favorite apps. Only one app can run at a time.

[2] Carter, et.al. Epidemiology of Hospitalizations and Deaths from Heat Illness in Soldiers. *Medicine & Science in Sports & Exercise* **2005**, *37* (8), 1338−1344.

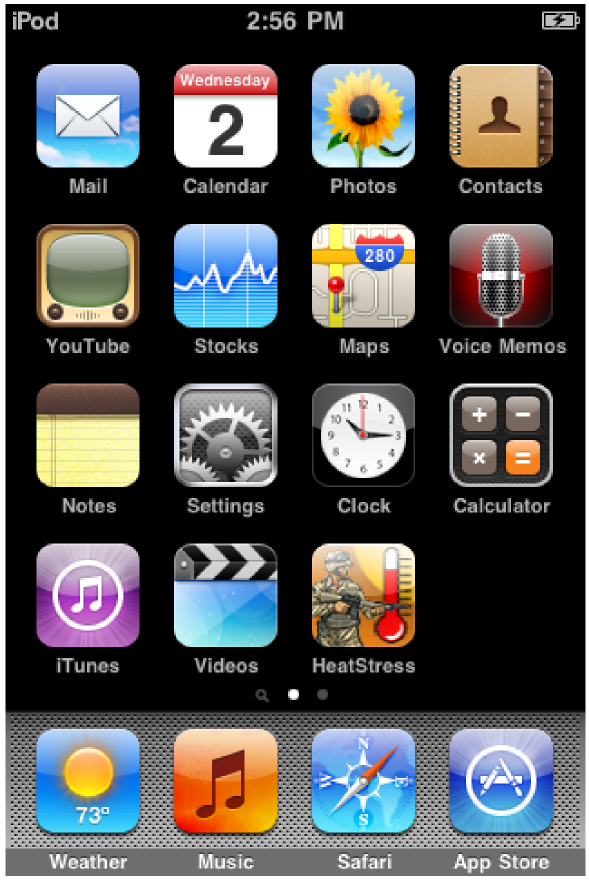


Figure 1. Launch screen.

## 5.2 Site View

Figure 2 shows the Site view, which is the first screen (known as a "view") of the app that is displayed upon tapping the app icon. The MHSDA app is a multi-view app with a tab bar (bottom of screen). The user enters the required inputs (default values always available) by tabbing through the various views and selecting the fields that the Soldier wishes to modify. Upon exit, default values displayed are set to the values that were last entered via data persistence. Text field inputs (latitude, longitude and elevation fields), labels (Latitude, etc.), segmented controls (latitude and longitude hemisphere fields) and a date picker view (aka picker) GUI elements are all used in this view. A picker functions by the user spinning the wheel vertically for each of the selection item(s) until the value of his or her choice is aligned with the shaded center horizontal bar. The date/time defaults to the current device time as initially set up by the user.

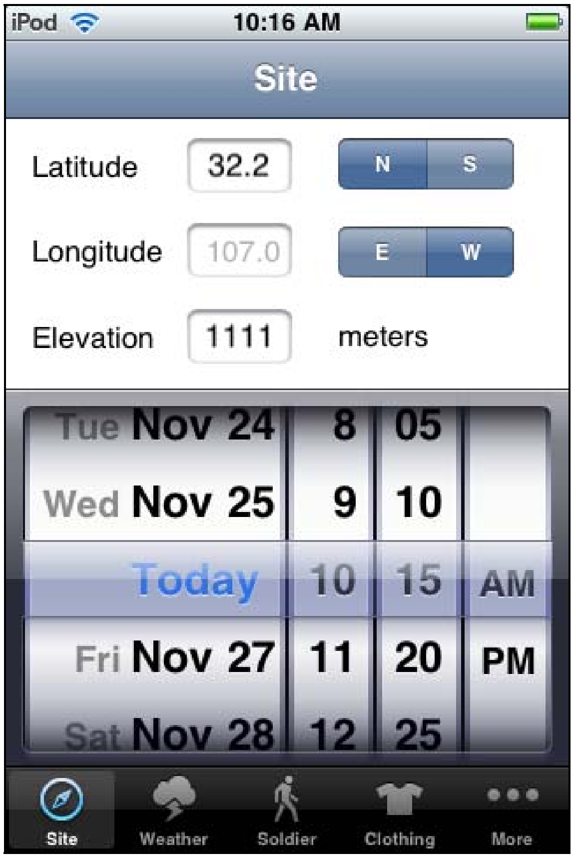


Figure 2. Site view.

Unfortunately, Apple does not provide a virtual numeric keyboard that allows for the entry of only numbers and the decimal point ('.') character, thus the full QWERTY virtual keyboard pops up when the user taps in the latitude and longitude fields, forcing additional screen taps. However, entries are restricted to numbers and the "." Character. A numeric-only keypad pops up for the elevation field, as this field only requires integer entries. A unique feature of the iPhone and iPod Touch devices (due to its internal accelerometer) is the capability to undo typing in an entry field by simply shaking the device. Upon doing so while the focus is in an entry field, the user will be prompted as to whether to undo the current entry or cancel.

The location service (based on the Wi-Fi capability) can be used (if turned on) to try and approximate the latitude and longitude of the device. It is possible for Wi-Fi access point administrators to register the coordinates of the access point. After doing so, the Apple devices can read these coordinates and use them in apps. This capability was not coded into the current app for the primary reason that it is unlikely that there will be access to Wi-Fi hotspots in a tactical environment. Also, having the location service turned on uses additional power in the devices. If desired, this service could be added such that an attempt could be made to automatically fill in the latitude and longitude fields.

### 5.3 Weather View

The next view in the sequence of tabs is the Weather view, as shown in figure 3. This view is used to input local weather conditions. As with the Site view, this view consists of segmented controls, labels, a text field and a sky picker. Note that the wind and humidity entries are simple categorical inputs as opposed to quantitative values. The rationale for this was to keep the app as simple as possible and one that could be run by a layman with no meteorological expertise and no weather instrumentation. Handheld weather sensors are available on the market today, however, and it would be straightforward to modify this (and other views) to allow entry of quantitative values (e.g., for the current temperature field).


Figure 3. Weather view.

### 5.4 Soldier View

Next is the Soldier view, shown in figure 4, which is used to input specific details about the Soldier's physical size, days of acclimatization (how many days the Soldier has resided in the current locale) and his or her work rate. Obviously the higher the work rate, the higher the probability of heat stress injury will be, all other inputs being the same. Note that segmented controls can be utilized to allow the user to set a unit associated with an entry. Since the app stores (persists) the user entries from one session to another (even if the device is turned off), it is likely that some of the data (such as Soldier weight, height and days of acclimatization) will only need to be entered a single time.

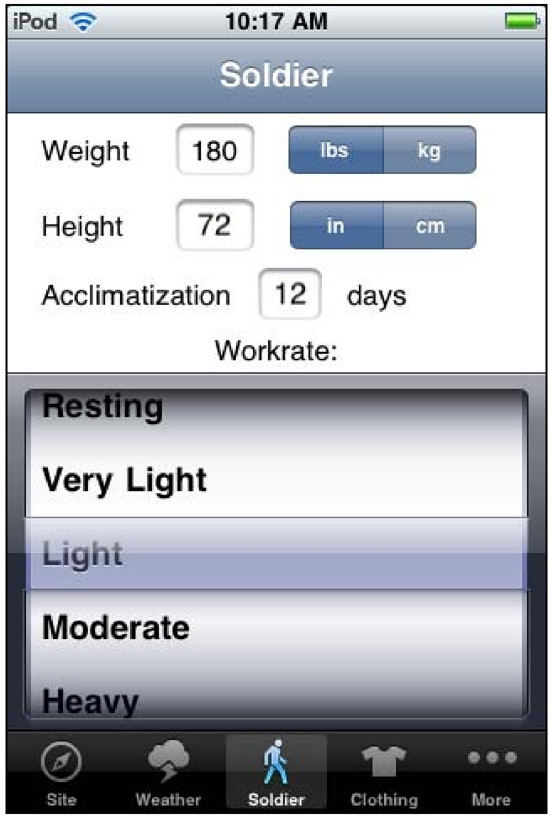


Figure 4. Soldier view.

There is one notable difference between the Apple tabbed view and that of Windows Mobile devices (e.g., PDAs). Instead of having a "More" entry to indicate additional views, Windows Mobile devices have right or left arrows to indicate additional choices. Upon tapping either arrow, additional tabs will show up at the bottom of the screen. However, in the Apple environment, selecting the "More" tab simple opens a new view with a table listing of the additional views (see figure 5) that can then be tapped. The Windows Mobile paradigm seems more consistent.


Figure 5. More tab.

## 5.5 Clothing View

The Clothing view, shown in figure 6, allows the user to select one of over a dozen clothing choices from a picker. As the descriptions can be rather lengthy, only an abbreviated description may be displayed in the picker. However, once selected, a detailed description automatically is shown in a read-only text view below the picker. Clothing parameters have been provided by the USARIEM and are derived from experimental testing on an instrumented manikin.


Figure 6. Clothing view.

Adding GUI elements to the view(s) is as simple as dragging and dropping elements from the Interface Builder window and then configuring items, such as its size and position in the parent view, font size and style, default value, etc. Outlet(s) (a special kind of instance variable) are then assigned to any input variable(s) (e.g., the clothing choice as selected by the user) so that the computational algorithm has access to the user inputs. This is part of the Model-View-Controller (MVC) paradigm of programming in which these three different functions of the program are kept separate. In this manner, maintenance of the code is much easier. Thus, if something in the View module needs to be modified, it can be done independent of the other modules. This ensures reusability of code as well.

### 5.6 Output View

After completing input for all desired parameters, the user can then select the More tab. Upon doing so, a new view appears that lists two additional views that may be selected. One of these views is the Output view. This contains the heat stress output parameters as seen in figure 7. These values are computed based on the user selected inputs via the previous views. The computation and display is instantaneous. Output text fields in this view are read-only (i.e., the user cannot modify the values by tapping those GUI elements). As seen, output variables are extensive and provide useful guidance to the user. The Wet Bulb Globe Temperature (WBGT) represents an estimate of the WBGT, which is a legacy parameter that has been used by the Army for many years to estimate heat stress susceptibility.

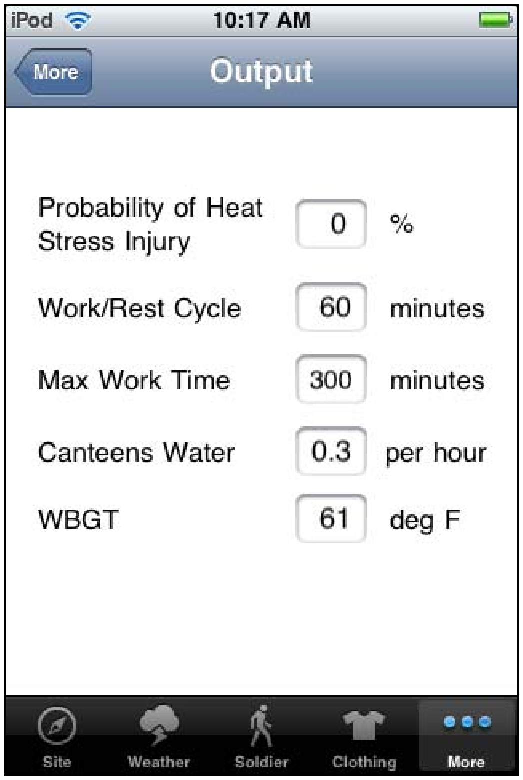


Figure 7. Output view.

The Probability of Heat Stress Injury represents an estimate of the heat stress injury probability if the work/rest cycle, maximum work time and water intake guidance values are NOT followed. It is assumed that after the safe maximum work time limit has been reached, the Soldiers will rest in cool shade for several hours. The maximum water intake is limited to 1.3 quarts (e.g., canteens) per hour as drinking more than that amount per hour is potentially dangerous due to the fact that the human body cannot absorb much more than that.

### 5.7 Info View

The last view available is the Info view in figure 8. This provides a means to display background information, caveats, acknowledgements, etc., about the product. In abiding with the Apple philosophy of expediting program startup, the information view is not the initial screen upon program launch. It is straightforward to add custom logos (e.g., the ARL and USARIEM logos in the top corners) to any view by simply creating and saving your graphics as portable native graphics (.png) images and then inserting and positioning them via the previously mentioned Interface Builder window.

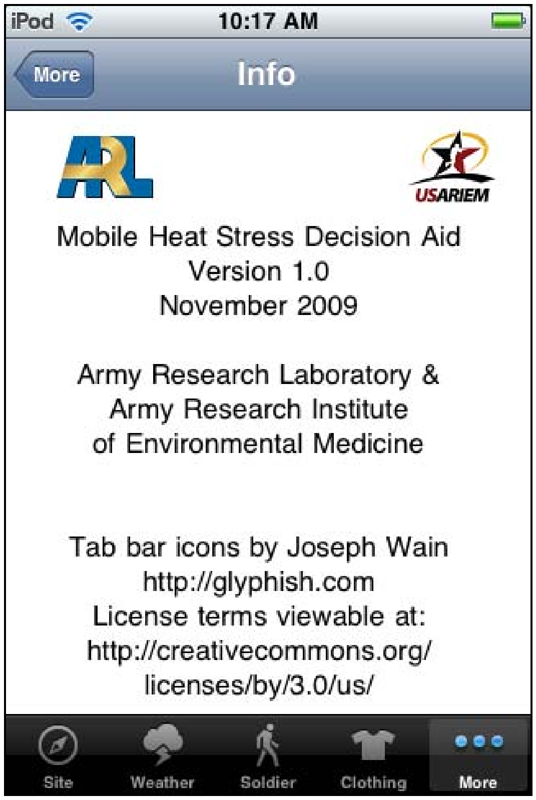


Figure 8. Info view.

## 6. Browser Capability

The iPod Touch has a web browser (Safari) built-in capability, which will allow access to any number of browser apps over the internet, assuming there is an internet connection (e.g., via Wi-Fi). The following image is the MHSDA as a browser app as displayed in landscape mode on the iPod Touch device (but developed for a desktop/laptop environment). When the iPod Touch or iPhone device is rotated so that the screen is horizontal (figure 9), the display automatically switches to landscape mode (and returns to portrait mode when rotated back to vertical). This is only a prototype for the iPod Touch as the browser display was tailored for a larger screen. However, by placing your thumb and forefinger in close proximity to each other on the screen and then "stretching" them apart, the browser display will automatically zoom in (and zoom back out when you "pinch" your thumb and forefinger together on the screen). Thus, even for web pages not designed specifically for the iPod Touch screen, one can make the screen inputs more useable via pinch and stretch techniques. The screen capture in figure 10 represents a portion of the screen shown in figure 9 that is displayed via the "stretching" technique. With the zoomed-in capability, it would be much easier to accurately select and edit the various input parameters.

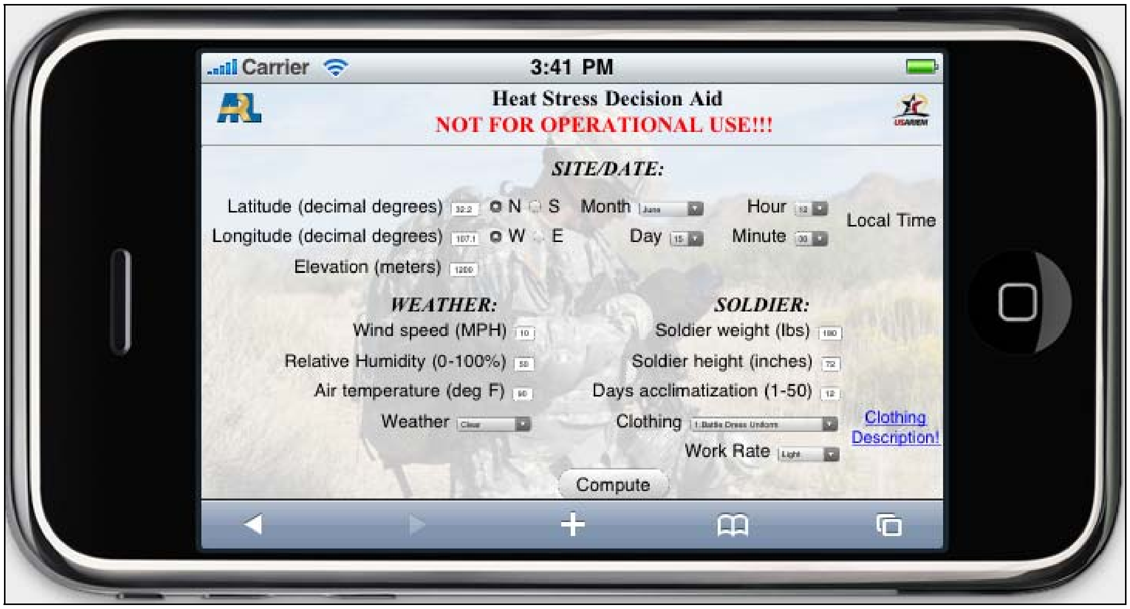


Figure 9. Heat stress browser.


Figure 10. Heat stress browser zoomed in.

Although an attempt was not made to consume a web service on the device, an internet search of the capability turned up a multitude of sites indicating that it is certainly possible to do so. Web services represent one of the latest and most widely accepted client-server technologies for running processes remotely or retrieving remote data. We are currently developing an enterprise app that will utilize web services for the client-server interaction. Once complete, we will test and evaluate the iPod Touch.

## 7. Relational Database

Storing and retrieving data to/from large datasets is much more efficient when utilizing relational databases as opposed to simple text files. More than one of the ARL Battlefield Environment Division's weather-related apps rely on relational databases; thus, if it is desired to host any of them on the iPod Touch, a relational database capability would be required. Fortunately, the iPod Touch includes the SQLite relational database. Thus, in theory, large databases, such as the Integrated Weather Effects Decision Aid (IWEDA) impacts database and the Gridded Meteorological Database (GMDB) could be hosted and used. SQLite even supports the storage of binary large objects ('blobs') which the GMDB makes use of. The advantage of having this capability on the mobile devices means that the IWEDA and/or GMDB could be synchronized locally on the iPod Touch so that remote wireless communications would not have to be relied upon. Then IWEDA, as well as any apps that require access to the GMDB (e.g., weather or weather impacts visualization,    hem./bio diffusion models, etc.) could be run locally. It is desirable that development of a simple app to test and benchmark the database capabilities (e.g., blob create, read, update and delete; table creation and query; data entry; etc.) be undertaken at some point to evaluate the potential for weather app support. Certainly the storage capabilities (up to 64 GB) of the devices will support large relational databases.

## 8. Conclusions

A number of mobile computing devices have flooded the consumer market over the last decade. These include PDAs, Apple iPod and iPhone devices, and smartphones (e.g., running either the Windows Mobile or Android operating system). This has created an opportunity to leverage this technology for military advantage, particularly for dismounted Soldiers. A number of apps have been developed for one or more of these devices (one has been fielded). With increasing options and capabilities, the opportunity to provide even more advanced apps for the military exists and will continue to be exploited. In FY11, an Android-based smartphone will be used to host one or more apps (to include a simplified MHSDA). This will allow a head-to-head comparison of some of the tradeoffs between it, the iPhone Touch, and PDAs.

## List of Symbols, Abbreviations, and Acronyms

| | |
|---|---|
| AAB | All American Bowl |
| app or apps | application or applications |
| ARL | U.S. Army Research Laboratory |
| GMDB | Gridded Meteorological Database |
| GUI | graphical user interface |
| IDE | integrated development environment |
| IWEDA | Integrated Weather Effects Decision Aid |
| MFC | Microsoft Foundation Classes |
| MHSDA | Mobile Heat Stress Decision Aid |
| MVC | Model-View-Controller |
| PDA | personal digital assistant |
| .png | portable native graphics |
| SDK | Software Development Kit |
| TOC | tactical operations center |
| USARIEM | U.S. Army Research Institute of Environmental Medicine |
| WBGT | Wet Bulb Globe Temperature |

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