mClinic

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Abstract
mClinic and the Technology Assisted DOTS Project provide a case study of health care system design geared towards developing world needs. This system design process provides lessons on developing technology-based systems for the developing world. The paper encompasses a history of the project, from inception to prototype, and the steps taken by the authors to develop a culturally and socially appropriate, efficient and cost effective system. In addition to producing a functional prototype, the mClinic project, through this documentation and analysis of the process, provides a foundation for future development efforts and suggestions for overcoming some of the challenges that arise from remote development.

Introduction

Designing technology-based systems for the developing world in the developed world is a challenging undertaking. Designers are faced with various layers of complexity in the development process, from inception of idea to full implementation and deployment. Effectively overcoming these challenges requires creativity in problem-solving and patience in abundance.

The following paper provides a case study of a health care technologies project that was conceived in the United States with the ultimate objective of deployment in the developing world. Although the discussion is focused on one specific implementation, the lessons learned from this process can provide a guide for future efforts. Most importantly, this experience fills a much needed gap in the existing literature. Current literature contains some comparisons of remote usability software options,[1] and the pros and cons of remote versus the more common co-present form of usability testing.[2] However, little has been said about *very* remote usability testing of a user interface; testing which provides indispensable feedback as it puts the development team in direct contact with the intended users. The remote user testing lessons learned through the course of this project, in combination with other recommendations for system development, offer a methodological foundation for future research and system development.

Project Motivation: Tuberculosis Globally

The humanitarian and economic costs of tuberculosis (TB) are global and staggering. The impact is particularly high in developing countries where poverty, poor nutrition, housing conditions, and lack of basic healthcare contribute to the spread of TB. TB lowers productivity, resulting in increased poverty and poorer nutrition - vicious cycle that leads back to increased TB rates. TB is estimated to lower the incomes of the world's poorest citizens by $12 billion.[3] Each year over 2 million people die from the disease, making it one of the leading infectious causes of death among young people and adults. Combined with HIV, TB is exceptionally deadly, accounting for approximately 13% of AIDS-related deaths per year. HIV rates have soared in Africa; one third of all HIV-positive individuals develop TB.[4]

Currently, the accepted best-methodology for treating TB is a combination of antibiotic medication delivered through a system called *directly observed therapy, short-course* (DOTS). In this method, TB patients are observed taking their medications by a health professional or, occasionally, a family or community member for the first two months of treatment. Over the following four to six months patients usually administer their own antibiotics. During this unsupervised period a fair number of patients default on the prescribed drug regimen, resulting in higher rates of treatment failure. Reasons for default vary, but often include lack of access to transportation or funding for transportation, lack of education or understanding about the

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[1] See: "A Comparison of Synchronous Remote and Local Usability Studies for an Expert Interface," Brush, Ames, and Davis, *CHI 2004*, April 24, 2004. http://www.ocf.berkeley.edu/~morganya/research/chi2004-remote.pdf
See also : "Remote Usability Testing Tools Preston, *Usability Interface*, Vol 5, No. 3, January, 1999. http://www.stcsig.org/usability/newsletter/9901-remote-tools.html

[2] See: "Remote Online Usability Testing: Why, How, and When to Use It," Dabney Gough and Holly Phillips, *boxes and arrows*, June 9, 2003. http://www.boxesandarrows.com/view/remote_online_usability_testing_why_how_and_when_to_use_it

[3] "Basic Facts on TB: Stop TB, fight Poverty" The Stop TB partnership, March 24, 2002

[4] Maher, D., Mikulencak, M. (1999). What is DOTS? A guide to understanding the WHO-recommended TB control strategy known as DOTS.

importance of finishing antibiotic therapy, forgetfulness, and sharing of medication with family or others.

Non-adherence to a treatment regimen can result in increased incidence of multi-drug resistance, low cure rates, and spread of TB.[5] Higher treatment failure leads to only partially-treated patients, resulting in further spread of disease, particularly in areas with a substantial number of at-risk patients in close quarters. In some areas these problems have led to implementation of DOTS programs for the total duration of treatment that have been very successful. However, high costs and the disruption of the patient's lives have limited the settings where this has been applied. In spite of claims that the DOTS program is fully implemented and that all patients receive this level of care, in many countries the health care system does not have adequate financial resources and personnel and are unable to monitor all of the registered TB patients for the appropriate time period.[6] The soaring TB rates and lack of funds in Africa are pushing DOTS to or past its limits in two main areas:

1. Financial sustainability beyond the second month of the six month treatment course;
2. Effectiveness in reaching rural patients due to lack of resources.

Project Motivation: TB in Kenya

Kenya has seen a 500% rise in TB infection rates in the last 10 years. Incidence of TB has climbed to 540 per 100,000 of the population per year and globally it has moved to 12th in the world for TB burden. The country claims 100% DOTS coverage for 2 months of directly observed treatment, though it is likely that this is an overestimate of coverage.[7] Even with high rates of DOTS, treatment failure rates in Kenya are estimated to be 20% and the system is operating at full capacity. Without more funding or implementation of new, less expensive methods there will be no way to maintain countrywide DOTS coverage.[8]

In 2001, Dr. David Green, a South African physician, undertook a new initiative in management of treatment in TB patients who did not have access to a DOTS program. Now known as "The Compliance Service", Dr. Green's initiative utilizes SMS (short message service) to provide patients with medication reminders.[9] This text messaging medication reminder service has had positive results in a setting where it was impossible to implement full DOTS coverage. Although there is not yet sufficient evidence that the SMS system has comparable or better compliance rates then DOTS, Dr. Green's system suggests that messaging systems may be used to improve TB programs.

In addition to the work of Dr. Green, the use of telemedicine has been increasing in parts of Africa in order to improve care available to rural patients and to provide better tracking for patients with chronic disease. The rise in these services has corresponded with the increased mobile network deployment and adoption and use of mobile services.[10] The African Research and Medical Foundation (AMREF) deployed a mobile phone service for remote patient diagnosis

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[5] Maher, D., Mikulencak, M. (1999). What is DOTS? A guide to understanding the WHO-recommended TB control strategy known as DOTS.
[6] *Ibid*
[7] Dr. James Moyaie, TB Control Programme Coordinator, Kajiado District, personal communication.
[8] Kenya Country Profile, WHO Tuberculosis Report, 2004.
[9] http://www.bridges.org/case_studies/137, http://www.comminit.com/strategicthinking/stdigitalpulse/sld-1664.html
[10] In Kenya, it is estimated that mobile phones outnumber landlines 20:1 with mobile penetration at about 15% of the population. http://www.budde.com.au/Reports/Contents/Kenya-Mobile-Market-Overview-and-Statistics-3451.html

in several countries including Kenya.[11] Patients and health care clinic staff in rural areas are able to contact specialist physicians for diagnosis and treatment recommendations. The South African Cell-Life project provides mobile-phone based tracking for HIV patients.[12] Care workers are trained to gather relevant patient information, including data concerning medication compliance, and enter it into a mobile phone on the spot. The objective of this project is more efficient use of human resources and better data on HIV patients.

Inspired by the work of Dr. Green and the growing evidence of the benefits of telemedicine, the Technology Assisted DOTS project (TAD) aims to provide an economical and extensible solution for the lack of human and financial resources faced by clinics in the developing world. With this system, patients receive treatment reminders, educational, and other voice or text messages delivered from a clinic-based computer to their mobile phone.

Kenyan Feasibility Study: Overview of Results

The TAD team[13] received funding through the MOT-UNIDO Research Fellowship Program to conduct a feasibility analysis of the TAD system. Research was conducted during a six-week period in Kenya during the summer of 2005. During this time the team interviewed tuberculosis patients, health care workers, and third-party cell phone owners in nine communities spread across Kajiado District (in southern Kenya).

Questions were designed to survey cell phone ownership across different sections of the population, reasons for non-compliance with treatment, and the social acceptability and technological feasibility of the system. As tuberculosis patients are likely to be more rural and of a lower socio-economic status than the average individual, the team hypothesized that they would be less likely to own a mobile phone than other members of the population. Community members with cell phones were therefore also interviewed to determine tolerance and willingness to pass messages along on behalf of the patients. Willingness on the part of the patients to receive messages via a third party was also explored. Selected hospital workers were asked to complete a user interface evaluation in addition to completing the interview.

Overall, 217 patients, 17 health care workers, and 30 local mobile phone owners were surveyed. Results indicated that all parties were amenable to a medication reminder system such as TAD. Community mobile phone owners were willing to act as message conduits; tuberculosis patients, however, expressed that this would violate their confidentiality and would prefer not to receive messages this way. As part of a clinical trial, phones would need to be provided as the majority of patients did not own or have direct access to a mobile phone.[14]

Kenyan Feasibility Study: Overall System Concept

The proposed system was discussed with patients and framed in the context of the existing DOTS program to provide a basis for understanding. Approximately 90% of patients felt that the TAD system would prompt them to take their medication and that the system could provide a suitable substitute for the existing person-based system. A few patients stated that the ability to interact with their treatment clinic would also be important to them.

Hospital workers were also asked for their opinion on the proposed system and for suggestions to make it more effective after receiving a high-level explanation. Most stated that

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[11] http://www.amref.org/index.asp?PageID=63&ProjectID=94&PiaID=3&CountryID=1
[12] http://www.cell-life.org/home/home.html
[13] The authors and Aubree Gordon, PhD candidate at the School of Public Health, UC Berkeley
[14] Results of the study are available at http://dream.sims.berkeley.edu/groups/mclinic/technology_assisted_dots.doc

they thought the idea was sound, but would like the system to also be interactive in order to record answers to health related questions and flag anomalies in patient data. In a common scenario suggested by health care workers, a patient would receive a message (text or voice) inquiring about their health. The patient would respond to the message by entering a number on the keypad corresponding to a subjective scale (e.g. 0-9, 0=”horrible”, 9=“wonderful”). The accumulated responses over time or across multiple messages would be used to determine if the patient needed to come to visit the clinic, or needed further intervention measures. Several viewed the system as a way to improve patient education, one of the most frequently cited reasons for non-compliance, and most preferred that the patient be given the option of receiving voice or text messages in the language that best suited them.

Kenyan Feasibility Study: Patient Medical Records

In addition to the discussion about the proposed system, some hospital workers participated in a user interface evaluation. The goal of the evaluation was to assess assumptions and understandings about the computer, and its applicability to their daily work, in a highly educated but largely non-technical population.

A browser-based data entry form was created to correspond to the paper TB patient information card maintained by the clinics.[15] This was a visually identical representation of the paper version in use. Hospital workers were shown the interface and asked to enter data for a fictional patient. The objective was to note how the worker responded to the interface and the keyboard, in order to understand how to best design a simple, intuitive interface that would require minimal instructions and training to use. Hospital workers with previous computer experience were able to navigate and enter data more easily than those without it, though all individuals expressed interest in typing classes to improve efficiency and understanding of the keyboard. Forms used text boxes and text areas where one would normally write in information, and checkboxes where the individual would normally make a tick mark. These were easily understood by the hospital workers and the concept of clicking to make a check was quickly accepted.

Two variations of the interface were presented to the hospital workers. The first featured the entire form laid out on one page and required scrolling to see all the information. The second provided hyperlinks to different sections of the form. The rationale was that parts of the form are not relevant to all patients, and that it would make more sense to only view those sections that are pertinent. However, contrary to expectations, all of those interviewed preferred to have all the information laid out before them on a single page. Scrolling was not an issue once mouse-based navigation was explained because users knew to expect (based on their experience with the paper form) that more information must be further down the page. Hyperlinks in the second version were confusing, even to those with computer experience. There was general agreement that partitioning the data was unnecessary because currently irrelevant information could be applicable to a patient sometime in the future.

[15] The browser is merely a GUI tool, running locally – no internet connection is required, and certainly not expected. Note that this computerized data entry form is included in the system overview diagram in Appendix A.

Research finding	Implication for system design
Concept acceptable to and welcomed by both health professionals and patients	System development to functional prototype stage should be pursued
Virtually no internet connectivity (except possible very slow mobile phone connection)	System should function completely locally. At most, periodic low-bandwidth asynchronous batch processing possible
Shared-phone model limited by confidentiality concerns	Not necessary to focus on this use case in message and system design
TB patient population has lower than average rate of mobile phone penetration. Thus a clinical trial would need to provide basic, inexpensive phones	System must be completely back-end, relying on patients' phones only for the ubiquitous SMS, voice, and voicemail capabilities
Cost driving factor in every decision	Free or minimal system cost is essential
Basic clinician-patient interaction & communication valuable	Allow for basic patient response to text or voicemail questions sent to them
Browser-based GUI successful	Continue to use as GUI

Table 1. Key implications of MOT-UNIDO Fellowship research for system design.

mClinic Final Project: System Overview

Based on the promising results of the Kenya Summer 2005 research and the display of interest by public health students and professors, it was decided that a functional system prototype should be developed. The development efforts would be geared towards creating a system that could be used in a clinical trial, as well as documentation to provide guidance for future related efforts. The full TAD system functional prototype consists of:

1) Patient medical record component (computer-based entry);
2) MessageWiz: browser-based wizard for recording, storing, editing, and scheduling text and voice messages;
3) Dialer: backend dialing system for sending both text and voice messages.

Appendix A provides a clear illustration of the overall system, which will assist greatly in understanding the following detailed explanations.

While designing and developing the system there were three key metrics to consider:

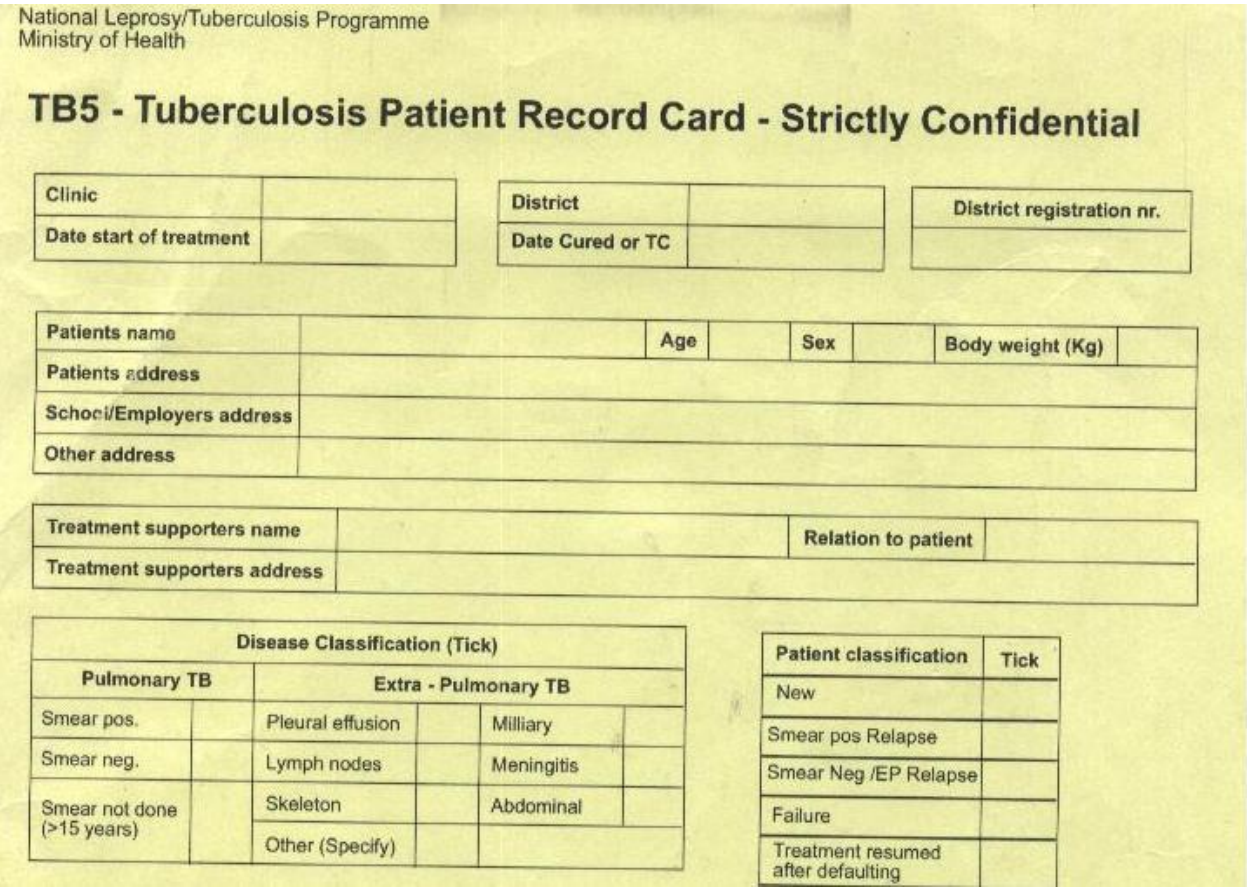
1) *Cost*:
   The marginal financial situation of both patients and health departments in the developing world require the design to incorporate free or low-cost technologies;
2) *Ease of use and learning*:
   Target users have minimal tech skills, and likely limited time to spend learning a new system. This metric is especially relevant for the UI design;
3) *User needs*:
   System should meet the expressed needs of the users as much as possible (See Table 1).

mClinic: Patient Medical Record (PMR)

The PMR component provides an electronic version of the paper-based medical record system for TB that is currently in place in Kenya. The record is standardized and used throughout the country in all clinics that treat TB patients. Based on the user feedback obtained

this summer, the electronic form has been designed to look exactly like the form currently used by health care workers. Although the design of this form results in a less aesthetically pleasing user interface, the user assumptions and expectations about where things are located on the form and the order in which the user is accustomed to entering information should be preserved in order to best facilitate a transition from paper to electronic records. This is particularly important because the population that would be using the patient medical records system has little to no computer skills, and varying levels of literacy that can make scanning a page for pertinent information challenging. When fully implemented, the PMR component will require authentication including a user name and a password in order to protect patient confidentiality.

The PMR system consists of web forms that allow health care workers to select whether they want to enter information for a new patient or update existing patient information. Minimal user interface design was necessary to maintain the look and structure of the existing paper-based form. As additional information needed to be added to the existing for, during summer research health care workers were asked where appropriate placement of this information would be on the form. The additional information provides details relevant to the patient's messaging preferences and includes the preferred language and format of the message, the desired frequency to receive messages, and the mobile phone contact information for the patient.



National Leprosy/Tuberculosis Programme
Ministry of Health

TB5 - Tuberculosis Patient Record Card - Strictly Confidential

Clinic		District		District registration nr.
Date start of treatment		Date Cured or TC		

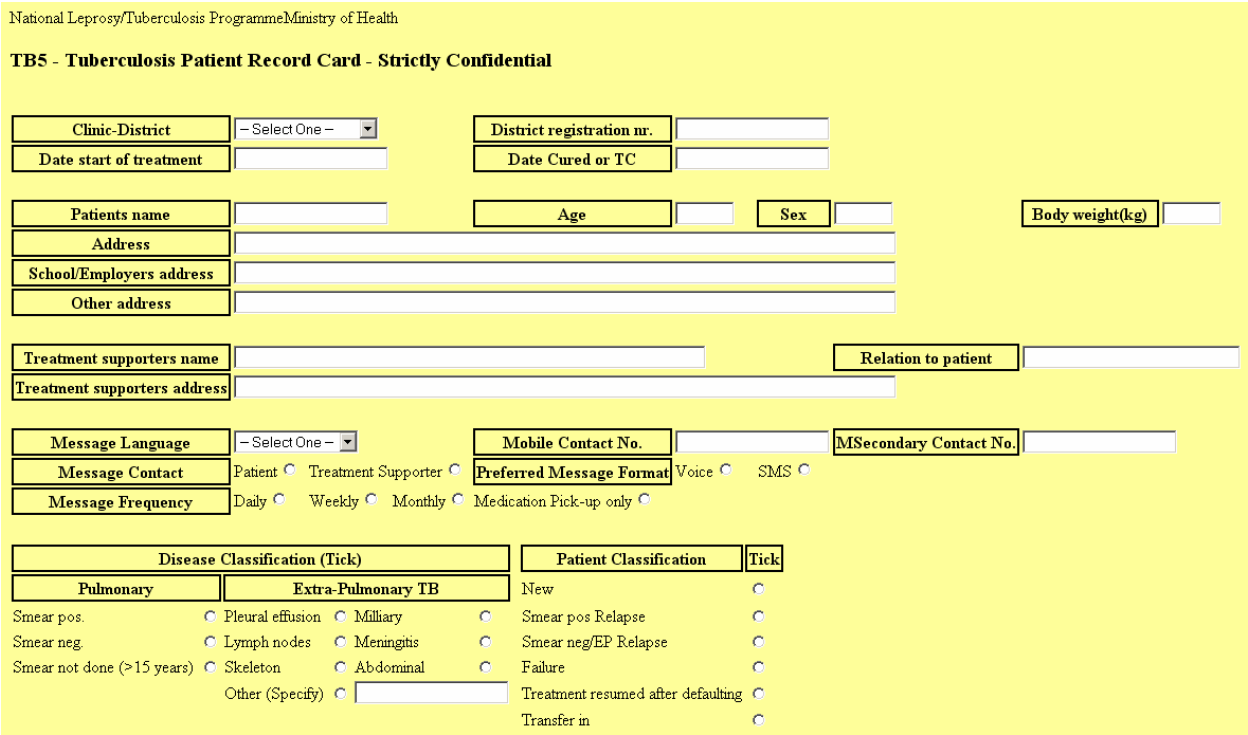
Patients name		Age		Sex		Body weight (Kg)	
Patients address							
School/Employers address							
Other address							

Treatment supporters name		Relation to patient	
Treatment supporters address			

Disease Classification (Tick)					
Pulmonary TB		Extra - Pulmonary TB			
Smear pos.		Pleural effusion		Milliary	
Smear neg.		Lymph nodes		Meningitis	
Smear not done (>15 years)		Skeleton		Abdominal	
		Other (Specify)			

Patient classification	Tick
New	
Smear pos Relapse	
Smear Neg /EP Relapse	
Failure	
Treatment resumed after defaulting	

Figure 1. Paper TB Patient Medical Record, for full record see Appendix D.


National Leprosy/Tuberculosis ProgrammeMinistry of Health

TB5 - Tuberculosis Patient Record Card - Strictly Confidential

Clinic-District | – Select One – | District registration nr.
Date start of treatment | Date Cured or TC

Patients name | Age | Sex | Body weight(kg)
Address
School/Employers address
Other address

Treatment supporters name | Relation to patient
Treatment supporters address

Message Language | – Select One – | Mobile Contact No. | MSecondary Contact No.
Message Contact | Patient | Treatment Supporter | Preferred Message Format | Voice | SMS
Message Frequency | Daily | Weekly | Monthly | Medication Pick-up only

Disease Classification (Tick)						Patient Classification	Tick
Pulmonary		Extra-Pulmonary TB				New	
Smear pos.		Pleural effusion		Milliary		Smear pos Relapse	
Smear neg.		Lymph nodes		Meningitis		Smear neg/EP Relapse	
Smear not done (>15 years)		Skeleton		Abdominal		Failure	
		Other (Specify)				Treatment resumed after defaulting	
						Transfer in	

Figure 2. Electronic Patient Medical Record Card with mobile contact and preferences added.

Technical Implementation

A) *Tools* PHP was used to construct the form, which then inserts the data entered into a MySQL database. This information is later extracted from this database by the messaging wizard.
B) *Costs* Basic PC: ~$500[16]

mClinic: MessageWiz:

The messaging wizard component was developed in conjunction with the *Information Systems 213: User Interface Design and Development* coursework. The system allows health care workers or a system administrator to create, save, edit, delete, and schedule voice and text messages. This part of the system also features a "Records & History" component that allows an advanced user to check the status of messages, view errors, and stop sending certain messages if necessary. The component was designed on the premise that most messages send indefinitely and that once the system is up and running there will be minimal creation or stopping of messages. User feedback from summer research was also incorporated into the design of this system.

Appendix B illustrates the navigational architecture of the MessageWiz user interface. Appendix C features screenshots of key elements of the final MessageWiz design. Further

[16] Note that the cost of the computer itself, though significant, is less relevant to assessment of the system design because one is required regardless of design details. However, note that the software chosen hardly demands top-tier expensive hardware or OS. Many programs exist in the U.S. to obtain decent free or minimal-cost used computers in good condition for applications such as this.

information, including complete documentation of the user interface design process, is available here: http://tinyurl.com/rdu42. The final version of the interface is linked from that site.

Technical Implementation:

A) *Tools*
   1) HTML/CSS, PHP, MySQL, Apache server
   2) AutoIt3 scripting tool, Audacity audio software
   3) Headphone/microphone set for computer

B) *Costs*
   1) Software all free
   2) Headphone/mic: $15

mClinic: Dialer

The dialer component serves several functions and interacts with both the patient medical record information and the messaging wizard. It obtains messages scheduled to be sent from the message wizard, and places them into a queue. The dialer is also responsible for querying the patient database to match messages with the intended recipients. These two parts are as follows:

- **Message Version:** Note that each of the objects in the queue is actually a Message *Group*, consisting of several text and voice messages in multiple languages, bundled together. The Message Group is defined by the content of the messages, which remains the same. The various individual message *versions* are merely translations of this same content into different languages, or are different formats (text vs. voice).
- **Recipient:** Recipients are defined by patient criteria selected when the Message Group was created in the MessageWiz. Each patient matching the criteria is sent a text and/or voice message *version* in his/her preferred language (which was entered in the PMR system).

Technical details:

- **Text messages:** The dialer uses AT commands to pass the message through the data cable to the modem-equipped phone and cause it to send the message along to the patient's phone.
- **Voice messages:** Before the dialer begins sending messages, a Bluetooth hands-free connection is setup between the computer and the modem-equipped phone. This allows the computer full audio connection to the phone: any sound output by the computer is fed out directly through the phone; incoming audio is also audible through the computer's speakers.

  The dialer then uses AT commands through the data cable to cause the attached phone to call the patient's phone. Once the phone is picked up (voicemail or actual patient), the dialer is triggered to play the voice message (which was recorded in the MessageWiz interface) over the Bluetooth audio connection, and hang up when it is done.
- **Response:** The same setup will allow for patient response via text message. The AT command set can retrieve messages from the phone to the computer, which can then parse the message and return the information to the MessageWiz interface. This

functionality has not yet been implemented do to time constraints, but the necessary components are present.

Technical Implementation:

A) *Tools*

1) JDBC used with MySQL database for information processing
2) Java's javax.comm package used to pass AT commands and text messages to a modem-equipped phone
3) Bluetooth dongle and WidComm stack[17]
4) Nokia 7610 mobile phone[18]

B) *Costs*

1) Bluetooth dongle (~$20)
2) Mobile phone with modem and Bluetooth[19]: ~$100
3) Data cable: ~$20 locally
4) Airtime: unresolved; SafariCom or Celtel may be interested in donating airtime as part of corporate social responsibility initiatives (and marketing!)
5) Basic PC: as discussed above in PMR section

mClinic: User Interface Design and Usability Overview

Because the TAD system creates new tasks and work-flows for the health care workers, it was decided that the largest user interface component, the messaging wizard, should be designed with user interface design best-practices and in conjunction with IS 213. Utilizing this class for the development of the largest user-interface component allowed for access to additional student resources and professional and peer feed-back, as well as a structured environment in which to develop and run user testing.

mClinic: Personae and Scenario Development

Although there was not direct access to the eventual end users of the system, creating distinct personas based on interactions with health care workers from the summer research in Kenya helped guide user interface and system development. Personae reflected the paradox of highly educated individuals with low rates of computer literacy. Initially four personae were created, though through design iterations focus was placed on only two of the personae, the two Kenyan nurses "Beatrice" and "Agnes". Each persona was given a personal background and story, goals that related to both personal and professional life, and a list of tasks that are completed in pursuit of those goals. The use of tasks and goal analysis helped keep the system constrained to emphasize only that which was most appropriate for the personas to accomplish. (For full description of the personae see Appendix E).

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[17] WidComm Bluetooth stack may be proprietary now? This was unclear when downloading it off of a link in a technical help forum.

[18] Note that this is the phone linked to the computer, used for doing the dialing and sending text messages – *not* the patient/recipient's phone. Basic modem-equipped phones available in Kenya, including Nokias with presumably similar AT command set implementation. See also footnote in cost section below

[19] Modem-equipped phones are fairly inexpensive, starting at around $USD 85 (cheapest handsets in Kenya about $USD50). Cost of Bluetooth-equipped phone with hands-free/headset capability unknown, but likely ~ $USD100.

In addition to the use of e, scenarios were developed to guide the user interface and system design. Scenarios reflected situations experienced during the summer research. The scenarios evolved over time to reflect a greater understanding of the end user and also provided assistance in estimating typical usage patterns and discovering edge cases.
(For full description of the scenarios see Appendix F).

mClinic: Usability Testing Participants

The most critical characteristics of the target population (Kenyan health professionals, primarily nurses) are (a) high education and domain (TB/health care) knowledge, and (b) low computer skill level. Additionally, imperfect literacy in English can be assumed, despite fairly high fluency in it. Thus, to the extent that efficient textual scanning is a key skill for interacting with information-rich user interfaces such as web pages,[20] the target population can be considered low-literacy users.

In order to emulate these critical aspects of the target users, a combination of local health care professionals and beginning, Spanish-speaking computer users were chosen. Their feedback and insights at various stages of the design process to provide feedback were invaluable.

Three health care workers were involved at various stages in the design process. The first (US#2) is employed in the employee health division of a major health care provider, and is responsible for initiating contact with employees who were delinquent on job-specific health requirements – namely TB tests and follow-up. The second (US#4) was a nurse administering DOTS to tuberculosis patients, including immigrant and intransigent patients. This role requires tracking and communication issues not entirely dissimilar to those observed in Kenya. This individual was an ideal tester as she also had experience administering care to TB patients in the developing world and was able to provide guidance on domain-specific vocabulary and effective types of patient interactions. The third health care worker (US#5) was employed in high-volume specialty clinic and was responsible for running software that provides reminders for patient appointments and related services. This individual also provided a demonstration of the software used by the clinic for patient reminders and was willing to discuss things most useful to learning the program and things that were problematic.

In addition to the health care workers, beginning computer users were surveyed. One individual (US#2) was employed in the same occupational health department mentioned above. This participant described herself as “ignorant of computers”, inexperienced with them before the current job. As her colleague above, this individual was also willing to demonstrate the employee records system and discuss its strengths and shortcomings. Two other novice computer users (US#0, US#1) were non-English speaking immigrant Hispanic women taking a computer course at a community center. Although testing with non-English speaking users had the potential to introduce additional complexities, this was one of the few accessible populations that had limited exposure and access to computers and therefore provided a good beginning-computer resource. The seeming liability of using non-English speaking users for testing was actually an asset as these users more closely mirrored the target users in terms of English literacy.

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[20] Nielsen, Jakob. “Lower-Literacy Users”, *Alertbox*, March 14, 2005.
http://www.useit.com/alertbox/20050314.html Excellent points on this topic, especially regarding lower-literacy users’ inability to scan text and the resultant reduced field of view.

Although these individuals were able to provide valuable feedback, there are cultural differences that were not able to be replicated. The end users of the system are all fluent and literate in English to varying degrees as well as at least one "tribal" language. All government business, including healthcare, is conducted in English, however there are certain nuances between American English and Kenyan English. Without testing with native Kenyans, it was difficult to evaluate the choice of vocabulary used throughout the system. As discussed later, through cooperation with Kenyan contacts, a remote user testing program was initiated.

	USABILITY TESTING STAGE		
PARTICIPANT	Work Practice Observation	Paper Prototype	2nd Interactive Prototype
US#0 (novice computer student)	■		
US#1 (novice computer student)	■		■
US#2 (Employee Health Nurse)	■		
US#3 (Employee Health Asst.)		■	
US#4 (TB Nurse)	■	■	■
US#5 (Specialty Clinic)	■	■	■
Kenyan Nurse (low computer skills)			■
Kenyan A (low-computer skills)			■
Kenyan B (low-computer skills)			■

Table 2. This table demonstrates which parts of the usability test specific individuals participated in.

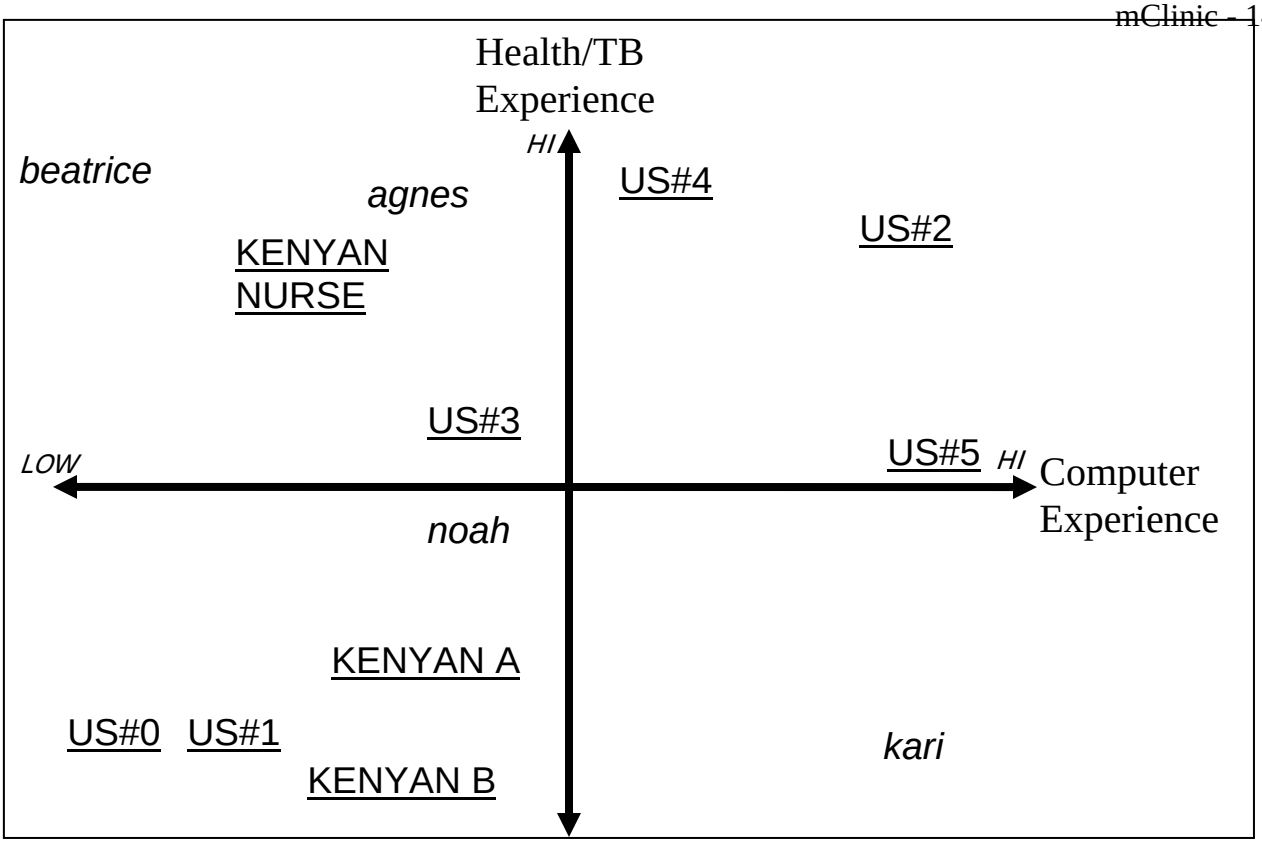

Figure 3. Personae (lowercase) and user test participants (CAPS) charted relatively along the axes of domain extpertise and computer experience.

mClinic: Description of Usability Test Participants

Both the participants in the user tests and the personas developed can be described, relative to each other, along the two axes of domain expertise and computer experience, as shown in Figure 3. Note that the intention is to approximate the target users/personas: Kenyan nurses "Beatrice" and "Agnes." The Kenyan Nurse of course is closest, and then perhaps US#3 (the Employee Health assistant). But, because of the obvious difficulty in finding locally this type of user (possessing professional expertise and education without computer savvy), the strategy was also to combine the findings from:

a. Those embodying the important computer novice attribute (US#0 and US#1, the computer center students, and Kenyans A and B);
b. Those possessing the second key attribute, domain expertise in health care, especially TB. This second category includes US#4 (TB nurse) and US#2 (Employee Health nurse).

Note also that US#5 (specialty clinic employee) does not embody either of these attributes. Rather, she was valuable because of her expertise with the user interfaces for a high-volume automated phone call reminder system for appointments and other patient communication.

mClinic: Usability Testing Procedures

Consent was obtained at the start of each user testing session. In total, the two health care workers were surveyed three times each, the occupational health employee once, her assistant once, and computer center students two times. A total of three tests were conducted remotely with Kenyans.

Each user interface test consisted of a series of tasks that the user was expected to complete with minimal instruction or guidance. (For full listing of user tasks see Appendix G) Due to the domain specific content of the system, separate sets of tasks were developed for health care professionals and other users. The rationale was to keep testers focused on the system and eliminate errors or questions caused by domain-related uncertainties. The objective of the tasks was not varied, merely vocabulary and content.

In the U.S., the tests were conducting using a locally available desktop computer with internet connection to access MessageWiz online. Note that a team member's computer was brought along to run MessageWiz locally, but in all cases this was less convenient. In one case this would have required the participant to use a laptop mouse substitute entirely unfamiliar to her. Thus, in all cases the participants used their own equipment familiar to them, which helped eliminate test effects due to unfamiliar equipment.

mClinic: Remote Usability Testing

The criteria for an acceptable remote usability testing tool set for this project were:

1) Mouse movements and clicks, and all keyboard entry, must be viewable – *live* - from a computer in the U.S.
2) Audio connection (live and two-way) between at least the test participant and U.S. tester (perhaps also with the Kenya-side facilitator, simultaneously)
3) Recording capability for both audio and video
4) Minimal software install and configuration of the remote (Kenya) computer, because of potential restrictions in Kenyan internet cafes, and to reduce the preparatory work required by the facilitator
5) Very cheap or free.

Regarding this last point, extremely low cost is a requirement not only because of lack of external funds for this project, but in keeping with this constraint on the rest of the system development. As with the system artifact developed, this setup and methodology for remote usability testing is intended to be replicable by others with minimal funds, as that is the financial situation for many projects targeted at developing regions.

There are several technologies available for remote usability testing, including Camtasia, WebEx, Morae, pcAnywhere, and newer entrant Ethnio.[21] These are generally too expensive to be considered, or did not provide the full functionality required. In the case of Ethnio, it left the Beta testing stage, yet was not available for pay-per-use at the time this project's testing commenced. There is also the widely available free option of Windows' Remote Desktop, but it does not provide the both ends of the connection the ability to simultaneously view the desktop, mouse pointer, and keyboard entry as it happens.

Therefore, a combination of viable free products were cobbled together to create the desired functional setup. The two key pieces were RealVNC[22] for the video/desktop sharing, and

[21] Ethnio is at: http://www.ethnio.com/ See footnotes 1 and 2 for links to more information on options available, and comparisons of them.

[22] http://www.realvnc.com/ There's also a short review of it here: http://mobileoffice.about.com/od/softwarebasedconnections/gr/realvnc.htm

AutoRecorder to record each session. These are mentioned in the numbered list below in their respective places, as are the other components of the tool set used.

Note that requirement #4, above, determined the use of the VNC Server on the U.S. computer, rather than the Kenyan one. This latter option, with the VNC Server in Kenya, would have been preferable. After all, the other half of the application is in fact the *Viewer*, and provides exactly the functionality the observers needed. Additionally, the Kenyan test participant would not have had to deal with the cumbersomeness of accessing MessageWiz in a browser half the world away. However, the complications of getting the VNC Server to work in various different internet cafes were far too great. In particular, configuring the router's settings to route traffic for a specific port to the particular computer the facilitator was using would have been nearly impossible for the project team members to implement remotely, even with the facilitator's help.

To implement the remote usability tests for mClinic, these six components were used:

1. A computer in Kenya connected to high-broadband internet. "Cyber cafes" in two semi-urban towns and in the capitol, Nairobi, were used. (Chosen based on proximity to participant and connection capabilities)
2. A visual connection to display the participant's mouse pointer movements and clicks, and keyboard strokes. This was provided by use of a small Viewer app (emailed to the facilitator and downloaded to local desktop by him) that connected to a VNC server installed locally in the U.S. on a team member's laptop.
3. An audio connection to the user (and facilitator at times). The solution for this was VoIP using Skype PC-to-PC.
4. Software for recording the video and audio. AutoRecorder and Audacity were used, respectively.
5. Second computer in the U.S. for parallel communication with the facilitator (because the team member's laptop screen is wholly dedicated to displaying the MessageWiz browser).
6. Chat program to provide parallel live communication to the facilitator as necessary (with facilitator) on a second computer. Gmail Chat was used, in combination with Gmail for quick file transfer (user tasks, consent forms, etc.)

In Kenya, with the above hardware and software in place, the facilitator was initiate the audio connection using Skype, and login to the VNC Server (given IP and password) to gain access to MessageWiz in a manner that would allow live viewing as well as recording of the usability test. A project team member was also able to login to the VNC Server as the co-facilitator and primary observer of the test session. Note that a second team member was also able to login to the VNC server and share the connection to view the usability test simultaneously.

For use in conjunction with reviewing the detailed steps below, Appendix H provides a screenshot showing the primary observer's screen. Note that this is the person who co-facilitates from the U.S. and operates the VNC Server (including the video recording) on one computer while interacting with the screen shown in Appendix C on a second computer.

Detailed Steps of this procedure**:**

Remote observer/co-facilitator, prior to beginning of the test:
Visual:
1) Email VNC viewer
2) Set temporary password on VNC Viewer
3) Check current IP address [double-check that it is current & correct]
4) Provide User with IP address, and temporary password
5) Turn on VNC Server
6) Setup recording device [e.g. AutoRecorder 2.1]
7) Setup desktop in optimal visual configuration:
   - Have web page or application already open;
   - Make the Windows Toolbar auto-hide (otherwise will take up valuable space in Viewer)
8) Pre-configure Browser view:
   - If using the browser merely as a UI, with intended navigation options provided within the page (as was the case for this project), hide the Navigation toolbar.
   - Hide other toolbars as desired to maximize view for remote participant.

Audio:
1) Make sure both sides have good headphones + microphones
2) Skype or other VoIP in both sides, installed & setup, both logged in
3) Setup recording device/software [e.g. Audacity]s
4) Choose 'Microphone' option in Sound Recorder (recording display section)
5) All User (or facilitator) on VoIP, test audio connection & recording

Starting Test:
1) Have User (or Facilitator) logon to VNC server, using IP address & password already sent them, accept connection if necessary
2) Press F11 for full-screen view
3) Have User expand their Viewer window to take up whole screen
4) Start Audio & Video recorders
5) Instruct participant to begin

Facilitator:

In the midst of assessing and implementing these technical solutions, one must remember that the most critical aspect is the actual test participants. The on-the-ground facilitator in Kenya for all the remote usability testing, Edward Lantei Taine, was the key element in making the entire process work. He recruited the participants, compensated them, setup the hardware and software, managed consent forms and post-test responses, and supervised the actual test. The importance of finding a competent and trusted facilitator in the remote location cannot be overemphasized. While the remote observers (i.e. those not co-located with the participant) can do a fair bit of the facilitation via audio or chat connection, this is not an adequate substitute.

Once one is found, time should be taken not only to instruct the person in the technical setup, but also to train her or him in how to properly facilitate the usability test. This was not done ahead of time for this project, partly due to time limitations. The facilitator learned rapidly

from the instructions given by the remote observers, but proper preparation would have helped the efficiency and effectiveness.

Successes with Implementation

The VNC Server/Viewer worked well. Two team members were able to login, in addition to the Kenyan facilitator, with no perceptible degradation in service. (Note that although the project team members are often referred to here as "observers," in fact their connections did not differ from the Kenyan's: they share the connection and can also control the mouse and perform actions on the Server computer). Also, the screen recorder was able record the sessions to a standard video file, at a sampling frame rate and quality settings that produced an adequate video without substantially degrading the performance of the VNC connection.

Difficulties with Implementation

A successful trial run of the various parts of this remote usability test setup was performed with the facilitator prior to the commencement of testing. In spite of this, in *all* of the subsequent usability tests – and additional abortive attempts at testing – the VoIP audio component failed. This was a major blow, because despite the full, recorded visual data of user actions, the project team members could not access the test participants' thought processes as they "talked through" their interactions with the prototype. In some cases the quality was so atrocious as to be completely useless; in other attempts the quality was superb – but for only 20-30 seconds at a time!

For the first two remote tests, the rest of the setup worked fine. A day and a half later, the next two subsequent tests had to be cancelled because the facilitator could not get the Viewer to login to the VNC server. This was despite the fact that another team member was able to do so (from a separate location and different ISP).

Finally, it should be noted that the text input rate from the keyboard was quite slow. This could probably be helped by slowing down the video sampling rate. However, for the purposes of assessing a UI design which does not involve substantial text entry (note that lightweight text entry into forms was required for this project), the setup is sufficient. This is particularly true if the participants are computer novices with slow typing speeds, and thus less affected by keyboard input delay.

Addressing the Difficulties

Once it was determined that Skype would not function, after many attempts, the testing continued with a chat client as the means of communication with both facilitator and test participant. This was far from ideal, but did allow the test to continue, with the remote observers relying on the full visual display (also being recorded) and the sparse facilitator and participant chat comments as the task continued. The observers also sent questions to the participant via chat, when unable to determine why the participant was stalled, or to ask a question about a specific part.

In between the individual test sessions, the facilitator and the project team usability test coordinator planned various options to try to obtain a working VoIP connection. This included attempts earlier in the morning, with different headsets and computers, different cyber cafes, and different towns/cities. Unfortunately, even attempts initiated in internet cafes in Nairobi, the Kenyan capitol and most modernized city in the region, failed. It was finally surmised that there may be software on the Kenyan side limiting the bandwidth accessible to VoIP. This limitation

may be imposed by the internet café, the ISP, or the Kenyan government, all of whom have conceivable motivations to limit the use of VoIP.

Developing Systems for the Developing World: Overview

Understanding how Western innovations are adopted and utilized in the developing world is essential when considering application development for this population. In Kenya, telecommunications infrastructure and services have historically been sparse, costly, and unreliable. As a result, mobile phones were quickly adopted and are the primary communications tool for many people. Diffusion of internet services has been slower outside of large urban areas due to little competition in the ISP market and a reliance on old telecommunications systems for connectivity, as well as the high costs of computers. In rural areas, post offices or copy shops may provide services as these entities are likely to have an existing landline over which to obtain connectivity. Being aware of these factors can help guide both the system and user interface design processes by taking into account infrastructure limitations and existing user mental models.

Developing Systems for the Developing World: User Interface Design

In designing the user interfaces for both the patient medical record component and the messaging wizard component, existing user mental models provided the basis for development. The patient medical record interface required little extrapolation as there was an existing paper-based form to work from and interviews confirmed that the users expected little difference in the appearance, organization, and functionality. The idea of lines to write text easily transferred to text boxes and text areas and the form already required the use of “tick marks” which are represented with checkboxes. Radio buttons were introduced on the web-based form to limit the user’s ability to make more than one selection for areas where this is not appropriate, however, this may not be necessary as users already assume that only item can be checked for that characteristic at any given time.

For the messaging wizard user interface the types of messages that potential users are likely to interact with already provided the basis for the design. Research indicated that nearly all health care workers had a phone, or had access to a phone, and most had used SMS. Although many had not ever used a computer, those that had had experience with email and this is likely to be the first function a new computer user learns. The commonalities between these two messaging interfaces were explored and certain concepts were integrated into the component interface and vocabulary.

In addition to use of a messaging paradigm, picture calendars were implemented instead of text-only dates for scheduling messages. When scheduling dates or appointments, users are likely to find the current date on a calendar and count out by the number of days or weeks into the future instead of identifying a specific date. The picture calendar allows the user to continue to do this instead of forcing them to change their way of thinking about time. (See Appendix G for screenshots).

As previously stated, some health care workers have a little to a lot of computer experience while some have none. User interface devices (for example, tabs, drop-down menus, scrolling, and hyperlinks) that are common in the developed world should not be taken for granted; it should not be assumed that users will have the same expectation of how things work. Many of these things are unintuitive and create added stress for a user who is unfamiliar with how they work.

It was also important to take into account the linguistic abilities of the population the interface was designed for. All Kenyan health care workers are required to speak English as they are government employees and all government business is completed in English, however, the level of verbal comprehension and literacy varies from person to person. It therefore cannot be assumed that an individual can simply scan a page to locate the information they looking for. In addition, our user interface testing indicated that neither developed or developing world users are likely to read directions no matter how familiar or unfamiliar they are with a system, so words cannot be relied upon to guide a user through the interface.

Language issues, in combination with the potential difficulties caused by user interface devices, resulted in a very simple wizard-like structure for the messaging component. Users are given simple, binary choices. After each decision they are presented with the most relevant information, but nothing more. Pages that require scrolling due to length have an indication that there is more information for the user to explore. Text is larger and bolder than it might be on a standard web site to provide for easier scanning and greater visual clarity (many individuals that need glasses often do not have them). On some pages where it is not possible or rational to provide a binary decision for the user, links for actions affecting the whole page are located on the left, and links for actions affecting a specific item on the page are located with that item. (See Appendix G for screenshots).

Lastly, as witnessed in the interface evaluations, consistency proved to be a key to user success. If some interface pages were implemented in a particular way and some in another, the user was unsure of where to locate information or how to behave when they come to a page that does not meet expectations developed from previous interactions. Consistency throughout the interface quickly creates foundational expectations and allows the user to focus on the task they are trying to accomplish and not the way the task is being accomplished.

Developing Systems for the Developing World: System Design

In designing an overall system for the developing world, infrastructure and technology access limitations provide an excellent guide for what is and is not recommended or possible. In countries such as Kenya, broadband has become available at a high-cost in urban areas, but is not a realistic option for a non-profit entity such as a health clinic. Landlines are not ubiquitous, and are also costly and unreliable leaving mobile phones are the preferred method for data transmission. While this is the most economically viable means for data services, it does not allow for an “always on” connection. The system must be able to run locally on a computer and able to synch up with a remote computer. Data transmission must be designed to work with extremely low speeds.

Availability of electricity is a related issue. Not all areas will have electricity, and power outages may be frequent due to a variety of factors including weather, outdated technologies, and military conflict. Technologies should be designed to use the lowest amount of power possible, and battery back-ups should be available. Systems should be able to quickly recover from frequent loss of power with minimal human intervention.

Cost is a paramount concern and limiting factor, however the availability of materials and resources locally is also important. Technical projects can take advantage of open source projects to eliminate licensing fees, but developers need to be aware of norms in area technical schools so that the system can be supported by local resources. Utilizing materials found locally is also recommended so that any issues that arise can be resolves efficiently and in a cost-

friendly manner. While these technologies may not provide the most glamorous results, they will produce most effective.

Conclusions and Recommendations:

Developing a computer-based system for the developing world is a rewarding but challenging undertaking. Difficulties are compounded when the system is being developed remotely with access to more "advanced" technologies and limited ability to test the system in the actual environment in which it would be deployed. While it is essential to possess an intimate understanding of both the need or problem being addressed and the culture being designed for, there are also many creative ways to approach the design process to maximize the likelihood of success.

Projects should be conceived to meet a specific need, however seemingly trivial or insignificant. Attempting to solve world hunger is appealing, but projects will be more successful and ultimately have greater impact if designed with a directed focus. The means of delivery should leverage existing technologies or services and increase their value to the end user by improving some aspect of quality of life.

Testing the feasibility of the project in the country or region where it would initially be deployed is essential. This time can be used not only for testing the physical infrastructure required for implementation, but also for developing an understanding of target population and their actual needs. By working directly with the individuals that would be affected and gathering their input, the project can be refined and targeted and have a much greater chance of eventual adoption. Talking to locals may reveal that the intended population may not be the best suited but that another population would benefit greatly. This experience can also show limited or no value in the initial idea, and help foster the development of more culturally appropriate ones.

For the user interface development process, the intended user is the best resource however, they may be inaccessible for some or all parts of this process. Searching out local individuals with similar qualities can provide an adequate substitute. Creating personae based on the actual eventual users can make evident the relevant qualities or characteristics a substitute user should possess. It is likely there will not be any one set of people that meets all of the relevant attributes, so it is important to seek out a combination of groups that possess one or two of the most important user criteria each. Designing tests specific to that criteria will maximize information that can be gleaned and extrapolated from a specific user group.

It is possible that there may be issues such as vocabulary that simply cannot be addressed by a surrogate user. Remote testing provides a means to address these issues, as well as to involve intended users if they are available and willing to participate. However, remote testing comes with its own potential complexities including working across different time zones, training on-ground staff for appropriate recruiting methods and test administration, network or other technology failures, and coping with cultural differences or language barriers that result in faulty data.

Lastly, it is important to cultivate an understanding of how current systems work, how users are understanding and are utilizing them, and what external constraints will be placed upon the entire system simply because it is located in the developing world.

The central thrust of these recommendations is to provide the foundation of a rigorous methodology for pursuing technical systems development in the developing world. The initial challenges faced by developers in this environment may prove daunting, but through additional

research and standardization of protocol, barriers to successful deployment and implementation can be broken down and benefits of small efforts realized.

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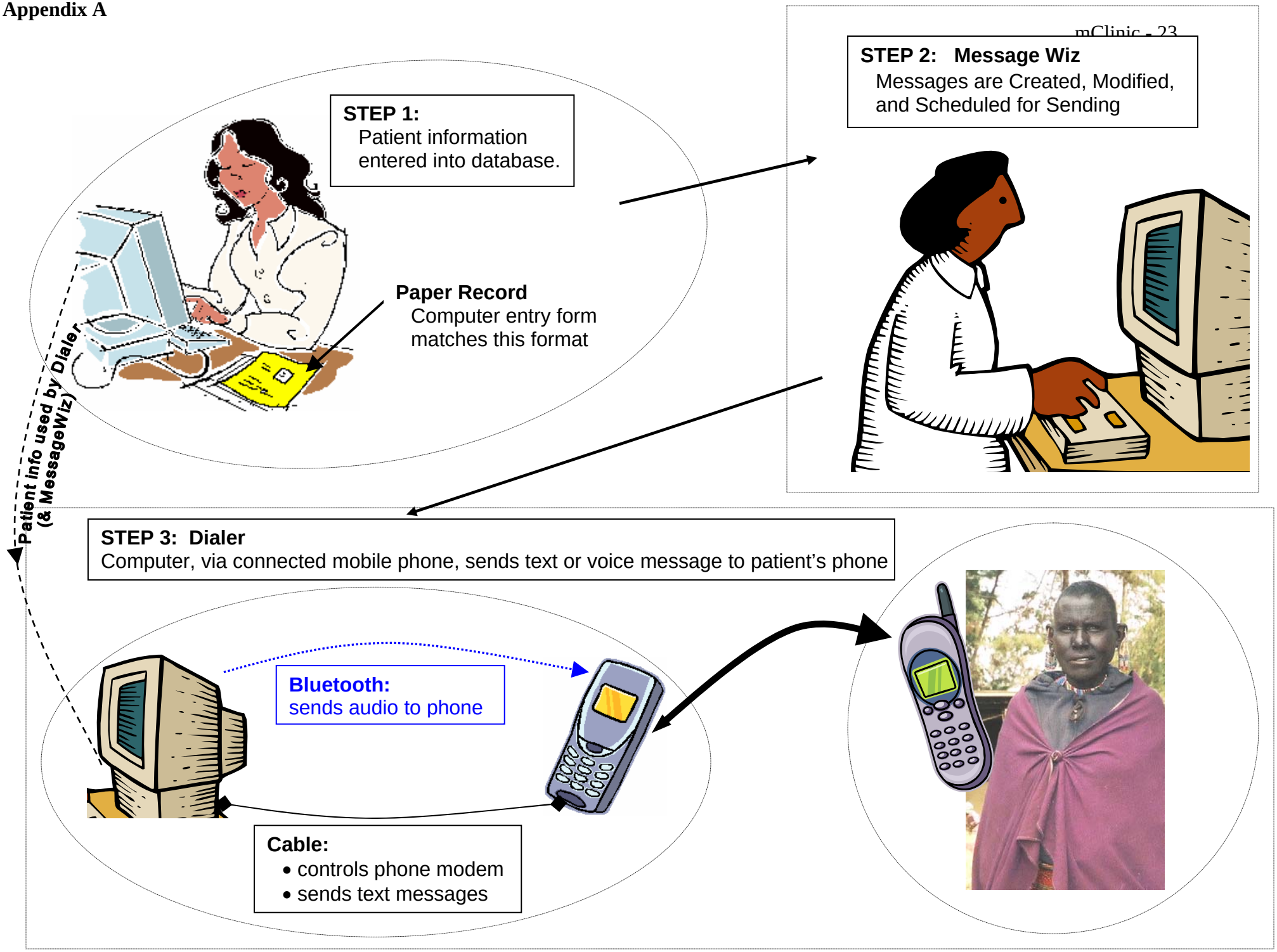
- User Interface Testers: Our enthusiastic and helpful volunteer testers in both Kenya and the U.S. who remain anonymous per the conditions of agreement.MOT Fellowship Kenyan research team: Peninnah and Joseph Tombo, Joseph Ntereka, Edwin Taine, Charlie Kisoso, and Sautet.
- Our partners and sponsors there, Eliud A. Imbayi and Dr. James Moyaie

Appendix A


STEP 1:
Patient information entered into database.
Paper Record
Computer entry form matches this format
STEP 2: Message Wiz
Messages are Created, Modified, and Scheduled for Sending
Patient info used by Dialer (& MessageWiz)
STEP 3: Dialer
Computer, via connected mobile phone, sends text or voice message to patient's phone
Bluetooth:
sends audio to phone
Cable:
• controls phone modem
• sends text messages

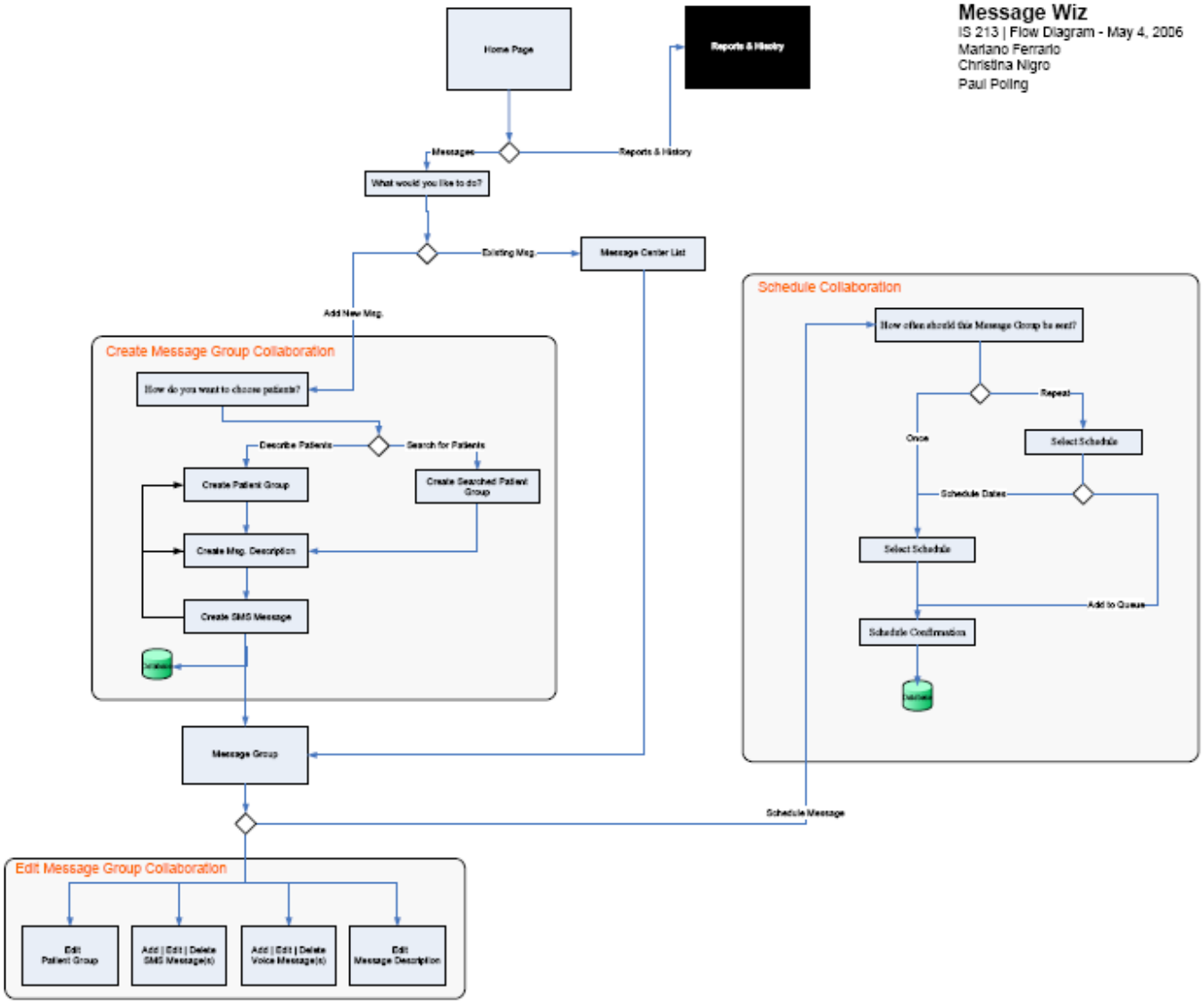

Message Wiz
IS 213 | Flow Diagram - May 4, 2006
Mariano Ferrario
Christina Nigro
Paul Poling
Home Page
Reports & History
Messages
Reports & History
What would you like to do?
Existing Msg.
Message Center List
Add New Msg.
Create Message Group Collaboration
How do you want to choose patients?
Describe Patients
Search for Patients
Create Patient Group
Create Searched Patient Group
Create Msg. Description
Create SMS Message
Message Group
Schedule Collaboration
How often should this Message Group be sent?
Repeat
Once
Select Schedule
Schedule Dates
Select Schedule
Add to Queue
Schedule Confirmation
Schedule Message
Edit Message Group Collaboration
Edit Patient Group
Add | Edit | Delete SMS Message(s)
Add | Edit | Delete Voice Message(s)
Edit Message Description

Figure 4. MessageWiz Home Page

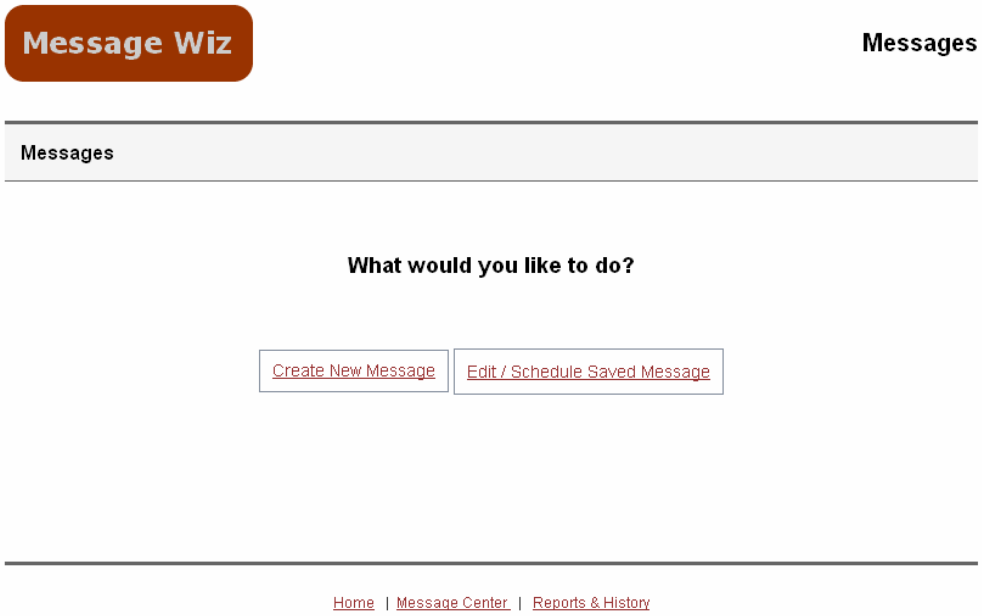


Figure 5. If user selects "Messages" they are given a binary decision.

Figure 6. If the user selects "Edit/Schedule Message" in Fig 2, they are given a list of existing messages to choose from.

Figure 7. . If user selects "Create New Message" in Fig 2, they are given a choice of how to select patients.

Message Wiz

Message

Home » Message Center » New Message Group

Version 2

Patient Information - Describe the patients you want to contact.

1. Select Patient Information 2. Enter Message Group Information 3. Enter SMS Version

Personal Details

Age

- [x] All Age Groups
- [x] 0 to 5 years old
- [x] 6 to 12 years old
- [x] 12 to 55 years old
- [x] Over 55 years old

Sex

- [x] Both
- [x] Male
- [x] Female

Clinic

- [x] All Clinics
- [x] Isinya
- [x] Kittengela
- [x] Kaijado
- [x] Nairobi

Treatment Plans

Figure 8. If the user selects "Describe Patients" in Fig 4, they are provided with a list of attributes that maps to the patient medical record card.

Message Wiz

Message

Home » Message Center » New Message Group

Message Group Description

1. Select Patient Information 2. Enter Message Group Information 3. Enter SMS Version

Describe your message. Complete each section, please.

Category: -- Category List --

Subject:

<< Back to Patients | Continue >>

Home | Message Center | Reports & History

Figure 9. Once the user selects criteria in Fig 5, they are then prompted to select the message category and subject (title).

Figure 10. When the user selects continur in Fig 6, they are required to select a language and enter a text (SMS) message.

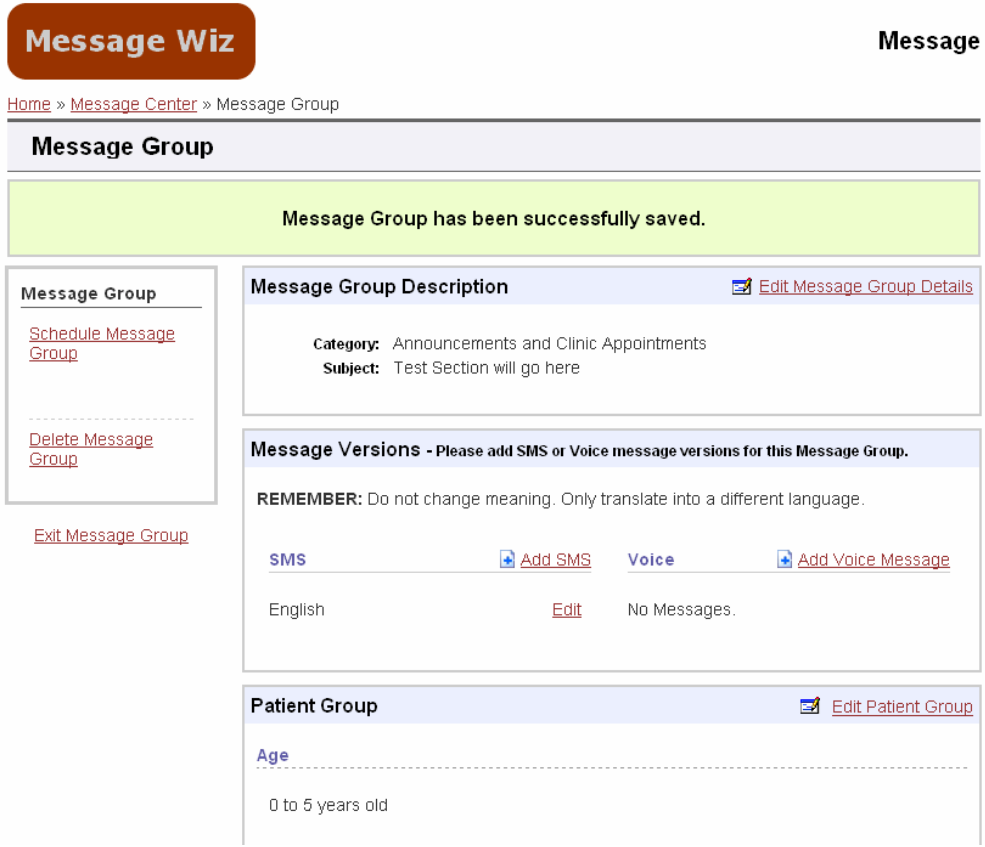


Figure 11. After the user selectes "Add New" in Fig 7, the screen showing all relevant message information is displayed. From this page the user can schedule the message, delete the entire message, edit different potions of the message, or exit.

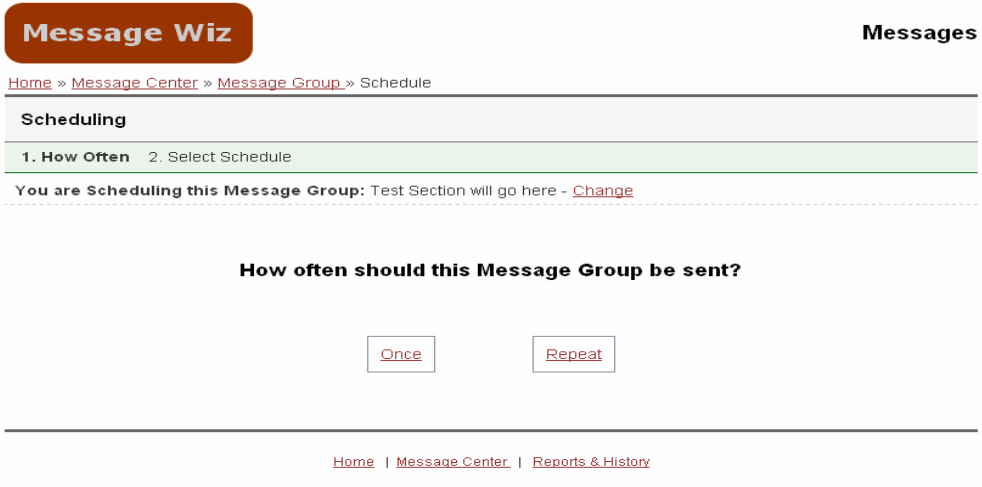


Figure 12. If the user selects "Schedule" in Fig 8, the are asked how frequently the message should be sent.

Figure 13. If the user specifies that the message should be sent "Repeat" in Fig 9, the are given a choice of how often the message should be sent.

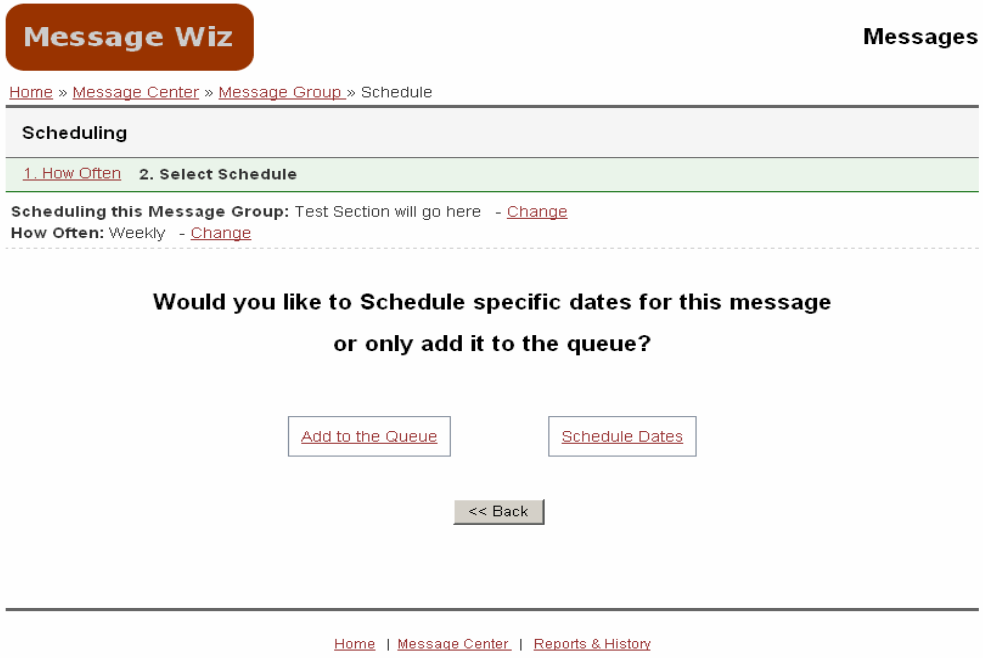


Figure 14. The user is then prompted to decide if the message should be added to the existing queue or if it needs to be scheduled to be sent between specified dates.

Figure 15. If the user elects to "Schedule Dates" in Fig 11, they are provided with picture calendars to select the start and end dates.

Figure 16. The user is provided with a confirmation page that allows them to make changes if necessary.

National Leprosy/Tuberculosis Programme
Ministry of Health

TB5 - Tuberculosis Patient Record Card - Strictly Confidential

Clinic	
Date start of treatment	

District	
Date Cured or TC	

District registration nr.

Patients name		Age		Sex		Body weight (Kg)	
Patients address							
School/Employers address							
Other address							

Treatment supporters name		Relation to patient	
Treatment supporters address			

Disease Classification (Tick)					
Pulmonary TB		Extra - Pulmonary TB			
Smear pos.		Pleural effusion		Miliary	
Smear neg.		Lymph nodes		Meningitis	
Smear not done (>15 years)		Skeleton		Abdominal	
		Other (Specify)			

Patient classification	Tick
New	
Smear pos Relapse	
Smear Neg /EP Relapse	
Failure	
Treatment resumed after defaulting	
Transfer in	

SCC regimens	Tick
2RHZE/6EH	
2RHZ/6EH	
2SRHZE/1RHZE/5RHE	
2RHZ/4RH (children)	
2SRHZE/4RHZE	

Result sputum - smear examination at month:					
0	2	3	5	6	8

Intensive Phase (daily) - 2 months	Tabs./gr.
RHZE (150/75/400/275 mg. tabs) -[4FDC]	
RHZ (150/75/400 mg. tabs)- [3FDC]	
S (1 gr. vial)	

Continuation Phase (daily) - 4 to 6 months	Tabs.
RHZE (150/75/400/275 mg. tabs) -[4FDC]	
RHZ (150/75/400 mg). tabs - [3FDC]	
RH (150/75 mg. tabs) -[2FDC]	
EH (400/150 mg.tabs)- [2FDC]	
E (400 mg.tabs)	

Re-treatment (daily) - months 3	Tabs.
RHZE (150/75/400/275 mg. tabs) -[4FDC]	

Monthly body weight (Kg)								
Month	1	2	3	4	5	6	7	8
Date								
Weight								

Culture/Sensitivity results*	
Date:	
Streptomycin (S)	
Rifampicin (R)	
Isoniazid (H)	
Ethambutol (E)	

*Fill: S = Sensitive or R = Resistant

Treatment outcome	Date:
Cured (sm. negative)	
Treatment completed (no smear result)	
Failure (Sm. Positive)	
Died	
Defaulted	
Transferred out	

Gaeff test

Patient referred by		
Unit	Tick	Date
VCT centre		
HIV care clinic		
STI clinic		
Home Based Care		
PMTC clinic		
Private sector		
Self referral		
contact invitation		
Name unit		

Patient referred to		
Unit	Tick	Date
VCT centre		
HIV care clinic		
STI clinic		
Home Based Care		
PMTC clinic		
Private sector		
Chemist/pharmacist		
Name unit		

HIV status	
Test results	Tick
Negative	
Positive	
Not done	

(If HIV +)

Regular sexual partners tested for HIV	
Yes	No

Prophylaxis Opportunistic Infections			
	Tick	Date start preventive therapy	Date stopping preventive therapy
Cotrimoxazole			
Other (.....)			

CD 4 count (If done)	
Date	Result

Anti Retroviral Therapy			
ART Regimen	Tick	Date start ART	Date stop ART
Stavudine(d4T) + Lamivudine (3TC) + Nevirapine (NVP)			
Stavudine(d4T) + Lamivudine (3TC) + Efavirenz (EFV)			
Zidovudine (ZDV) + Didanosine (ddI) + Lopir			
Zidovudine (ZDV) + Didanosine (ddI) + Nelfinavir (NFV)			

Personae:
Four personae were developed to encompass the different types of users that could be affected by the system. These personae reflect the types of individuals working in Kenyan health care clinics and are based on interactions with individuals during the Summer 2005 feasibility study.

Agnes Mwathai
32-year-old Female nurse working in Kenya at a dispensing clinic.
Computer skill level: low

Agnes works as a nurse at a health clinic that is also a dispensary for tuberculosis patients. The clinic is located in a large suburb and it takes Agnes 30 minutes to walk to work everyday. As a nurse Agnes enjoys her work very much. Her daily routine consists of checking patient's vital signs, doing wellness assessments, and assessing the patient's eating and sleeping habits. Agnes works with four other nurses that she gets along with very well. Agnes has been working at the same clinic for 3 years now, and she doesn't feel that she has seniority in comparison to the other nurses. This frustrates her, because she would like to be assigned to a clinic closer to her extended family. It would be hard for her to leave the clinic because she does not have as much experience as a lot of other nurses in the clinic closer to her family home. Agnes is also frustrated because she never knows how many patients are going to show up on a daily basis. This is difficult for her, because she never knows how to prepare and often time she finds herself without enough medicine. She wishes that somehow the patients and staff could keep better track of who is coming to the clinic each day. Agnes is single and very spiritual and goes to church on a regular basis. She has a cell phone and sends frequent text messages to her friends and family. Agnes grew up in a small town in rural Kenya where her family still lives today. She misses her family immensely, and visits them almost every weekend. Agnes speaks her tribal language, Kamba, as well as Swahili and English. She does not speak Maa, the predominant preferred language in the region. She doesn't know how to use computers very well. She can only check her email, but is interested in learning more as it seems to be an important set of skills.

Goals:

- Successful treatment of patients
- Wants to gain seniority in her job, so she can find a job closer to her family
- Improve the efficiency of her working environment by improving the consistency of patient flow (feast or famine) so she can see her son more often
- Lower the frustration of communication with other tribes

Justification:

Agnes represents a typical young nurse, combining extensive medical knowledge with minor computer experience. Her personal goal to get a job closer to home, her single-mom

status, her inability to speak the tribal language of many of her patients, and her interest in computers are all details drawn from nurses we met in Kenya.

Beatrice Koitei

48-year-old Female nurse with over 20 years of experience as a nurse

Computer skill level: none

For the last 8 years, Beatrice has been working in the Loitokitok TB manyatta. The TB manyatta is a special collection of residences for TB patients designed to improve compliance during the initial intensive phase of treatment. Beatrice loves her job and is considered to be a veteran in her field; many other nurses look up to her as a role model. She is great at problem solving and all of the patients are fond of her. The patients that she sees come from very rural surroundings. She will often let her patients use her cell phone to call their families or other contacts who own a mobile phone in their home community. Beatrice's main job responsibility is administrating medications to resident TB patients during lunchtime. After lunch, she checks vital signs, patients' weights, and assesses how each patient is doing. Although Beatrice is a seasoned nurse, she still gets sad and frustrated by the number of children that must live in the manyatta with their families and are dying from Tuberculosis. Beatrice gets very frustrated at work when the manyatta runs out of medications. Her clinic relies on the government to supply these drugs to them on a regular basis, and when a shipment is missed there is nothing she can do and her patients suffer. This is a major problem because her patients will not receive the drugs. Outpatients coming to the clinic often must travel over 20 – 100 kilometers to find out that there are no drugs available. Beatrice wishes that she could communicate to her patients when drugs are not available either by cell phone, word of mouth, or a message board. Bottom line, she just wishes she could talk to her patients in a better way. Also, Beatrice is frustrated when she finds patients that haven't finished their proscribed medication treatments. This is becoming a critical problem in Kenya because patients that don't finish their medication cycle are becoming resistant to the drugs themselves. Beatrice does not have any computer skills but is willing to learn. She has seen people use computers at the post office, and is very curious as to what they can do. She wants to learn because she wants to start sending emails. She also hopes that she can use computers to help track the patients at the clinic in a better way. Beatrice lives with her family. She is married with 4 children and has a donkey to help carry water and a small posse of goats. Beatrice speaks several tribal languages, along with Kamba, Swahili and English.

Goals

- Prevent patients from coming to the clinic unnecessarily when drugs are not available
- Improve medication completion of current patients to ensure patients from becoming resistant to existing medication
- Mentoring younger nurses to become better nurses
- Keep working a few more years to support her family

Justification

Beatrice best represents the average current nurse in her complete inexperience with computers. Less skilled with computers than even Agnes, she further complements her fellow nurse in her additional years of experience. With her greater seniority she has been able to secure her post near the home area of her and her husband's families. Beatrice's tribal connection to the community and ability to speak the language, Maa, of her many rural Maasai patients reinforce her commitment to her work. This is reflected in Beatrice's frustrations with medicine supplies and other patient hardships.

Kari Trauph
25-year-old Female grad student studying social policy from Sweden on a 6 week internship
Computer skill level: high

Kari is on a 6 week internship with the Swedish International develoment Agency (SIDA), hoping to gain valuable experience working in the developing world. This is Kari's second time to East Africa and she feels comfortable working in the country. She is fluent in many languages including Swedish, German, French and English, but she is still struggling to learn Swahili.
Kari has been assigned to work in a TB clinic but doesn't have a specific job title, as befits her lack of experience in the health field. Kari works in any aspect of the hospital, basically helping out anywhere she is needed and able to assist. This is exciting for Kari because everyday there is a new challenge and the job is always very interesting. Kari loves helping people, and enjoys the Kenyan people very much. Kari is living with a host family and loves the little kids that live there because they like to brush her long blond hair, and they always try to braid it. On weekends, Kari goes out with the local girls in town for drinks where they talk and tell stories. Kari is very good at computers and works on one everyday when she is back in school. She considers herself an expert computer user with a lot of experience. Kari doesn't like the food in Kenya, and misses her pickled hearing.

Goals

- Work for an international development company in east Africa after graduation.
- Learn local languages
- Help improve living conditions.

Justifications
Kari, as someone highly skilled with computers but unversed in the health field, balances out the other personas in each of these areas. Additionally, she represents the perspectives of both a volunteer and an NGO of a Western donor country, important players in health initiatives in the developing world.

Noah Taine
25-year-old Male pharmacist in Kenya
Computer skill level: low

Noah is a 25 years old and works in the local pharmacy across the street from a busy clinic in a large suburb of Kenya. He has been working there for 3 years and is going to community college part time to finish his degree in Pharmacy. In school he has completed his basic courses and is hoping to gain enough money so he can go full time and become a licensed pharmacist.

At the pharmacy, employees and patients like him because he is soft spoken and good at his job. Noah's main job responsibility is taking patients prescription scripts and dispensing the medication. Noah is careful to dispense the correct drug and the amount of drug that has been prescribed, though he never checks to see what other drugs the patients are taking. That task is not feasible due the lack of persistent patient records and Noah's own lack of pharmaceutical or medical training. Noah enjoys his job and helping people. Noah has a girlfriend who he likes very much, and is thinking about asking her father to let him marry her once he has enough money to buy more cows for her bride price. He lives across the river from the clinic and walks to work every day. Noah has some computer experience and knows how to check his email and surf the internet. He likes using computers, but doesn't do it very often. He mostly checks his email, once every week or so when he goes to the post office to check the numbers of the beer-cap lottery. Noah has a cell phone and knows how to send text messages, but doesn't use his phone very much to make outgoing calls because it is so expensive.

Goals

- Become a full pharmacist
- Get married and start a family
- Open up his own pharmacy
- Get online

Justification

Noah fills the role of a low-medium computer user with functional but not expert knowledge of the health field (except in the specifics of dispensing medicine). A person of similar qualifications might well be the most likely user of our system, since the nurses and other medical staff have other responsibilities.

Scenarios:
Four scenarios were developed to encompass the typical daily activities of the various personas. Scenarios were utilized to help frame the scope of the system.

A day at a TB manyatta

Beatrice walks from her home to the TB manyatta to talk to the doctor and the other nurses to see if there are any problem cases that came up during the night. The patients are outside cooking their breakfast over open fires (*see man at right*) and having some chai (black tea with much milk and sugar).
During the course of the morning, Beatrice will see TB outpatients that need to pick up medication (as they do each week or month). She doesn't know how many people might come in, but she treats as many people as she can before lunch so that those who live farthest away can walk home before dark. Other staff members prepare lunch, and the patients line up to receive their food and medication - the two are linked to facilitate observed compliance with the treatment regimen. After lunch, she goes through each of the patient's medical record card and notes today's date and the medication dosage received by that patient. Throughout the afternoon, Beatrice sees more outpatients as they drop in and checks some of the resident patients' vitals signs, such as weight and temperature, and listens to their lungs. With outpatients and manyatta residents alike, she discusses their recent reaction to and compliance with the drug regimen, talking about issues they might have and emphasizing the importance of completing the medications.

A day at a Health Center
Agnes arrives at her semi-urban health center at around 8:30 in the morning, and there are already several people lined up outside (*see picture below*). She see a wide variety of patients who are visiting for various reasons, including malarial symptoms and pre- and post-natal checkups. Today is the last Tuesday of the month, which is the main TB medication pick up day. (In the continuation phase of TB treatment, patients come once a month to pick up medicine, whereas intensive-phase patients who aren't in a residential manyatta do so weekly).
Most of the patients in line have the small TB card with them that serves as both a portable health record and return-date reminder card.

For today, Agnes is assigned to work especially with the TB patients. She meets with each patient (or child patient's parent) and performs quantitative measurements and qualitative checks. As she checks vital signs and weight, Agnes discusses with each patient how they are reacting to the medication and how they feel in general. She also tries to get feedback how well they are complying to the medication: Are they taking their medications daily? Are they sharing their meds with others? She might tell them again how important it is to maintain their drug regimen, to avoid resurgence of the disease - or even development of fatal multi-drug-resistant TB. To communicate effectively with some of the patients, she will need a translator - a colleague or perhaps another patient.
Agnes initials the patient's personal card of the patient and the clinic card, writing on both the patient's expected return date. She then takes the clinic card and puts it into the file box. She also collects the government's cost-sharing fee from the patient (which may be waived due to extenuating circumstances).

Swedish Swahili

Kari arrives at the manyatta at 8:00, after some of the patients but ahead of many staff members, and hopes to avoid more than one more cups of chai this morning. She doesn't know what she'll be doing for the day, so she meets with the head nurse to find out where she will be assigned and what they want her to help out with. Actually, the only tasks which Kari is able to do are dispensing medications during lunch and weighing babies (*see picture*) and adults. Often, Kari works beside the nurse and fills out the clinic cards while the nurse is treating the patients. She also helps dispense medications for outpatients, writes their return dates on their cards, and verbally informs those who speak Swahili when they should return.

Pharmacy Phrenzy

Noah is in charge of dispensing medications. Today is the main day of the month for TB drug collection, so when he arrives in the morning he hopes that there will be enough to supply however many people show up. For the TB outpatients, he prepares the standard bundles of medicine, ready for them when they finish with the nurse or doctor. For all patients, he deciphers the prescription written out on the patient card (or substitute scrap of paper), counts out the pills, and hands the medications to the patients. He explains the dosage, frequency, duration, and any peculiarities of the medications. Noah makes sure that each patient understands the date when he or she should return (even if he has to explain it to some as "the day after the third market day of the month").

Task Set One (used with low-fi and initial interactive prototype)

1. Create and save a patient group: The group should contain females who are referred by the VCT Centre and have a sensitivity to Isonizaid.
2. Find and select the patient named Joe Smith and send them a one-time 'Happy Birthday' message on June 5th.
3. Go to the reporting section and re-send a failed message.
4. Compose and send a weekly medication pick-up reminder in French to all continuation phase patients. The message should begin sending on March 10.

Task Set Two (used with all other interactive prototype versions)

Set of three tasks (US):

1. Create and save a new Announcement message called "Independence Day Party Invitation" which is for patients of all ages and all genders in all clinic.
    a. Create a text message in English
2. Find the message "Pregnancy and Treatment" and schedule it to be sent one time only on May 5th.
3. Create and schedule a message for all patients receiving ARV treatment. The message should be an announcement that December 1 is World AIDS Day.
    a. Create a text message in English.
    b. Schedule the message to be sent on a repeat basis, every week, starting today. It should stop sending June 5th.

Set of three tasks (Kenya):

1. Create and save a new Announcement message called "Jamhuri Day Party Invitation" which is for patients of all ages and all genders in all clinics.
    a. Create a text message in English
    b. Create a text message in Swahili
2. Find the message "Pregnancy and Treatment" and schedule it to be sent one time only on May 5th.
3. Create and schedule a message for all patients receiving ARV treatment. The message should be an announcement that December 1 is World AIDS Day.
    a. Create a text message in Swahili
    b. Schedule the message to be sent on a repeat basis, every week, starting today. It should stop sending June 5th.

Set of four tasks (US):

5. Create and save a new Announcement message called "Independence Day Party Invitation" which is for patients of all ages and all genders in all clinics and invites them to a 4th of July celebration.
    a. Create a text message in English
6. Create and save a new Medication Reminder message.

The message is for children up to age 12, in the intensive phase of treatment plans, and also the continuation phase, on all types of medication.

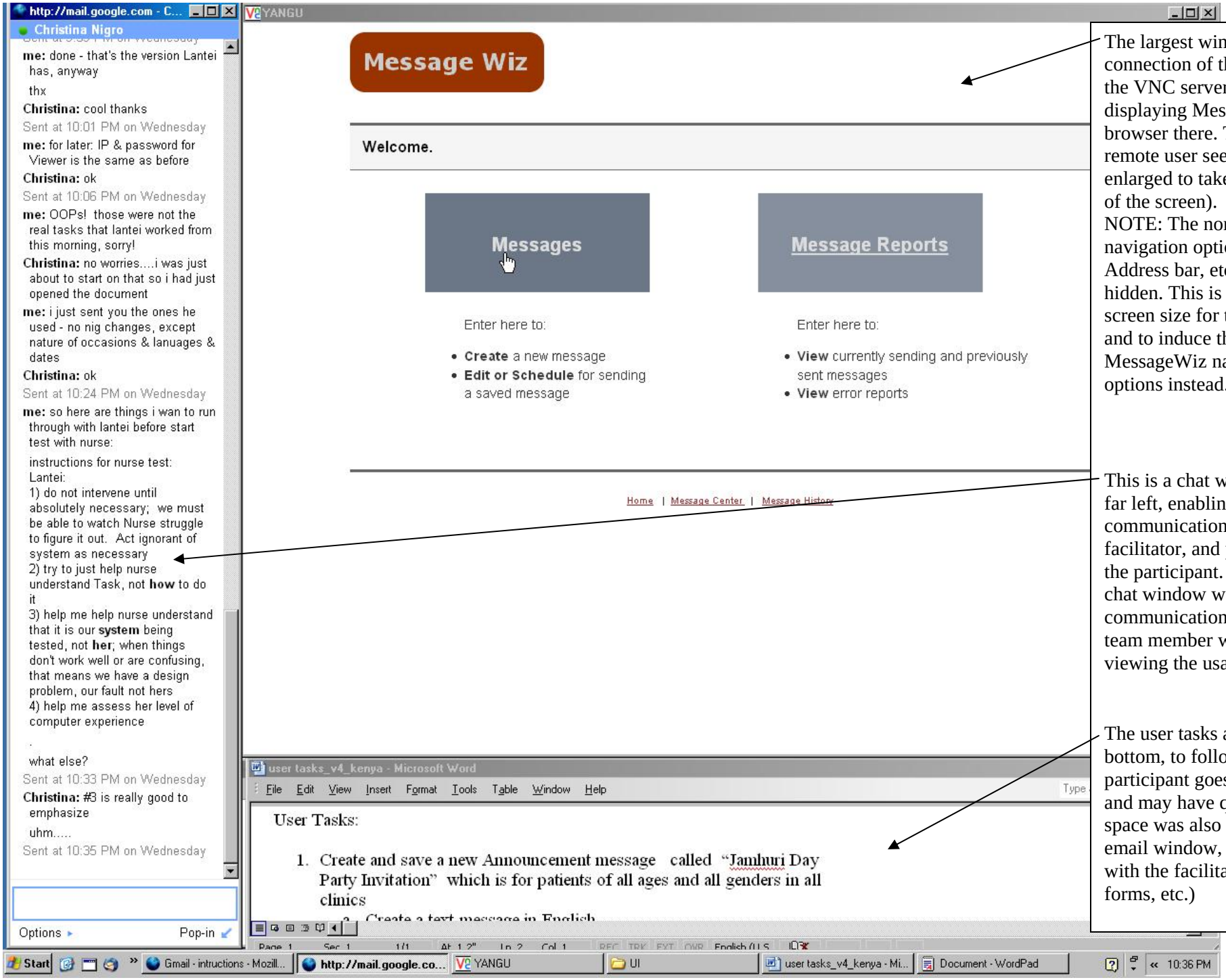
   a. Create a text Message in English
   b. Check the message.
      Now you remember that you want to say that children must take milk or food with their medication so you need to edit what you already entered.

7. Create and schedule a message for all patients receiving ARV treatment. The messages should be an announcement that December 1 is World Aids Day.
   a. Create a text message in English
   b. The message should be sent on a repeat basis, every week, starting today. It should stop sending June 5.
8. You want to schedule the Medication Reminder message you created in task 2. Find and schedule this message to be sent one time.
   Choose the date you want it to be sent, any date is OK.

Set of four tasks (Kenya):

1. Create and save a new Announcement message called “Jamhuri Day Party Invitation” which is for patients of all ages and all genders in all clinics
   a. Create a text message in English
   b. Create another text message in Swahili
2. Create and save a new Medication Reminder message.
   The message is for children up to age 12,
   They are in the intensive phase of treatment plans,
   and also the continuation phase, all types of medicines.
   a. Create a text Message in English
   b. Check the message.
      Now you remember that you want to say that children must take milk or food with their medication so you need to edit what you already entered.
3. Create and schedule a message for all patients receiving ARV treatment. The messages should be an announcement that December 1 is World Aids Day.
   a. Create the message in Swahili
   b. The message should be sent on a repeat basis, every week, starting today. It should stop sending June 5.
4. You want to schedule the Medication Reminder message you created in task 2. Find and schedule this message to be sent one time.
   Choose the date you want it to be sent, any date is OK.

Appendix H: Screenshot of Primary Observer's Display



The largest window is the connection of the computer to the VNC server of the laptop, displaying MessageWiz in a browser there. This is what the remote user sees (but is enlarged to takeup more or all of the screen).
NOTE: The normal browser navigation options (Back, Address bar, etc) have been hidden. This is both to increase screen size for the remote user, and to induce them to use the MessageWiz navigation options instead.

This is a chat window on the far left, enabling parallel communication with the facilitator, and possibly also the participant. Often a second chat window was added for communication with a second team member who was viewing the usability test.

The user tasks are at the bottom, to follow along as the participant goes through them and may have questions. This space was also used for an email window, for file sharing with the facilitator (consent forms, etc.)