Designing Appropriate Computing Technologies for Rural Development

Tapan S. Parikh
School of Information | UC Berkeley
http://ischool.berkeley.edu/~parikh | parikh@berkeley.edu
Microfinance: Global Movement
– Grameen Bank & Muhammad Yunus – 2006 Nobel Prize

Self-Help Groups (SHGs) - ROSCAs, ASCAs, Village Bank, etc.
– Collect savings during meetings
– Use capital for small loans
– Business, livestock, education, health care, etc.
– Repayment based on peer pressure

Decentralize financial service provision
SHGs are being linked to banks

- Access more credit at better rates
- Other services (insurance, investment, savings, etc.)
- Local intermediation can reduce cost of service
- Excellent repayment performance (90-98%)

However, many obstacles

- Spread across remote rural areas
- Limited education, infrastructure, financial capacity
- Documentation practices are inconsistent
- Difficult to assess credit risk and make decisions

Parikh - ICTD 2006
Information can bridge the divide
- Connect the formal and the informal
- Provide oversight and understanding for SHGs
- Provide credit ratings and risk analysis for banks
- Result: SHGs get better rates for better performance

Can we design a system for SHGs to aggregate data?
- Accessible to users
- Accurate and efficient
- Intermittent power, connectivity
- Generalizes to other applications
Understand Context
A highly 'embedded' approach to designing, developing and evaluating technology

Build Solution
CAM: a mobile phone toolkit for distributed data collection in the rural developing world, and several applications using it

Evaluate Impact
Microfinance – actively used in India
Agriculture – pilot in Guatemala and Mexico
Public Health – tested in Tanzania
Step 1: Understand

2002-3
Investigate interface design space for rural users
  – SHG members and supporting staff
  – Some may be semi-literate or illiterate
  – Use SHG data collection as sample application

Only previous work was Grisedale et al., CHI 1997
  – Data collection for rural health care workers in Rajasthan
  – Using Apple Newton

We used laptop / PC for maximum flexibility
  – Not considering real deployment issues
contextual study
<table>
<thead>
<tr>
<th>எண்</th>
<th>Member Name</th>
<th>No. Subscription</th>
<th>வைத்தியம்</th>
<th>உண்டாயம்</th>
<th>பெற்றம்</th>
<th>வாங்டு பிறகு</th>
<th>விளகுதல்</th>
<th>கொடுக்கும் பெருமை</th>
<th>முதலி</th>
<th>வரவேற்று</th>
<th>மேல் பெருமை</th>
<th>செயற்பாடு</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| கல்பாடம் | 11/11 (End of Year) |

கைசெய் புதுச்சேரியமைப்பாளர் மற்றும் பாதுகாக்கும்
Coordinator: [Signature]

கணிப்பாளர்: [Signature]

கைசெய்: [Signature]
<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>50</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12.10.02 50
05.10.02 50
22.09.02 50
15.09.02 0
03.09.02 50
26.08.02 50

Group Investments

Bank balance 6850
Two-month iterative design study conducted in a village

32 rural users - farm laborers (10 semi or illiterate)

✔ Paper formats are important
✔ Local language audio builds trust
✔ Numeric input/output is accessible
✔ Guide the user through the task
✔ Realistic icons are better
Step 2: Build

2004-5
1) Agents - Rural Service Providers

Agent Model: Provide services through local intermediaries

- Employ underemployed youth and women
- Convenient for users / clients (travel is hard!)
- Common motif for many services
  - Primary health care
  - Retail supply chains
  - Agriculture
  - Communications, etc.
- In microfinance, {bank, NGO} field staff collect info, repayments & deliver reports
Mobile phones are the perfect client device
  – Exponential growth across developing world
  – Numeric Keypad, Speakers & Microphone
  – Intermittent network, Battery-operated, Low-cost
  – Supports Agent-based service model

Problems and Limitations
  – Small screen: adapted WIMP metaphor
  – Numeric keypad: text entry is difficult
  – Difficult to program applications

source: grameen-info.org
3) Paper User Interfaces

Leverage affordances of paper in digital UIs


However, thus far these approaches have had limited impact

Rural developing world could be the killer application

– Familiarity with paper formats
– Offset high technology cost by performing some operations on paper “client”
CAM: Application Toolkit for Mobile Phones

CAMForms
interactive paper forms

CAMBrowser
mobile phone app
to process forms

<function name="a_click">
  d = input_date("Date", "date.wav");
  i = input_int("Interest", "int.wav");
  p = input_int("Principal", "pri.wav");
  if (d & p & i)
    http_put("...");
</function>

CAMScript
scripting language
for form interaction
Formulario de Inspección Interna de Asobagri

**Direcciones:** Este formulario de inspección consta de 12 secciones. Para ingresar una sección al teléfono, deberá de ingresar el código de barras correspondiente, seguido del código del productor. A continuación, el teléfono comenzará a proporcionar espacio para contestar las preguntas de esa sección. Si usted quiere tomar alguna fotografía o hacer una grabación de audio para proporcionar evidencia de su inspección, usted puede ingresar el código de barras con el título "tomar fotografía" o "grabar audio", respectivamente, seguido también del código del productor.

### Sección 0 Información General

<table>
<thead>
<tr>
<th>Código de barras</th>
<th>Fecha</th>
<th>0.1.</th>
<th>0.2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>90/00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91/00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Información adicional

- **0.3.** ¿Cuántas parcelas tiene? __
  - a. __
  - b. __
  - c. __
  - d. __
  - e. __

### Sección 1 Semillas y Tratamiento

<table>
<thead>
<tr>
<th>Código de barras</th>
<th>Fecha</th>
<th>0.1.</th>
<th>0.2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>90/01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91/01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Preguntas de interés

1. **1.1.** ¿Hizo 1. Si semillero? __
   - 2. No

2. **1.2.** Cantidad de semillas en libras:
   - 1. Plantas
   - 2. Ceniza
   - 3. Água Caliente

3. **1.3.** Que sustituto 1. Mat. uso para desinfectar:
   - 1. Orgánico
   - 2. Natural
   - 3. Convertion
   - 4. Convencional

#### Recomendaciones inmediatas:

### Sección 2 Fuentes de plantones y cafés

<table>
<thead>
<tr>
<th>Código de barras</th>
<th>Fecha</th>
<th>0.1.</th>
<th>0.2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>90/02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>91/02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Detalles adicionales

2. **2.1.** Compró 1. Si almaceno de caffé? 2. No

   - Estatus 1. Orgánico
   - 2. Natural
   - 3. Convertion
   - 4. Convencional

2. **2.2.** Sintió 1. Si algunos frutales dentro de la parcela?

   - Cual 1. Cítrico
   - 2. Banano

   - Estatus 1. Orgánico
   - 2. Natural
   - 3. Convertion
   - 4. Convencional
Barcode Detection - RoHS 2004
CAM: Key Features

**Tight linkage to paper practices**
- Retain paper as the authoritative local record
- Avoid abstract, menu-driven interaction
- Not optimizing for local labor – don't need OCR!

**Simple, scripted programming model**
- Easy to program and use

**Multimedia Input & Output**
- Capture audio and images instead of text

**Disconnected Operation**
- Transfer data using SMS, MMS, Email (and HTTP)

```<function name="a_click">  
date = input_date("Enter Date" "date.wav");  
amt = input_int("Enter Amount", "amount.wav");  
message_note("Say your name","sayname.wav");  
record_audio("name.wav");  
email("tap2k@yahoo.com", "a="#amt, "name.wav");  
</function>```
CAM: Dataflow in Microfinance

Framework for SHG data collection and reporting
Increased transparency within SHG
Improved documentation when applying for loans
Provide new services to members (e.g. flexible savings)

ekgaon.com
Step 3: Evaluate

2006-8
**Task:** Record transactions during SHG meetings
- Users: 14 field agents from NGO
- 7th grade to college educated
- Simulated and in situ testing

**Results:**
- Learnable: Learned within 1-3 sessions
- Efficient: 30 secs per form, 8-10 mins per meeting
- Accurate: Error rate < 1% (0% for in situ tests)
- Users performed significantly better with audio
CAM: Impact in Microfinance

Commercialized by ekgaon technologies pvt.ltd
2 NGOs / 17 agents / 700 SHGs / 10000 members
In active use in Tamil Nadu since October 2006

ekgaon.com
Supply Chain  Javid and Parikh - ICTD 2006
- Monitor inventory at rural warehouses
- Plan collection & distribution
- Tested in Uttar Pradesh, India

Public Health  DeRenzi et al. - ACM CHI 2008
- Automate clinical protocols
- Reduce training, improve adherence
- Tested in Tanzania

Agriculture  Schwartzman and Parikh - MobEA 2007
- Monitor cultivation using pictures, audio
- Provide extension and certification
- Pilot w/ 1000 coffee farmers in Mexico
Internal control system for agri-cooperatives
Maintain quality, certifications (organic, fair trade)
Pilot w/ over 1000 small farmers in Oaxaca, Mexico

Inspection
Evaluator use mobile phones to monitor farms

Evaluation
Evaluator use a web application to give feedback

Report Generation
Generate reports for extension and certification

w/ Yael Schwartzman
Integrated Management of Childhood Illness (IMCI)

Use of IMCI protocol can significantly reduce child mortality (Armstrong, 2004)

Automate using mobile device to reduce training, improve adherence

w/ DeRenzi, Lesh, Borriello, Mitchelll
Tested with IHRDC in Mtwara, Tanzania

Measured adherence to the IMCI protocol

Observed 27 e-IMCI sessions, 24 paper-based sessions

Use of e-IMCI can significantly improve adherence compared to current practice

Preferred by all users
Empower local people to build their own solutions

Physical tools for content creation and application development

Paper formats, visual and tangible programming

Future Work: Support Local Creators

w/ Yaw Anokwa
Long-term Vision

Equitable Economic Development
Environmental Sustainability
Freedom & Political Stability
Information Technology
Decentralization
Final Thoughts

Design for real people & problems
Attracts diverse & energetic students
Impact sustains credibility & collaboration
Thanks for all the Fish

Yaw Anokwa, Brian DeRenzi, Paul Javid, Neil Patel, Yael Schwartzman, Anil Gupta, Vijay Pratap Singh Aditya, Kaushik Ghosh, Apala Chavan, Sarit Arora, Puneet Syal, K. Sasikumar, Muthu Velayutham, Gaetano Borriello, Neal Lesh, Kentaro Toyama, ekgaon technologies, CCD, Mahakalasm, Asobagri, CEPCO, D-Tree, Dimagi, Cell Life, IHRDC, Jataan, HLFPPT, Media Lab Asia, HFI, UW CSE, UW MLC, Intel Research, MSR India, Ricoh Innovations, Transfair, David Bonderman, SEEP, IDRC, ekgaon and everyone else I've had the pleasure to work with.