CHAPTER 2
Electronic Support for Rural Health-Care Workers

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The India Healthcare Project began in 1994 as a collaborative project between the Government of India, Apple Computer, Inc., and CMC, Ltd. of India. The project’s initial impetus came from the Indian government’s interest in providing electronic support to village workers in their rural health-care system. The health-care workers were burdened with demanding data-collection and paperwork responsibilities, which affected the quality of their work and their ability to provide primary health-care services to the people they serve. The project team designed a system based on the Newton handheld computing technology, with the intent to lessen the paperwork burden, improve data accuracy, and empower the village health-care worker to provide timely care and information. The project has reached the end of an investigation and research phase and has been turned over to CMC, Ltd. for further development.

Introduction

In the fall of 1994, the India Healthcare Project began as a collaborative effort between the Government of India (GOI) and Apple Computer. As the project began to unfold, other partners from India’s information technology and design industries became central to the project. Its purpose was to provide research and initial testing of an electronically based support system for rural health care in India.

India’s health-care system includes a very large rural system administered by the GOI. The system is hierarchically deep, starting from the government’s Health Minister and percolating down to community health-care workers, who go visiting from house to house in the rural areas. According to 1991 census, the system provides health care for a rural population of 630 million people in 32 states (Rural Health Division 1995).
Initial collaboration between the GOI and Apple Computer spelt a possibility of providing portable, laptop computers to the health-care workers in the villages. These workers, Auxiliary Nurse Midwives (ANMs), are the system’s direct point of contact with the people. By design, each ANM is responsible for administering to 5,000 persons, typically distributed over several villages and hamlets. She (ANMs are exclusively women) operates from a subcenter, located in or near one of the villages under her charge. The subcenter includes her office, with registers and other items needed for paperwork, dispensary materials, first aid care materials and other medical supplies. Often the villages and hamlets she serves may be located a number of miles apart. She calls on the houses within her charge once every month. She is not provided any transportation facility by the government. Her duty is to collect basic demographic data, administer immunization, advise on family welfare, and educate people on mother-child health programs. Figure 2.1 shows an ANM with villagers under her purview.

In its meetings with Apple Computer, GOI representatives were introduced to the Newton Message Pad, a new product introduced by Apple in 1993. The Message Pad provided advantages exceeding those of laptop computers. It was lower in cost, worked much longer on its internal batteries, was smaller in size and lighter in weight and therefore even more portable. It also provided for pen-input and interaction, thus requiring less keyboard and mouse skills. The Health Ministry was intrigued with the Message Pad’s capabilities, and decided to use it for a research project aimed at supporting the work of the village health-care system.

In accordance with the GOI’s aim to support its fieldworkers, a team from Apple Computer adopted a grassroots strategy and began observing and learning about the work of the ANMs in the field. A study site was selected in cooperation with the government, in the state of Rajasthan, near the city of Ajmer. The location was chosen as one that would be representative of other sites throughout the country. It possessed an averagely equipped technology infrastructure for the introduction of the new technology and practices. It offered a good chance to learn what the requirements and chances of success would be for introducing similar technologies in other parts of the country.
A number of factors made it imperative that Apple’s team form collaborations with Indian companies to carry out the research phase of the project and to provide a vehicle for ongoing development after the research phase was completed. The Apple team was a research group whose charter did not extend beyond prototyping and field study phases of the project. To engineer and maintain a new system of technology support would require a permanent presence and availability. In addition, in order to gather knowledge of the ANMs’ work practices and functions, local knowledge, transportation, access to health-care personnel and facilities, and a general local presence would be needed. The two partners Apple chose to work with were the Center for Diffusion of Information Technology (CDIT) and CMC Ltd., headquartered in Delhi, with offices throughout India. The CDIT in particular could provide coordination and communication to the government along with knowledge of the field site and the health-care structure. CMC is an established technology development leader within India, capable of providing an ongoing development team, field maintenance, and a research and development center in Hyderabad.

As the project unfolded, the National Institute for Design in Ahmedabad also became indispensable. A student from the institute served as an intern on the project and provided continuous field presence that Apple’s team could not maintain.

**Objectives of the Project**

- **To provide support tools that would allow ANMs to reduce time spent doing paperwork.** ANMs fill in a battery of periodic reports and deliver them to their Supervisors, who in turn deliver data, to a “Computor” who generates summary analyses to proceed up the system’s reporting chain. This data-gathering function provides factual information on the rural population’s growth, birth rate, and immunization rate. Filling out the periodic reports by hand is laborious and time-consuming, which at times takes days. The Newton-based electronic system would enable automated report generation, on the basis of data entered day-to-day, during or after the ANM’s rounds.

- **To increase the accuracy of the data flowing up from the ANMs through the health-care reporting structure.** The paper-based data system requires redundant data entry (i.e., various forms requiring the same baseline data along with special reports) with no provision for consistency. Moreover, the reported data may be inconsistent or incomplete. The electronic system would minimize or eliminate redundant data entry, perform consistency checks as well as provide checks for allowable data values, and provide a permanent storage system for archiving the needed data.

- **To provide a means for getting health-care data at the village level into an electronic form.** The Computor’s job, in the paper-based system, requires that he produces a number of summaries, all
composed by hand. Electronic data submission and compilation would not only ease the current process but would make more ad hoc, focused data analysis possible.

- **To provide the ANM with information that helps her to provide more effective service to the villages within her responsibility.** In the paper-based system, ANMs get little or no feedback from their data submissions. They do not get time-based summaries, trend spotting, or data-derived alerts. The Newton device would provide the basis for an on-demand information system for her to consult, so as to enable her to reflect on current conditions within her villages via the device. This information would include not only data summaries but also downloaded educational materials relevant to conditions as they develop.

**Investigation**

The first three site visits, from the fall of 1994 to the spring of 1995, were devoted to learning about various aspects of the health-care system, the ANM’s job, and the various challenges faced. The principal goals of the visits are listed below:

- **Learning about the physical environment of the field site.** The area around Ajmer is a desert with typical subcenters that lack indoor electricity or telephones. It was required to know about the existence of technology in the rural areas in the form fax machines, village telephones and postal systems.
- **Learning about the official health-care hierarchy, reporting system, and data flow.** To achieve this, paper models of the reporting structure and data flow, were constructed. These were later cross-checked with CDIT’s understanding and with persons at different levels within the structure itself.
- **Learning how the ANM does her job.** This included not only knowing her official functions as set out under the health-care system, but also her informal practices and roles within the village. Her job was reconstructed from the standpoint of her concerns and priorities. To do so, a ‘card study’ method was developed and employed allowing the ANMs to reconstruct their practices and priorities.
- **Learning to learn more.** This included locating and contacting the key persons, sources of information and also people who would offer support to the project.

**Technology Used**

The major part of the project was investigative. Before any technology could be designed or implemented, it was desirable to know the significant details,
the design of the health-care system and the work practices and concerns of the ANMs.

Accordingly, technology choices, other than those already mentioned (choice of the Newton Message Pad as a platform), were put on hold until field investigations were undertaken and an understanding of the ANM’s job and its context within the health-care system could be spelt out. The methodology was ‘user centered’ in the sense that technological features of the system were to be designed on the basis of this understanding. And later design stages included the direct participation of ANMs themselves to provide feedback, test hypotheses, offer suggestions, and speculate on its uses.

The platform for the design was the Newton Message Pad. The Newton technology (Newton Toolkit), now no longer in production at Apple, provided an operating system and development environment amenable to fast prototyping and modification. While the Message Pad product distributed in the United States and Europe featured handwriting recognition as a primary means of data input, it was not feasible to provide similar features for the Indian system to be used by the ANMs. Only a few ANMs in the field site could speak, read or write English. Hindi was the common language. To provide Hindi recognition would have been a very formidable project in itself; it was thus decided to provide an onscreen keyboard for data input.

It was desirable to provide the ANMs with a system that was in tune with their practices, priorities, and conceptualization of their work. The first task was to provide an appropriate data structure that would also provide a basis for navigational organization.

The hierarchy from subcenter to couples mirrors data structures currently represented in the ANM’s existing paper registers. The most critical design task was that of the system’s user interface. The system designed provided what would later be termed an “electronic register.”

Figure 2.2 Data Backbone

After numerous paper designs and mockups, an interface was developed. Its basic design was readily acceptable to the ANMs. Some important features of this design are listed below:
a) Navigation based on iconic representations of villages, households, families, couples, and individuals

Each icon, when tapped by the Message Pad’s pen, leads to the more specific record of that individual. Without having to tap down to the individual record, the individual’s status can be gleaned from the state of his icon. Immunization status, disease, and other conditions are noted by shadings, markings, and other modifications to the individual icons. The ANM gets an overall impression of the status of a household from the representation. She can add data, such as enrollment in a prenatal healthcare program and the icons will change to show the appropriate new status.

b) Customized font and keyboard

The design of the font for the ANM’s Message Pad required tailoring to meet the needs of the hot climatic conditions and non-backlit display of the Message Pad 120. In addition, Alexander Grünsteidl, the principal interface designer on the project, supplied a range of fonts and styles for various interface elements (buttons, field labels, menu items, etc.). The keyboard itself is based on the Indian Script Code for Information Interchange (ISCII) standard, with modifications to allow the normally invisible, shifted keyset to remain visible in the background of the unshifted keyset (Bureau of Indian Standards 1991). Hindi does not include a distinction between upper and lower case characters, but it does contain too many characters to include all in a single keyset.

c) Modifiable text constants

Since a prototype for a system was provided to be used in many parts of India, it was important to design a means for changing the onscreen text, script, and language easily. In fact, the prototype includes the capability of switching back and forth between English and Hindi onscreen text, and, in principle, any other required language. Text constants and font selections are kept separately from the main software code and can be altered without significant engineering skills. This feature became especially important because of the variation not only of language, but also of dialects within languages that differ from region to region.

Overall System Design

The system design provides for linking ANMs’ Newton’s clients with a desktop machine, held at the supervisor’s level. The supervisor’s desktop machine will receive compiled reports from the ANMs, backup their software and data, and provide educational materials in electronic form as downloads to the ANM’s
Message Pads. Selection of downloaded material is based on the requirements of the ANM’s reports. Thus, for example, when new cases of malaria show a rise beyond a set threshold, prevention and treatment materials can be automatically supplied in electronic form viewable by the ANMs’ on their Message Pads.

**Implementation Challenges**

The pilot project faced cultural, geographic, and social as well as technical challenges.

- Cultural and geographic challenges: The Newton technology was relatively new and its development environment unfamiliar, but even more challenging were the unfamiliar cultures, languages, and geography of India. The engineering teams from CMC as well as from Apple were not well oriented with the rural area of Ajmer. Besides eating, boarding and lodging, communication with ANMs and others within the health-care system required translators. These translators however quickly grew to occupy expanded roles not only as interpreters of what was worded, but also what was intended and felt.
- Subtle challenges in international collaboration had to be faced: Work between geographically separated teams (Apple in Cupertino, California, and CMC in Hyderabad, India) brings its own difficulties, including dealing with time differences, differing communication styles and infrastructures. Moreover, participation in the project carries different degrees of importance and different meanings to an Indian engineer and to one working in California. The two companies, Apple and CMC, also have different priorities, interests, and expectations from the project. All need to be balanced so as not to unintentionally sabotage well-meaning efforts.
- Social challenges: The Indian health-care system is vast and ambitious. Apparently no one seemed to comprehend the system completely. Introduction of this technological support system would have social effects. In the most informed of situations, armed with a theory of the social interactions in the system into which we were introducing our innovation, social impacts would still be unpredictable. A major challenge then, was to maintain respect for existing relationships of authority and responsibility while introducing an innovation that would produce changes.

One major area of change would be the future roles of the ANM, Supervisor, and Computor. Currently, the paper reporting system circumscribes a large part of their work. With data entered, stored, submitted, compiled, and analyzed electronically, how would their jobs change? Would the Computor be able to transfer his data analysis role to a computing environment? How would the availability of ad hoc reports and analysis change his role in the system? Would
the ANM be able to devote more time to interactions with villagers? Would she be able to cut down the time she spent preparing reports? If so, would her priorities change? How would the Supervisor’s relationship with the ANM change, as he would be able to see compiled reports with consistent data as uploaded to a desktop? Would this reduce his role, or would it empower him to spend more time in training and coaching?

The second question concerned the future position of the ANM within the village. The ANM often comes from an area other than the villages she serves. She is often better educated than the villagers are. After equipping her with an expensive electronic device, a handheld computer, would the perceived distance between her and the village community increase? How would the handheld device alter her conversations with villagers during her rounds? Knowing that computers are more distinctive and less common in India than in western environments, care was taken not to refer to the device as a computer and to avoid encouraging the ANMs to carry the device with them on their rounds.

- Technical challenges: In addition to challenges posed by the multiplicity of languages and scripts, and the team’s lack of familiarity with the new Newton technology and handheld interfaces, a number of technical challenges cropped up from the physical environment and rural infrastructure.

Figure 2.3 The Paper Reporting System

Although the Newton Message Pad can be equipped with a rechargeable battery pack, its battery life was not sufficient to rely on the sporadic availability of electricity in the ANM’s everyday environment. Batteries are expensive and awkward to carry and change as required. With the cooperation of Keep It Simple Systems, the team designed and tested a customized carrying bag for the Message Pad, incorporating a solar panel to continuously charge the Message Pad within the bag. The bag itself was modeled after bags commonly carried
by the ANMs to hold registers, immunization supplies, and other items. The solar bag also provides some measure of protection from rains.

Dust is a problem in the desert environment of rural India. The Message Pad’s serial port and the screen itself are particularly vulnerable to dust and sand. It is, as a standard, equipped with a rubber cover for the serial port and a lid to cover the display screen when not in use. Despite this, blowing dust could pose a problem. We experimented with a stretch-to-fit rubber boot for the device, which would also cushion against accidental bumps and drops. In addition, we tried out a clear plastic protective cover for the display screen, which could remain in place during use. These challenges may get magnified as the application of this system gradually increases. Awareness at this initial phase might help in smoothening out some of the practical problems that are at present anticipated.

### Implementation Results and Benefits

The India Healthcare Project has reached the end of its preliminary phases. It is too early to report results on a definitive, large-scale nature. Rather, our current results are qualitative and drawn from controlled field exposure (Graves and others 1998). The purpose of these field exposures has been to provide input for the iterative design of the support system.

However, the first results were impressionistic and very positive. ANMs showed no hesitation in using the device, taking the pen in hand, and tapping on the screen. Some had experience with keyboards and took easily to using the software version. Some even reported using the keyboard as ‘fun.’ They saw the parallels between the electronic system and their paper registers, coining the term ‘electronic register.’

Over all, although quantitative results are still unavailable, the ANMs believed that the system would be helpful to them. They saw that redundancies in data entry would be eliminated or at least reduced. The prospect of automated report generation made a very favorable impression. They felt that an initial training period, perhaps of one month duration involving one on one coaching, would be sufficient to make the device an integral part of their job.

The device’s display of the ongoing design was too dim and glare from the sun was too great. Later tests with a new, backlit display are expected to show considerable improvement. Much of the on-screen text produced difficulty. We had in many cases simply translated English text, such as ‘open’ or ‘cancel’, into Hindi equivalents. Such translations were very sensitive to local dialect and language subtleties that even our native Hindi-speaking translators could not foresee. This led to our placing a greater emphasis on a simple technical procedure for modifying and localizing on-screen text.

The actual practices of the ANMs were very different from the official accounts of their procedures and responsibilities. Many of the data collection capability techniques included in our prototype could not be used. Others were
inaccurate with respect to actual practice. Consequently, a further effort undertaken with increased leadership from our partner CMC focused on a reduced, simplified prototype.

**Conclusions**

Based on the pilot study, we draw the following conclusions.

- To provide support tools that would allow ANMs to reduce time spent doing paperwork. The Newton based electronic system would help in expediting work. This would not only save hours of tedious labor but also leave her with ample time and energy to devote more time to the people she serves.
- To increase the accuracy of the data flowing up from the ANMs through the health-care reporting structure. Although quantitative measures are required, the initial results seem to be promising. Elimination of redundancy and consistency checking would reduce the ANM’s paperwork. It is yet to be discovered how entering data into the electronic device will actually fit into her day-to-day routine. Maximum time would be saved if she carried the device with her on her rounds and entered the data directly. However, not all ANMs do this even with the paper register system. They often take notes in a diary and then transfer it to the registers later when they are back in their subcenter office.

The automated report will not only save time and effort for the ANM but also for the Supervisor and Computer by eliminating laborious hand compilation and calculation.

- To provide a means for getting health-care data at the village level into electronic form. This goal is well served by the existing prototype. The questions that will now need to be answered include how the solutions will scale over other regions of India and what effects the electronic medium will have on the roles and relationships within the reporting structure and on the significant changes it may make possible for ad hoc analysis, generation of timely information, and empowerment of the ANMs for more directed health-care activities.
- To provide the ANM with information that allows her to provide more effective service to the villages within her responsibility. Drawing conclusions with respect to this goal would be premature at this stage as the system has not yet been fully implemented.

The team from Apple Computer has completed its participation in the India Healthcare Project. Further pilots and larger scale implementation is in
the hands of CMC Ltd. Given the discontinuation of Newton technology, other handheld computing platforms will need to be examined. However, the results of the field investigation and prototype design are likely to achieve the desirable results.

References

