

Mobile Computer-Assisted Personal Interviewing with Handheld Computers: The Entryware System 3.0

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Computer-assisted data collection in survey research offers potentially lower costs, quicker turnaround time, and improved data quality as compared to traditional paper-and-pencil methods. The proliferation of handheld computers in recent years now makes these benefits more accessible to field researchers. Handheld computers are inexpensive, portable, and energy efficient, making them ideal field instruments. In this article, I review a new software product designed for mobile computer-assisted personal interviewing (MCAPI) with Palm OS handheld computers. Based on my experience with MCAPI in the field, I conclude that version 3.0 of Entryware software is a robust tool for face-to-face or self-administered structured interviews in field settings. I also consider some implications of this new technology for field research, including respondents' reactions and data quality.

Handheld computers have become commonplace, and field researchers should take note: These small, affordable computers are not just personal organizers. They offer absolute portability, extended battery life, an intuitive interface, and surprising computing power. In addition, the connectability of handhelds to desktop computers provides a mobile interface with standard software applications, and modem and wireless communications make it easy to transfer data to and from the field. The potential utility of handheld computers for field researchers is tremendous (Greene 2001).

This review considers a new product for the Palm platform that makes good on the promise of mobile computing for field researchers. Version 3.0 of Techneos Systems' Entryware software consists of two applications for designing questionnaires, transferring data, and conducting face-to-face interviews with Palm-powered computers. This technology offers several key advantages of computer-assisted interviewing in general but stands out for its true mobility and significantly lower hardware costs.

Here I offer a brief overview of mobile computer-assisted personal interviewing (MCAPI) in general and review the key features of the Entryware system in particular. I report my own experiences using Entryware software

during a recent project in Puerto Rico and consider some implications of this new technology for doing field research. Like other computer-assisted interviewing software, Entryware software was designed for survey researchers, so those who conduct primarily unstructured, open-ended interviews will not find it useful. However, researchers who conduct face-to-face or self-administered structured interviews in field settings will want to take a serious look at MCAPI with the Entryware system.

MCAPI: AN OVERVIEW

The use of computers in survey research has a brief yet productive history (Baker 1992). Couper and Nicholls (1998) suggested that no methodological development in the past half-century “may have more far-reaching effects on survey research than the application of computer methods to survey data collection and capture” (p. 1).

This development began in the early 1970s with the invention of computer-assisted telephone interviewing (CATI) (Fink 1983). By the mid-1980s, CATI had become standard in survey research organizations, and the availability of portable computers made it possible to extend the use of computers to face-to-face interviewing. Computer-assisted personal interviewing (CAPI) is now used widely in face-to-face interviews by university researchers, government agencies, and private-sector survey organizations around the world (Couper and Nicholls 1998). MCAPI, with handheld computers, should be seen as the latest step in this trajectory of computer-assisted methods of survey research.

CAPI methods offer several important advantages over traditional paper-and-pencil techniques. The first is that CAPI integrates data collection, data entry, editing, coding, and cleaning into a single process. As a result, it offers quicker turnaround time to a final product and potentially lower costs by eliminating postinterview processing. Second, CAPI improves data quality. CAPI software can help interviewers recognize and correct data input errors on the spot, and it completely eliminates the error-prone step of data entry. Third, CAPI facilitates more complex questionnaire designs than are feasible with paper-and-pencil techniques. It enables randomization of both question and response sets and makes complicated branching and skip patterns invisible to interviewers. In sum, CAPI offers a potentially quicker turnaround time, reduced costs, and improved data quality in survey research (Baker 1992; Couper and Nicholls 1998).

But there are drawbacks. For many researchers, the initial investment in CAPI software and hardware—generally, laptop computers—is prohibitive.

The overall expense is greatest for large-scale surveys with numerous interviewers and the need for more hardware, but even those carrying out small projects are likely to find the expense of multiple laptop computers unjustifiable. Another significant drawback to standard CAPI techniques is the restricted portability and relatively short battery life of laptop computers, which limits the mobility of interviewers. This limitation can be decisive for researchers who seek respondents in field settings or who work in areas where power supplies are unpredictable.

The increasing availability and affordability of handheld computers provide an attractive alternative to standard CAPI technology. Currently, the most widely available handheld computers are those running the Palm OS platform, although the Windows CE platform is steadily gaining ground. Entry-level Palm-powered handhelds such as the Palm m100 and Handspring Visor models are now available for less than \$100, and the most expensive models, which offer more features than most users need, top out at about \$450. Handhelds for the Windows CE platform generally are more expensive than Palm devices, starting at about \$350. But even at these prices, it would be feasible to outfit multiple interviewers for the cost of a single laptop computer.¹

Moreover, handheld computers offer the sort of real portability that field interviewers need. Specific models vary in size, but all are small enough to slip into one's pocket and not distract from the interaction between interviewers and respondents. Handhelds also free users from concerns over battery life and power supplies since devices with monochrome displays can easily run for weeks of heavy usage on two AAA batteries. Palm-powered devices with color screens and all pocket PC models consume battery life much more quickly and are therefore less desirable field computers, but even they are more energy efficient than standard CAPI hardware.

The advantages of handheld hardware have sparked interest among survey researchers since the early days of CAPI. The Netherlands Central Bureau of Statistics purchased its first handheld computers in 1983 (de Heer 1991), and Statistics Sweden was testing handhelds for CAPI around the same time (Couper and Nicholls 1998). In recent years, other institutions have experimented with handheld computers in large-scale national surveys (Forster and Snow 1995; Bosley, Conrad, and Uglow 1998). However, these early applications generally required substantial programming experience, were not widely available, and required expensive handheld computers. Fortunately, the proliferation of handhelds has brought about a boom in handheld software and affordable hardware. MCAPI is now available on a wider scale than ever.

ENTRYWARE SYSTEM 3.0

There are several applications designed for field-based data collection with handheld computers, but few are geared specifically to social researchers.² Among the serious attempts at MCAPI, Entryware software is, to my knowledge, the only one designed for the Palm OS. I am aware of two other MCAPI applications, Surveycraft's scyField-HPC and Mercator's Snap PDA Interviewer software.³ Perhaps because these products are add-in modules for core Windows desktop applications, they are both designed for the Windows CE handheld platform. This is unfortunate because it means significantly higher hardware costs, shorter battery life, and no relevant advantage in computing power over Palm-powered devices.

My experience with a previous version of Entryware software illustrates the flexibility and power of the Palm platform for mobile data collection. During a recent project in Puerto Rico, I used the Entryware system to conduct one hundred survey interviews in respondents' homes. These interviews included up to 268 questions—including multiple choice, yes/no, open-ended numeric, and open-ended text response—and lasted an average of sixty-eight minutes (Entryware software automatically records the duration of each interview). Such long interviews posed no problem for the software. Indeed, the Entryware system technically allows up to 32,000 questions per questionnaire and 1,295 responses per question. By contrast, the competing Snap PDA Interviewer software for the Windows CE platform has an upper limit of 50 questions per interview.

Running Entryware software on my Palm-powered device also provided plenty of battery life and memory for long days of interviewing. My gray-scale Handspring Visor Deluxe handheld runs for up to forty hours on a single pair of AAA batteries. Just in case, I always carried a spare pair for on-the-spot recharging in the field. Like most basic models, this handheld ships with 8 MB of memory, and the Entryware application itself occupies only 133 K. My large questionnaire required another 100 K, and each completed interview added about 20 K of memory. These specifications mean that I could have completed the entire project several times over before running out of room to store response data. Thus, my experience suggests that Entryware designers chose wisely in creating current versions of their software for the Palm OS because it maximizes the key advantages of handheld computers over standard CAPI technology: lower costs and greater mobility.

Software Overview

Version 3.0 of the Entryware line consists of two applications that are priced and sold separately. The core product is the Entryware Designer program, a Windows desktop application for designing questionnaires, transferring data to and from handhelds, and exporting interview data to other desktop applications for analysis. The hardware requirements for this program are minimal: Users need an IBM-compatible Pentium-class PC or better with Windows 95/98/2000/XP or NT 4.0, 20 MB of hard disk space, and 32 MB RAM. There is currently no Macintosh version of the Entryware software.

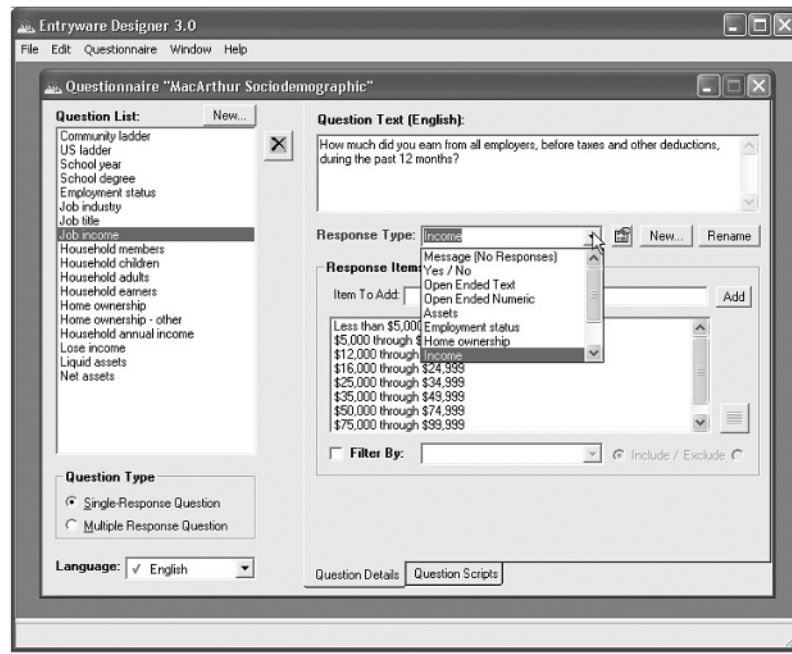
The second component of the Entryware system is the Entryware Interviewer program, a Palm OS application for collecting interview data on handheld computers. Version 3.0 includes a free application for Windows PCs that allows users to download questionnaires to handhelds and upload response data to PCs without using the Designer application. This application allows field staff to manage questionnaires and interview data but does not permit changes to the questionnaire design itself. The Interviewer software runs on any handheld computer with Palm OS 3.1 or later, and it requires very little RAM. Even entry-level devices with 2 MB RAM can store dozens of different questionnaires and response data from hundreds of completed interviews. The low cost and long battery life of such devices, as compared to more expensive models, makes them attractive field computers.

In January 2002, Techneos released version 3.0 of its Entryware Pro products. This major upgrade introduces several key new features (see below) and carries a new licensing scheme. For commercial users, a perpetual license for version 3.0 of the Entryware Designer application costs \$2,000 for the first workstation and \$1,500 each for the second to the fifth, with additional discounts on larger volumes. A perpetual commercial license for the Interviewer software starts at \$140 per handheld. An annual maintenance fee of 20% of the current list price applies to all perpetual licenses, providing toll-free technical support in the United States and Canada and all product upgrades. The software comes with a thirty-day money-back guarantee and an extensive, well-written manual in PDF format.

With version 3.0, Techneos is also introducing an option for annual commercial licenses at \$1,065 for the Designer program and \$75 for the Interviewer application. This pricing structure reduces the up-front expense and makes the Entryware system more affordable for one-time or occasional users. Regular users, on the other hand, will end up paying more over the long haul.

Many *Field Methods* readers will be interested in academic pricing. For academic institutions and full-time staff or students, academic licenses will

FIGURE 1
Screen Shot of Questionnaire Design Window
in Entryware Designer Software 3.0

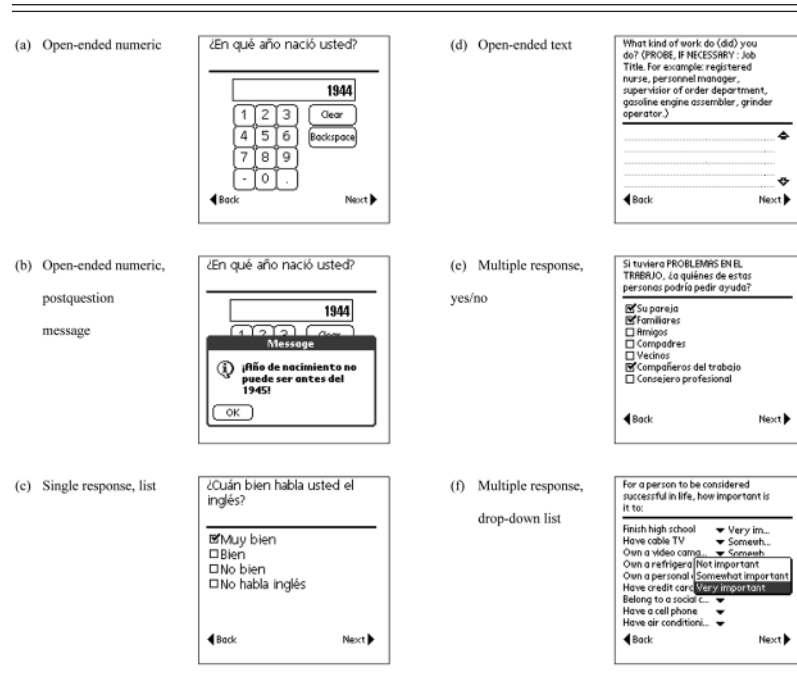


be available on an annual basis at a 50% discount from the price for commercial use. Annual licenses for academic users cost roughly \$530 for the Designer application and \$37 for the Interviewer program. These prices may still be prohibitive for graduate students and individual researchers without institutional support, but they should be weighed against potentially improved data quality, quicker turnaround time, and lower costs in postinterview processing. Techneos also offers special pricing to institutions that incorporate the software into course curriculum.

Features and Usability

The main window in the Entryware Designer program provides a straightforward, easy-to-use layout with access to the major features of questionnaire design (see Figure 1). Questions consist of three elements: the question text, responses, and scripts. Question text is used not only for questions but

FIGURE 2
Screen Shots from Entryware Interviewer Software 3.0
on a Palm OS Handheld



also for messages and instructions to interviewers or respondents. The text can contain nearly any character, including accents or other single-byte characters required in languages other than English (see Figure 2a–c). By late 2002, Techneos promises support for multibyte characters. The text-editing functions in the design application are very basic. To insert special characters required in my Spanish questionnaire, I needed to copy and paste question and response text from my word processor to the Entryware design window.

Questions must be specified as either single or multiple response. Single-response questions ask for just a single answer, but multiple-response questions allow users to ask about an entire list of items. For example, multiple-response questions are useful for collecting ratings about a series of items or for asking respondents to “check all that apply.” For both single- and multiple-response questions, Entryware software supports four response types: open-ended numeric, open-ended text, yes/no, and user-defined lists. Figure 2 shows questions from my survey in Puerto Rico that illustrate the

appearance of each response type on the handheld screen. Panels a–d show single-response questions, whereas panels e and f show different options for multiple-response questions.

Some researchers may find it useful to give respondents visual cues for multiple-response questions like those in Figure 2. In Puerto Rico, for instance, I handed respondents laminated cards with the response options printed in a large font for multiple-response questions or scale items. For literate respondents, these cards improved understanding of the question format and substantially reduced the length of the interview.

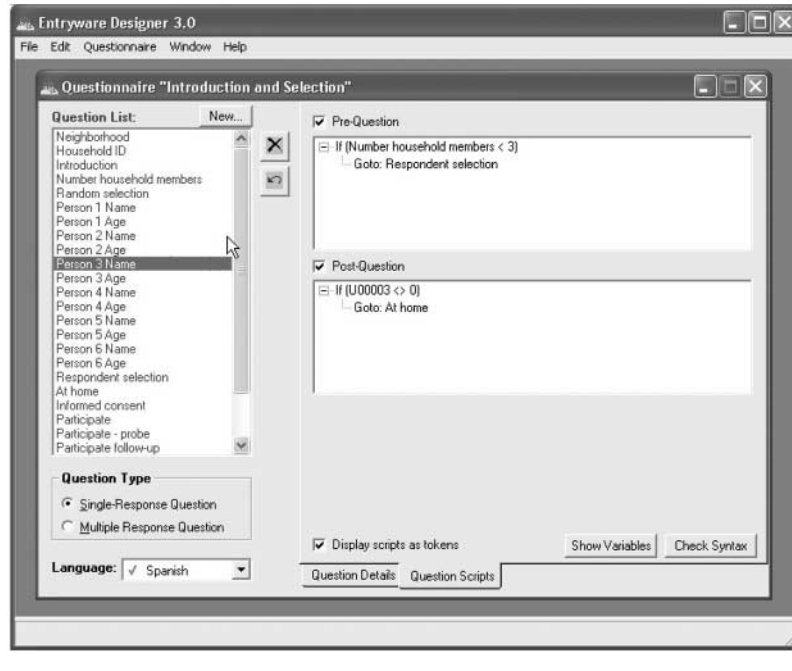
Two key advantages of CAPI methods are the ability to simplify complex branching and skip patterns and to validate data values during data collection. The Entryware Designer software offers these advantages through its scripting features. Scripts allow users to display messages (see Figure 2b), change question routing, and assign or calculate user-defined variables based on any number of conditions. The interface for building scripts is fairly intuitive and requires no programming. Figure 3, for example, shows a prequestion script from an Entryware questionnaire that I designed to screen sampled households and to select one adult household member at random to participate in the survey. This script tells the software to skip to the question “respondent selection” if the number of eligible household members is less than three. Simple scripts like this one are very easy to create. The script examples provided with the software give users a good sense of what’s possible with more complex scripts.

Researchers who work with multilingual populations will appreciate the ability to specify question and response text in up to fifteen languages for each questionnaire.⁴ Each questionnaire requires users to specify a default language, but if the questionnaire has been developed in more than one language, interviewers can choose an alternative language from the handheld during the interview. The software then automatically records the language in which each interview is conducted. This feature is particularly useful because questionnaire structure is independent of language use. Consequently, any changes in scripts, question order, or the order of response items will affect questionnaire structure across all languages, thus maintaining the comparability of response data (within limits of the translation).

The Designer software includes other features to balance the need for flexibility in questionnaire design versus control over changes that could result in ambiguous data. One key feature is the ability to choose one of three project modes—draft, pretest, or live—depending on the stage of questionnaire design.

Draft mode, for example, turns off warning and tracking features in the Designer application and prevents interviewers from saving response data on

FIGURE 3
Script-Building Interface in Entryware Designer Software 3.0



the handheld. In Puerto Rico, I used this mode to pretest branching and skip patterns and to verify translations and question format with key informants. When it appeared no more changes were necessary, I switched to pretest mode, which allowed me to save response data and engaged the modification log. This log tracks changes in questionnaire design and documents which version of the questionnaire is used in each interview. If there is a serious design flaw, the modification log would help researchers identify which data are unusable and why.

A critical feature of the Entryware system is the ability to work with multiple interviewers, as there is no limit to the number of handhelds used in a single project. Response data from multiple handhelds can be uploaded to a single PC, where the Designer program consolidates the data into a single file for processing. It is not even necessary that interviewers be in the same location: Response data can be uploaded from the field via a modem connection,

and Techneos promises an Enterprise version with Web-based synchronization and reporting in 2002.

Unlike some survey packages, Entryware products offer no data editing or analysis functions, so response data must be exported to third-party software for analysis. This limitation is inconsequential, because the Designer application processes and exports response data as a delimited or fixed-field ASCII file, or as a formatted SPSS data set (.sav) in which the question text is exported as variable labels. Users can define variable names, change variable order, and set missing values before exporting the data set. In practice, these features meant that, when I returned home after a long day of interviewing in Puerto Rico, my response data were instantly ready for analysis.

Like most Palm programs, the Interviewer application has a simple, intuitive interface and is easy to learn. It comes with a hands-on tutorial that can have first-time users up and running with very little practice. My research assistant in Puerto Rico, who had never seen a Palm-powered computer, mastered the interviewing software after the first few pretest interviews. This ease of use may translate to lower training costs relative to projects with standard CAPI technology (Bosley, Conrad, and Uglow 1998). Some interviewers may be put off by the small screens of handheld computers, but Entryware software allows users to improve the appearance of questionnaires on the handheld. Users can choose between two font sizes (see Figure 2a–c versus d–f) and can customize the number of lines allotted to question and response text.

Several new features in version 3.0 incorporate key advantages of CAPI over paper-and-pencil interviewing and make the software much more compelling than the version I used in Puerto Rico. For example, users can now minimize the risk of bias from question order by rotating or randomizing response lists. There are also improved functions for validating response values, ensuring that case data is complete, filtering response items, and piping response text to subsequent questions. Frequently used questions can be copied from one questionnaire to another, complete with response alternatives and scripts to ensure comparability.

Field Applications

The use of handheld computers in field research raises long-standing concerns about how respondents' reactions to technology may affect data quality. After twenty years of research, there remains little evidence of mode effects in traditional CAPI (Baker 1992; de Leeuw and Nicholls 1996; Lynn 1998). Yet the novelty of handheld computers makes it important to consider

this potential source of bias—especially in settings in which handheld computers are not yet commonplace. In Nepal, Greene (2001) reported that informants who encounter handheld computers for the first time generally respond with curiosity. He added that the technology contributes to a “sense that the interview is an important event” (p. 182) and that it has improved the quality and efficiency of data collection.

This response resonates with my own experience in Puerto Rico. In the communities where I worked, few people had ever seen handheld computers. Many survey respondents were curious about the device, asking, “Is that a computer?” When I showed them how it allowed me to enter their responses directly, most seemed impressed by the technology. My research assistant told me that she felt more professional using the handheld to conduct the interviews, a common reaction among users of standard CAPI technology (Baker 1992).

Handheld computers offer a distinct advantage over laptop computers because they facilitate a more natural interaction between the interviewer and respondent (Bosley, Conrad, and Uglow 1998). Indeed, I found it easier to maintain eye contact and a natural flow of conversation using the handheld computer than is possible with even paper-and-pencil methods. There is also evidence that computer-assisted interviews are shorter than paper-and-pencil interviews, which may improve respondents’ willingness to participate (Lynn 1998). As this technology proliferates, we need more systematic studies to evaluate the effect of handheld computers on data quality and respondents’ reactions to participation, as compared to other interviewing technologies.

Handheld MCAPI should be particularly attractive to researchers who collect survey data about sensitive topics such as sexual behavior, substance abuse, or criminal activities. Baker (1992) reported that respondents in a CAPI interview may be more likely to report behavior they perceive as negative or embarrassing than are respondents in a traditional paper-and-pencil interview. However, more recent studies argue that computerization itself is not as important as is mode of administration: Self-administered questionnaires reduce social desirability effects relative to traditional face-to-face interviews (Tourangeau and Smith 1996; Moon 1998). In an effort to improve the accuracy of survey data, therefore, many researchers have moved to computer-assisted self-interviewing.

Handheld computers make it easier to take this technology to the field, especially since the Entryware handheld interface can be set up for self-administered interviews. Handhelds running Entryware software can be used for fully self-administered interviews or in combination with interviewer-administered questions. The portability and intuitive interface of

handheld computers make it easy for respondents to interact directly with the computer.

In some cases, it may be valuable to link MCAPI interviews with self-administered paper questionnaires that researchers can collect or receive by mail at a later point in time. This approach would be useful, for example, to collect a subset of data about sensitive topics or events that take place after the interview. Using Entryware software for MCAPI together with paper forms designed for electronic scanning (Weller and Baer 2001) would be a feasible option in such cases. To link the MCAPI interview with the self-administered questionnaire, interviewers could simply record a serial number from each paper questionnaire during the initial MCAPI interview. For large samples, it might be worth automating this process by scanning a bar-coded serial number directly into the handheld.⁵

My experience using the Entryware system confirms that it is a robust tool for implementing MCAPI in face-to-face structured interviewing. This new technology can be used in a wide range of field settings and provides the key benefits of CAPI to field researchers. However, it may not be appropriate for all types of structured interviewing. For example, in earlier phases of my work in Puerto Rico, I tried to use the Entryware system in structured ethnographic interviews with methods for cultural domain analysis (Weller and Romney 1988). The Entryware system turned out to be too cumbersome for interviewing techniques such as free lists, pile sorts, and identification tasks, all of which require greater flexibility to move between questions and to access response data from previous questions or even from previous interviews. This limitation is to be expected since Entryware software is designed specifically for survey research and therefore assumes a fixed, linear progression from one question to the next. When this degree of structure is not appropriate, forms-based data collection software is likely to be a better alternative.⁶

My experience also suggests that the Entryware software is at its best in surveys that include mainly closed-ended responses. The software does support open-ended text, but efficient text entry on Palm OS computers requires either mastery of the Graffiti handwriting system or an alternative text-entry system. Graffiti handwriting uses an alphabet with simplified characters, and with practice it can be at least as efficient as normal handwriting. For example, I use my handheld daily and enter text with Graffiti handwriting at about thirty words per minute, slightly faster (and far more legible) than with pencil and paper. However, my research assistant in Puerto Rico never mastered the Graffiti system, and eventually we agreed that she would ask only questions with closed-ended responses. In situations that demand more open-ended text, I would recommend purchasing an external keyboard. Current models

range in size from so-called thumb boards to full-size QWERTY keyboards that fold up and fit in your pocket.⁷

CONCLUSION

Potential users should note that Entryware software is not meant to be an all-in-one survey package. It does not include data-editing or analysis functions, and it lacks the project and sample management features of some desktop survey packages. However, the Entryware system is the best solution for field researchers who want to capture the power of mobile computing in face-to-face structured interviewing. This robust product delivers the key benefits of computer-assisted interviewing to handheld computers. As such, it offers dramatically lower hardware costs and true interviewer mobility as compared to standard CAPI technology. The Entryware questionnaire design tools are intuitive yet powerful, and the Palm OS interviewing software is simple and easy to learn. The availability of this new technology has the potential to improve the conduct and quality of survey research in the field.

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NOTES

1. For more on the differences among handheld platforms and their use in field research, see Greene (2001).

2. For example, both Pendragon Forms (<http://www.pendragon-software.com/>) and Satellite Forms (<http://www.pumatech.com/>) allow users to design mobile data collection tools for Palm OS computers—the latter at a significantly higher cost. These products are general-purpose data collection tools that could be useful for social researchers in many applications. However, because they are not designed specifically for social research, they lack some key functionality of computer-assisted personal interviewing software such as randomization and

interviewer tracking, and they can be more cumbersome, time-consuming, and error prone in programming skip patterns or branching.

3. scyField-HPC has never been widely available in North America and soon will be unavailable elsewhere, too. The entire Surveycraft line is being phased out by its new owners, SPSS. SPSS is now an authorized distributor of Techneos's Entryware system.

4. Entryware software has built-in support for eleven European languages: English, French, Spanish, Portuguese, German, Dutch, Italian, Swedish, Norwegian, Danish, and Finnish. In addition, users can specify up to four other languages for each questionnaire.

5. Symbol Technologies (<http://www.symbol.com>) makes Palm-powered devices with built-in bar-code scanners. They also produce an add-in module for Handspring Visor devices that adds bar-code scanning to these popular Palm-powered computers.

6. I used thinkDB database software from thinkingBytes Technology, Inc. (<http://www.thinkingbytes.com>) to create data collection forms for structured ethnographic interviews. Pendragon Forms and Satellite Forms software may also be appropriate for similar interviewing situations.

7. For more on text-entry alternatives for Palm-powered devices, see the following:

<http://www.palm.com>
<http://www.handspring.com>
<http://www.thinkoutside.com/>
<http://www.landware.com/gotype/>
<http://www.thumbtype.net/>
<http://www.twsolutions.com/>

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