Designing Appropriate Computing Technologies for Rural Development

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Lecture #16: April 29, 2008
Today’s Outline

• My Job Talk
• Lessons Learned (or advice on how to start a career in HCI)
Financial Services for 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
- Limited education, infrastructure, financial capacity
- Documentation practices are inconsistent
- Difficult to assess credit risk and make decisions
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
Lesson 1: Choose an Interesting Problem

What most people remember about your work is the problem, not the solution. When you choose an uninteresting problem, you are locked into it, no matter how good a job you do. You should yourself be completely psyched and dedicate to the problem you are working on.
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
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Table with various columns and rows, but the content is not legible.
prototype testing
design iteration
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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

குழந்தைகள் போர்க்கை நிறைவு 1080

Bank balance 1600

Group Investments

Bank balance 6850
Lesson 2: Spent Lots of Time with Users

Science and Engineering are based on data. Time spent with users is the raw data that you will use for the rest of the project. There is no substitute for direct observation. Plus, it can be a lot of fun!
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
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
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

![Diagram showing villages, agents, and services]
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”
Lesson 3: Understand Prior Work

There is no sense in re-inventing the wheel (unless there is a darn good reason)
You should build upon the best work, it saves you time!
Look for examples both from practice and academia
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>
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<th>Fecha</th>
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### Sección 1 Sementillas y Tratamiento

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<td>901#1</td>
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</table>

#### 1.1 Hizo 1. Sementillo?

2. No


#### 1.2 Cantidad de sementillas en libras:

- Producto que uso para desinfectar: 1. Plantas, 2. Ceniza, 3. Agua Caliente

#### 1.3 Que sustrato 1. Mat, uso para el Organica sementillo?

- Producto que uso para desinfectar: 1. Plantas, 2. Tierra, 3. Arena

#### Recomendaciones inmediatas:

### Sección 2 Fuente de Plantones y Cebales

<table>
<thead>
<tr>
<th>Código de barras</th>
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<td>901#2</td>
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#### 2.1 Compró 1. Si almaceno de cebal? 2. No


#### 2.2 Sementillo 1. Si algunos frutales dentro de la parcela?

- Códigos: 1. Cítrico, 2. Banano

**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)
Lesson 4: Implement an Innovative Solution

This is your chance to make a difference!
Innovation is great – it's the reason that the problem was not solved already.
But make sure your innovation matches the tension points of the problem – and it helps to have the wind at your back!
If it requires writing a lot of code, then do it (or find someone that can)!
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
Lesson 5: Do a Rigorous, Honest Evaluation

Be rigorous in your evaluation

Be honest in presenting your results (especially to yourself!)

Your goal is to understand how your system works in practice.

This requires a variety of evaluation methods, a fine attention to detail, and lots of patience!
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
Lesson 6: Follow Through

If your idea is good enough, and your evaluation is promising – follow through on your idea to the conclusion

(On the other hand, if you are convinced its a bad idea, then cut your losses early)
Internal control system for agri-cooperatives

Maintain quality, certifications (organic, fair trade)

Pilot w/ over 1000 small farmers in Oaxaca, Mexico

Inspection

Inspectors use mobile phones to monitor farms

Evaluation

Evaluators 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

GIVE EXTRA FLUID FOR DIARRHOEA AND CONTINUE FEEDING

Plan A: Treat Diarrhoea at Home

1. GIVE EXTRA FLUID (as much as the child can take)
2. CONTINUE FEEDING
3. WHEN TO RETURN

Plan B: Treat Some Dehydration with ORS

- Give the recommended amount of ORS every 2 hours
- Monitor intake and output
- Call for further advice


w/ DeRenzi, Lesh, Borriello, Mitchell
Lesson 7: Branch Out and Generalize

Creative work is a combination of building on stuff you know and branching out in new directions.

If there are opportunities to do genuinely new work that leverages the stuff you know or have recently learned, do it!

But, eventually, you should always be thinking – what's the next quantum leap?
e-IMCI: Improving Adherence
DeRenzi et al. - ACM CHI 2008 (to appear)

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
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
ICTD: An Emerging Area

I-School / TIER, UC Berkeley
- Long-distance wireless, DTN
- Mobile phones, HCI, Social Science

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

Emerging Markets, MSR India
- Text-free User Interfaces
- Multiple mice for education

One Laptop Per Child (OLPC)
- Laptops for education

Other Universities
- MIT, CMU, Colorado, Waterloo
For Next Time

Discussion about the class – feedback for the professor and TA
Bring all your comments, suggestions, critiques, questions – from the sublime to the mundane, from general to specific
I encourage both positive and negative comments!
Long-term Vision

- Equitable Economic Development
- Environmental Sustainability
- Freedom & Political Stability
- Information Technology
- Decentralization
Future Work: Support Local Creators

- Empower local people to build their own solutions
- Physical tools for content creation and application development
- Paper formats, visual and tangible programming

w/ Yaw Anokwa
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.
paper prototyping
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
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
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
Under five mortality was 13% less in two districts implementing IMCI

Source: Armstrong et al., 2004
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
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<td>Feeling Ill</td>
<td>No different from before</td>
</tr>
<tr>
<td>Weight Change</td>
<td>Same or Little Change</td>
</tr>
<tr>
<td>Lack of Energy</td>
<td>The same or better</td>
</tr>
<tr>
<td>ASK: Have you needed medical care since your last visit?</td>
<td>Yes, No</td>
</tr>
<tr>
<td>Feeling Ill</td>
<td>No different from before</td>
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<td>The same or better</td>
</tr>
<tr>
<td>Needing medical care</td>
<td>Yes</td>
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**ASK:** Are you taking any new drugs or traditional medicines?

- [ ] No
- [x] Yes
<table>
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<th>Condition</th>
<th>Response</th>
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<td>Yes</td>
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ASK: Are you

New Drugs:
This includes drugs that are prescribed by another doctor or nurse or bought in a pharmacy or market as well as herbal remedies.
<table>
<thead>
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<th>Answer</th>
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<td>No</td>
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<td>Disclosing to Partner</td>
<td>Yes, I've disclosed</td>
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<tr>
<td>Thinks Pregnant</td>
<td>No</td>
</tr>
<tr>
<td>Missed Period</td>
<td>Yes</td>
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</table>

**ASK:** Do you have other problems that I didn’t ask about that you need to discuss with the doctor?  
- [ ] No  
- [ ] Yes
Patient has several new problems including:

- Needing medical care
- Fever
- Sores in mouth

Refer to Doctor
Building mobile tools for public health
Standards-based (XForms), Open Source

**Applications**
- Disease Surveillance
- Clinical Protocols
- Clinical Trials
- Household Surveys
- Birth and Death
- Support CHWs

**Organizations**
- OpenMRS
- EpiHandy
- EpiSurveyor
- Berkeley
- Washington
- MIT
- Cell Life (South Africa)
- MRC (South Africa)
- IRD (Pakistan)
- Dimagi
- D-Tree
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

3 billion people in the rural developing world have different limitations and capabilities.
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
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?
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