Designing Appropriate Computing Technologies for Rural Development

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University of Washington

Job Talk - Spring 2007
3 billion people in the rural developing world need the same information we do

✔ Business: new opportunities
✔ Finance: capital to invest
✔ Government: services & programs
✔ Health: informed, consistent care
✔ Education: personal advancement
3 billion people in the rural developing world have different limitations and capabilities

- **Money**: to buy technology
- **Education**: to use technology
- **Infrastructure**: power, connectivity
- **Time**: lots of available labor
- **Community**: lots of relations
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 Result
Microfinance – actively used in India
Agriculture – tested in Guatemala and India
Supply Chains – tested in India
Step 1: Understand

2002-3
Financial Services to the Poor

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
- Expensive to collect information and money
- 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
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
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Design Guidelines for Rural Users
Parikh et al. - ACM CHI 2003, ACM CUU 2003 (Best Paper)

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
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
2) Mobile Phones

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
- XAX, Digital Desk, A-Book, Paper PDA, Cooltown, Books with Voices, etc.

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, debe ingresar el código de barras correspondiente, seguido del código del producto. A continuación, el teléfono comenzará a proporcionarle 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 producto.

### Sección 0 Información general

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### Sección 1 Semillas y Tratamiento

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#### 1.1 Hizo el siembrador?
- Código de la parcela de origen de semillas
  - 2. No
    - Estado de la parcela
      - 1. Organica
      - 2. Natural
      - 3. Conversion
      - 4. Convencional

#### 1.2 Cantidad de semillas en libras:
- Producto que uso para desinfectar:
  - 1. Plantas
  - 2. Centiza
  - 3. Agua Caliente

#### 1.3 Que sustituto del Mat.
- Uso para el Organica sembrador?
  - 1. Plantas
  - 2. Tierra
  - 3. Arena

Recomendaciones inmediatas:

### Sección 2 Fuente de plantones y Reproducción

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#### 2.1 Compro el siembrador?
- Estado de la parcela
  - 1. Organica
  - 2. Natural
  - 3. Conversion
  - 4. Convencional

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#### 2.2 Si algunos frutales dentro de la parcela?
- Cual?
  - 1. Cítrico
  - 2. Banano

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**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)

```xml
<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)
Step 3: Evaluate

2006-7
**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
Supply Chain  
Javid and Parikh - ICTD 2006

- Monitor inventory at rural warehouses
- Track inflows and outflows of goods
- Plan collection & distribution

Health Care  
Future Work

- Collect disease data
- Monitor incidence, transmission
- Monitor treatment compliance

Agriculture  
Schwartzman and Parikh - MobEA 2006

- Monitor cultivation using pictures, audio
- Agricultural extension and certification
- Integrated with various sensors
Working with farmers in Guatemala and India
Extension staff collect geocoded video, images and data
Experts provide feedback and advice via parcel-wise blog
Enable remote certification – organic, bird-friendly, etc.

- Traceability
- Product Differentiation
- Land Use
Empower local people to build their own solutions

Physical tools for content creation and application development

Paper formats, visual and tangible programming
Future Work: Trust & Ownership

Rural users may never “own” technology

How do different identification technologies, interaction mediums and social contexts impact trust in computing?

Can we facilitate distant personal / business relationships?
ICTD: An Emerging Area

**TIER Group, UC Berkeley**
- Long-distance wireless, DTN
- Mobile educational software

**Digital Studyhall, Princeton / UW / MSR**
- Video for education
- Postmanet – physical networking

**Emerging Markets, MSR India**
- Design for semi-literate users
- Multiple mice for education

**One Laptop Per Child (OLPC)**
- Laptops for education

**Other Efforts**
- MSR funded 17/162 proposals
Contributions

Design Lessons for Rural Users
- importance of paper
- local language audio
- numeric i/o

CAM Toolkit
- paper user interface
- multimedia i/o
- scripted & asynchronous

CAM Evaluation
- usability
- generalizability
- real-world impact
Understand Context

ACM CUU 2003
ICTD 2006
IEEE Pervasive

Build Solutions

WWW 2006
IEEE Pervasive
MobEA 2006

Evaluate Results

ACM CHI 2006
ICTD 2006
Long-term Vision

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

ICTD: an emerging research area
Design for real people & problems
Attracts diverse & energetic students
Impact sustains credibility & collaboration
Thanks for all the Fish

Anil Gupta, Vijay Pratap Singh Aditya, Jaimin, Bhavin, Rushabh, Nilesh, Bharat, Kinjal, Kaushik Ghosh, Apala Chavan, Sarit Arora, Puneet Syal, K. Sasikumar, Paul Javid, Yael Schwartzman, S. Olaganathan, John, Bala, Swami, Muthu Velayutham, Edward Lazowska, David Notkin, James Landay, Gaetano Borriello, Richard Anderson, Ken Fishkin, Scott Klemmer, Kentaro Toyama, Eric Brewer, Greg Wolff, Batya Friedman, SRISTI, IIM-A, CCD, Mahakalasm, SEWA, Asobagri, Jataan, HLFPPT, Media Lab Asia, HFI, UW CSE, VSD Lab, UW MLC, Intel, MSR India, Ricoh Innovations, David Bonderman, SEEP, IDRC, ekgaon and everyone else I've had the pleasure to work with.
Honey Bee shares grassroots knowledge and innovation
Publishes 7 regional magazines about agricultural practices and other innovations
Interested in new ways to share content and facilitate communication
Developed multi-media distributed database and communications application
Networked using asynchronous CD-based updates
Implemented at kiosks in Gujarat, Madhya Pradesh, Maharashtra and Tamil Nadu
ekgaon technologies

ekgaon was founded in 2002 and works in providing technical, managerial and strategic support to community-led initiatives around India and the world. Currently we are based in New Delhi with a field office in Madurai, Tamil Nadu.

http://www.ekgaon.com

Other Partners and Supporters

Covenant Centre for Development
Mahakalasm SHG Federations
CARE India
Deutsche Gesellschaft for Technische Zusammenarbeit (GTZ)
Small Enterprise Education and Promotion Network (SEEP)
International Development Research Centre (IDRC)
Sarai New Media Initiative
Ricoh Innovations
Microsoft Research
Intel Education Program
E-Z Rural Computing

Easy to Use: Max outreach
Easy to Teach: Word of mouth
Easy to Access: Travel is hard
Easy to Share: Amortize high costs
Easy to Create: Local ownership
Easy to Adapt: Localization essential
Outline

1 Background: Microfinance
2 Contextual Design for Rural Users
3 CAM: Data Collection for Mobile Phones
4 Evaluation: Usability, Breadth, Impact
5 Future Work
6 Conclusions
Problems with Mobile UIs

User Interface
- Adapted point-and-click metaphor
- Text entry is difficult; limited use of other media

Mobile UI research has largely focused on improving display of web content on small screens
- WEST, PowerBrowser, Wingman, Digestor, AppLens, Summary Thumbnails, Collapse-to-zoom, etc.

Programming Model
- Proprietary APIs and programming environments
- Web-based applications require online connection