Teaching Resources for Handheld Computers

Kenneth L. Alford
United States Military Academy

Introduction

Computer technology continues to increase in capacity and decrease in size and cost. Today's low-cost handheld personal digital assistants (PDAs) provide many new opportunities for both faculty and students.

PDAs can be an effective tool for instructors to distribute course materials such as schedules, assignments, background readings, and lesson handouts. There are many commercial and freeware products that can be used to create course materials for students and faculty. These tools can be categorized into four general categories: (1) HTML and XML-based tools, (2) text tools, (3) calendar tools, and (4) programming tools.

Computing Environment

All 4,200 students at the United States Military Academy are required to purchase a personal computer and, beginning with the graduating class of 2003, a personal digital assistant as well (see Figures 1 and 2). Handheld and desktop computer purchases are centrally managed, and with very few exceptions all students within the same graduating class own the same computer, PDA, and software applications. Students purchase their personal computer and PDA prior to the beginning of their freshman year, and they receive initial training in the setup and use of the hardware and the software applications. There is a mandatory technology enhancement purchase scheduled prior to the beginning of a student's junior year, primarily used to upgrade equipment so that their personal computer and PDA will remain as current and functional as possible.

Growth of Handheld Computing

There is a growing body of research and experience regarding the undergraduate educational use of handheld computing devices. With increasing frequency universities and colleges are turning to handheld computing to solve problems and to provide students with additional resources. Here

---

The views expressed in this article are those of the author and do not reflect the official policy or position of the United States Military Academy, the Department of the Army, the Department of Defense, or the United States Government.

are a few recent examples where PDAs have been introduced to support university-level education:[1]

- The University of South Dakota has required that all students purchase a PDA since 2000.

- Penn State Abington has provided PDAs to students in selected courses since 1999.

- At Central Carolina Technical College students can apply for admission, register for classes, review the course catalog, access campus calendars, and read campus news using a handheld computing device.

- Capitalizing on the infrared capability of handheld devices, Stanford University has created "myStanford" —a web-based portal that allows students, faculty, staff and alumni to access university information through their handheld computers at access boxes placed throughout campus.

- Medical schools, law schools, MBA programs, and numerous graduate schools are also providing students support for handheld computing devices.

Figure 1. A cadet using a PDA during class

Handheld computing devices, including ruggedized handheld computing devices, are also increasingly being used by the military and various government organizations across the nation.

There are numerous free, low-cost, and commercial products available to increase the functionality and usability of personal digital assistants. PDA course resources can be categorized into four general categories: (1) HTML and XML-based tools, (2) text tools, (3) calendar tools, and (4) programming environments.
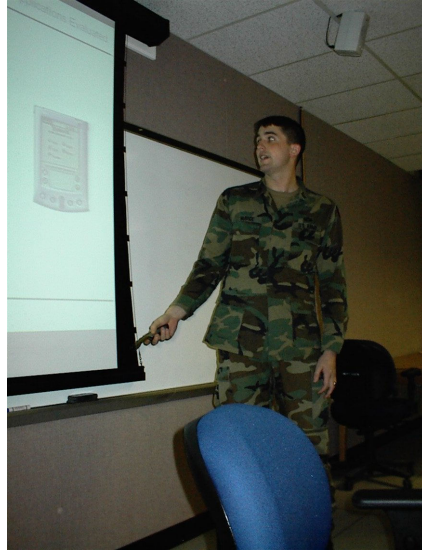
Figure 2. A cadet is shown giving a presentation
about handheld computing

HTML and XML-Based Tools

HTML (hypertext markup language) and XML (extensible markup language) pages can be formatted so that they can be saved and read on personal digital assistants.

There are numerous ways this capability can be used to support teaching. For example, instructors at West Point have formatted all of the following into HTML and/or XML pages to be read on PDAs:

- Instructor and student contact information

- Course syllabus and guidelines

- Course schedules

- Reading assignments

- Projects and other course assignments

- Supplemental reading assignments

- Class handouts

- Review information for exams

- Self-administrated, non-graded quizzes

- Web pages, websites, and other HTML documents

Two of the most popular programs for transforming web-ready pages into PDA documents are Plucker,[2] a freeware program, and AvantGo,[3] a commercial product. Plucker software, for example, allows users to easily create and update PDA-readable versions of single webpages, portions of websites, or entire websites. Users can configure graphic quality and size, timing of file updates, depth of search, and numerous other options.

Text Tools

As an alternative to formatting text into an HTML or XML formatted document, there are several text-based tools—each with its own unique file format—that can be used to develop documents that are readable on a PDA.

There are several no-cost and low-cost alternatives available for developing PDA documents. One of the quickest and easiest ways to send text and small documents to many PDAs is to use the Memo Pad feature found in Microsoft Outlook and several PDA synchronization programs. Using Memo Pad is a "bare bones" solution, but it does have the advantage that students can modify the original text they receive. Memo Pad notes are useful when students are asked to modify and return a document or assignment.

To obtain increased document functionality, instructors can turn to freeware or commercial software products such as PalmReader,[4] MobiPocket,[5] or Adobe Acrobat.[6] MobiPocket, for example, provides free trial versions for both a document reader and creator. MobiPocket supports the Palm OS, Windows CE, Pocket PC, SymbianOs, Franklin eBookMan, and Windows operating systems.

PalmReader provides all of the software and instructions necessary to create finished PDA-readable documents with text and limited graphics. Copies of the reader software are available for the Windows, Macintosh, Palm OS, and Windows CE operating systems. An advantage of using PalmReader or Adobe Acrobat is that the same document can be read on platforms using any of the four supported operating systems.

PalmReader uses a unique tag-based description language (see Table 1 for sample codes) that supports text styles, links, graphics, sidebars, footnotes, bookmarks, notes, and other features. The PalmReader markup language has few rules, shares many concepts with HTML, and is easy to learn.

Creating PalmReader documents is easy and fast. Instructors, or students, begin with a text document, add PalmReader formatting tags (to manage links, footnotes, paragraphing, formatting, graphics, and indexes within the document), drag the formatted file to the PalmReader text compiler (a free program called Dropbook.exe) which creates the finished PalmReader file (or reports any formatting errors that may be present in the document). The same finished document may be read on a PDA or desktop computer.

Code	Purpose
\p	Add a new page
\x	Add a new chapter
\t	Indent
\i	Italics
\u	Underline text
\l	Switch to large font
\n	Switch to normal font
\q="#linkanchor" Link Text\q	References a link destination that is somewhere else in the document
\Q="linkanchor"	Specifies a link destination within the document
\c	Centers text
\r	Right-justifies text
\v	Comments (not visible in the final document)
\w="50%"	Add a horizontal line in the middle half of the screen.
\B	Bold the text
\m="name.png"	Insert a graphic (filename: "name.png")

Table 1. Sample PalmReader Text Format Codes

PalmReader, Adobe Acrobat, MobiPocket, and a variety of similar programs can be used to create functional and extremely useful course-related documents and electronic books for handheld computers.

Calendar Tools

The ability of handheld computers to hot synch with calendar and other information located on personal computers makes calendar and schedule applications a natural target for coursework development. Faculty and students at the United States Military Academy use CHAOS (Course Hour Appointment for Outlook Scheduler) a Microsoft Visual Basic program for entering lesson dates, titles, and assignment information into their personal and handheld computers.

CHAOS-generated files are loaded into the Microsoft Outlook calendar and then synchronized with the calendar program on student PDAs. CHAOS automates the creation of lesson dates that are specific to West Point's One-Day/Two-Day lesson schedule. The CHAOS Course Director Tool helps course directors create short lesson descriptions and messages that students will see when reviewing appointments using their Outlook and PDA calendars.

The Course Director Tool recognizes numerous types of course schedules (See Figure 3):

- the standard 40 lesson course template

- an extended lesson variation of the 40-lesson course schedule

- courses that infrequently meet for two consecutive instructional hours, such as the freshman Computer Science course

- courses that always meet for two consecutive hours, such as the required freshman Chemistry course

- courses that have eight lab periods in addition to their regularly scheduled 40 lessons
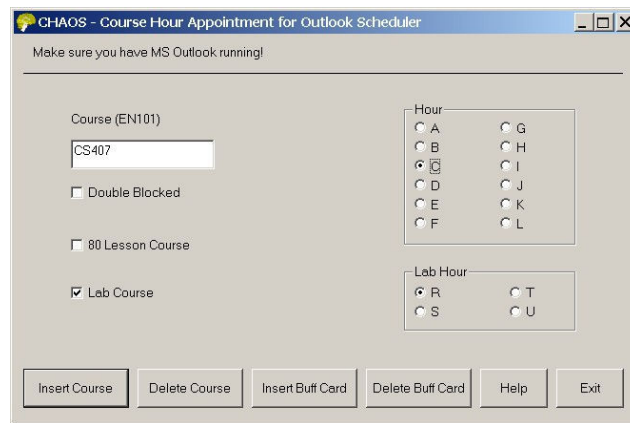
- courses that meet for 80 lessons.

Figure 3. One of the opening screens
of the CHAOS Course Director Tool

When course directors finish entering course information in the CHAOS Course Director Tool (see Figure 4), they send the file to a system administrator. The administrator checks their output file and publishes it on the web so that students and instructors can download it.

Instructors select only the hour in which they teach, and CHAOS handles the administrative details, such as assigning the correct dates to specific lessons, adjusting for compressed schedule days, etc. Figure 5 shows course information from CHAOS after it has been correctly loaded into a student calendar.

Students run CHAOS and enter course designations (such as, CS407) into the program. Lesson schedule information is automatically downloaded into their desktop calendar. This system ensures that all students in the same course have the same calendar and assignment information.

CHAOS is a useful tool for entering and synchronizing student and faculty calendars on personal and handheld computers. The same results can be achieved, though, without using a program like CHAOS. Course directors can create a calendar file with all associated course dates and schedule information. The calendar file can then be emailed or otherwise distributed to students and other

instructors who can import it into their individual desktop and PDA calendars. The end result can be the same as if a program like CHAOS was used to create the course calendars.
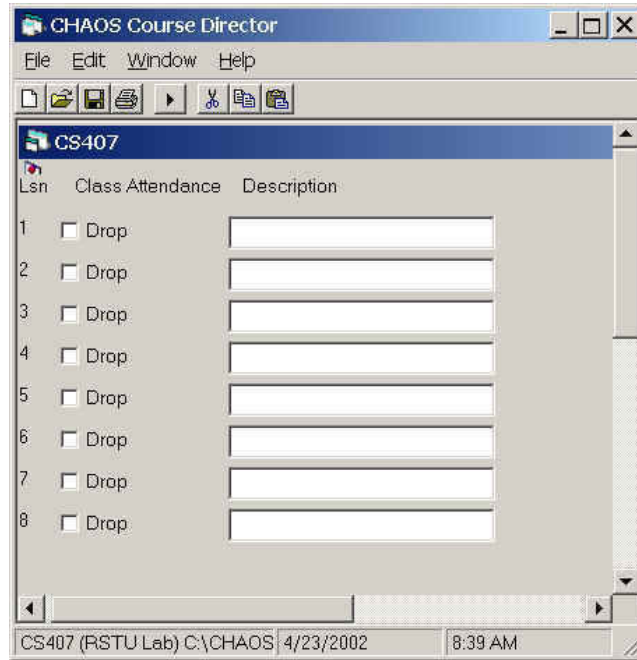

Figure 4. Using the CHAOS Course Director Tool,
instructors are able to provide lesson information to students

Faculty and students at the Military Academy have used this method to create and distribute calendars and schedules for student clubs, religious groups, student project teams, and a variety of other groups.
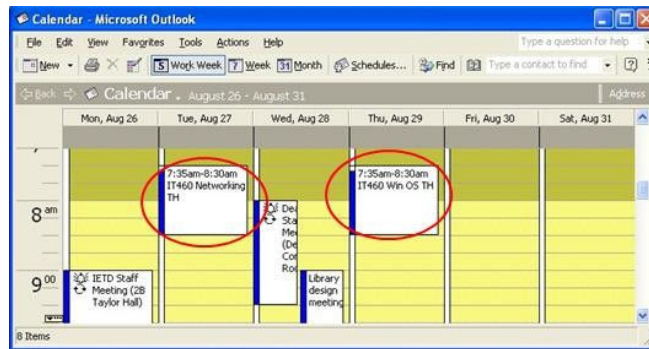

Figure 5. Lesson information is loaded
on student computers and hot synched with their PDAs

Programming Environments

Several software development environments exist for developing applications for personal digital assistants. Introductory information can be found online at numerous websites.[7] Java — whether

in the form of KVM (Kilobyte Virtual Machine), Kawt (an implementation of the Abstract Window Toolkit for the KVM), J9 (IBM's virtual machine that is supported by Visual Age Micro Edition), or any number of other flavors — is currently one of the most popular languages for programming handheld applications.

Application development is appropriate when existing PDA software resources cannot adequately satisfy student requirements. At West Point, for example, freshmen (who are referred to as plebes) must be able to recite the number of days that remain until each football game, spring leave, graduation, and other notable student activities. Faculty in the Electrical Engineering and Computer Science Department created a small PDA program entitled "The Days" that simplifies this daily ritual for freshmen students.

One instructor uses a PDA to choose which student to call on in class based on both the frequency they have been called on and the quality of their answers in the past.

Student Projects

In their senior year, students majoring in computer science at the United States Military Academy at West Point, New York are required to take two multidisciplinary senior project design courses. Each course is 3.0 credit hours with a 0.5 credit lab. These courses are part of an ABET-accredited computer science program. Throughout the year faculty members from several engineering departments gather information on suitable multidisciplinary senior design projects. Project customers range from funded Army research programs to inter-collegiate design competitions to local projects that will benefit one or more campus organizations.

Several senior design projects at West Point have successfully use PDAs as an integral part of project solution. Here is a sampling of some of the PDA-based student two-semester design projects:

- **Handheld Terminal Unit.** This student team contained computer science and electrical engineering majors. The Handheld Terminal Unit project team worked to replace the Army's Handheld Terminal Unit (HTU) with a platform independent, smaller, lighter, and less expensive system that can run on a personal digital assistant (PDA). HTU's are used for a variety of purposes—calling for fire from Apache attack helicopters, receiving or sending operation orders, submitting information on battlefield surveys, etc. The Army's current HTU costs approximately $18,000 and weighs 8.6 lbs. PDA's, on the other hand, weigh less than 1 pound and cost less than $200 each. This project was conducted in coordination with the Program Manager, Advanced Field Artillery Tactical Data System.

- **Perimeter Defense System.** This student project team consisted of computer science and electrical engineering majors. The Perimeter Defense System enables a defensive perimeter to be passively monitored by unobtrusive ground sensors. When a sensor is disturbed, the alert information is passed to a handheld computing device.

- **Controlled Parafoil Descent.** This student project team contained electrical engineering, computer science, and mechanical engineering students. The Controlled Parafoil Descent project created an unmanned aerial vehicle that was capable of autonomously navigating itself to a pre-designated location. The computer science team was responsible for designing and implementing the software portion of the flight control package. The software design team used a personal digital assistant as the hardware platform. Global Positioning System (GPS) hardware supplied a stream of latitude, longitude, and altitude information to the PDA. Software running on the PDA calculated the current flight path and any required adjustments.

All indications are that an increasing number of future senior design projects will incorporate handheld computer devices.

Benefits

There are many potential benefits for students and instructors that can be gained by using personal digital assistants. For example:

- **Versatility.** PDAs provide one of the most versatile computing platforms available today. Here are just a few of the many ways that PDAs can be used in and out of class: to perform or check calculations, to easily share data and programs, to edit written work and presentations, to read assignments, to take lecture notes, to record lab data, to schedule assignments and lectures, and to send and receive email.

- **Portability.** Personal digital assistants are small enough to fit in pockets, backpacks, and purses, but powerful enough to provide basic computing power almost anywhere. PDAs have even been used to provide progress and status reports during an ascent of Mount Everest and from a Russian *Soyuz* rocket.[8]

- **Maintainability.** Personal digital computers are easy to maintain. Software installation, updates, and removal are much less complicated than on the more powerful personal computers and servers.

- **Supports Collaboration.** In addition to being extremely portable, if student collaborative teams are equipped with PDAs and share the same software and files, there is a reduced concern that overall progress will be impeded if a mishap occurs to an individual team member's PDA or desktop computer.

- **Low-Cost.** Handheld computers are much less expensive than portable or desktop computers. Some institutions may find it pays to purchase numerous handheld computing devices instead of one desktop computer in selected classrooms.

- **Ease of Use.** Unlike desktop and portable computers which often have a steep learning curve associated with their use, students can be taught to use the basic functions of a personal digital assistant in an hour or two.

Challenges

PDAs can be a wonderful teaching resource, but there are also several challenges associated with developing and providing handheld resources to students.

- **Numerous Operating Systems.** If students are free to purchase their own PDAs, there will certainly be numerous operating systems being used at any given time within a single classroom. At best the presence of numerous PDA platforms and operating systems complicates the use of PDAs in the classroom, at worst it makes sharing specific applications and files difficult or impossible. Whenever feasible, institutions may profit from selecting and publicizing a recommended operating system for handheld computing devices—just as many institutions currently do for personal computers. It should be noted, though, that the use of intermediate programs on personal computers, such as Microsoft Outlook, can alleviate many compatibility problems.

- **Power and Storage.** PDAs continue to improve in power, storage, performance, and have made tremendous advances in recent years. It is a fact, though, that they are still well below the computing capability available on most other personal computing platforms.

- **Student Access.** Unless the purchase of a personal digital assistant is mandated and enforced by an educational institution – which is probably unlikely for the majority of undergraduate institutions—then not all students will have access to a PDA. All student and course resources provided for personal digital assistants must also be provided in another medium or format, which usually means more work for instructors and teaching assistants.

- **Potential for Misuse.** The ease with which data and handheld applications can be shared—while being one of the PDAs greatest advantages—can also provide the opportunity for misuse. PDAs, for example, should generally not be authorized for use during examinations and quizzes. The ability to easily, quickly, and silently beam information and answers from one PDA to another makes this a temptation best left untested.

Lessons Learned

Instructors at the United States Military Academy have created PDA instructional content for several years. Here are a few of the many lessons we have learned along the way:

- Concentrate first-and-foremost on usability. Excellent course content can be rendered almost useless by a poor presentation.

- Use graphics sparingly and ensure that they have been optimized. Graphics can unnecessarily consume valuable memory storage space on a handheld computing device. The threshold for deciding whether or not to include specific graphics must be set extremely high.

- Be extremely aware of size constraints. PDA storage capacity is rapidly improving, but it is still a constrained development environment. If possible, poll your students to find out what the lowest handheld common denominator is for the students in your course.

- Double-check everything, especially links and graphics, *before* you provide course materials and resources to students.

- Always provide alternatives for all PDA-based resources you develop.

- Recognize that your course materials will potentially be used on a variety of different PDA operating systems, screen resolutions, and color capability. Reference to specific colors in documents – "Click on the red link," for example – is meaningless for students who do not have a color screen on their PDA.

- Eliminate screen scrolling whenever possible; it is tedious and time-consuming on a PDA. Use links instead. You cannot provide too many links within a document.

- Limit the number of PDA file-reading programs you require students to load on their PDA. PalmReader, Plucker, and Adobe Acrobat, for example, are all excellent programs, but requiring students to load all of them in order to read a wide variety of instructional materials for your course could require an unreasonable amount of valuable PDA memory space.

Future Innovation

This is a relatively new field of pedagogical research, and there is much left to do. Innovative solutions are needed in many areas, for example:

- Improving the programming environments for developing PDA software applications.

- Reducing the development time for PDA applications.

- Providing additional multi-platform PDA software tools.

- Establishing widely accepted standards for platform-independent electronic books and files.

Conclusion

When viewed as another tool for instructors to use, personal digital assistants can provide students with excellent additional resources to help them learn.

Handheld computing and communication devices will continue to grow in importance and use as innovative ways are found to provide valuable resources and course materials for faculty and students.

Bibliography

1. Information about the experiences mentioned (and others) can be found online at http://www.palm.com/education/studies/archive.html.

2. The homepage for the Plucker software (which contains programs, instructions, samples, and source code) is found online at: http://www.plkr.org/index.plkr

3. AvantGo is a commercial software product that is often bundled with other PDA-provided software. Their homepage is available online at www.avantgo.com.

4. PalmReader software is available online at: http://www.palmdigitalmedia.com/-product/reader/browse/free

5. MobiPocket software is available online at: http://www.mobipocket.com/en/DownloadSoft/default.asp

6. Adobe Acrobat software for the PDA is available online at: http://www.adobe.com

7. http://www.onjava.com/pub/a/onjava/2001/03/15/java_palm.html, for example.

8. http://pressroom.palm.com/InvestorRelations/PubNewsStory.aspx?partner=-Mzg0TlRFMU1BPT1QJFkEQUALSTO&product=MzgwU1ZJPVAkWQEQUALSTOEQUALSTO&storyId=46910

KENNETH L. ALFORD is a lieutenant colonel (recently selected for promotion for colonel) with 25 years of active duty in the United States Army. He is currently an Assistant Professor and the Information Systems Engineering Program Director at the United States Military Academy, West Point, New York. He earned a Ph.D. from George Mason University and masters degrees from the University of Illinois and the University of Southern California.