Stages of Design in Technology for Global Development

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Information and communication technology projects designed to cost-effectively impact the world's poorest communities require more than technical solutions. A Microsoft research group shares its experiences and lessons learned implementing various ICT4D initiatives in India.

The battle against poverty is a continual engagement with humility—especially for technologists. In the area of research known as information and communication technologies for development (ICT4D), engineers work with social scientists to develop novel solutions to the challenges faced by the world's poorest communities. In most cases, these challenges can't be met simply by providing a useful technology. Although it's easy to specify the technical requirements to set up a PC with Internet access in a slum or a remote agrarian village, what it takes for technology to meaningfully impact a poor migrant worker or rural farmer is an altogether different problem that requires considerations of local economy, cultural norms, and stakeholder needs.

The Technology for Emerging Markets (TEM) group at Microsoft Research India (http://research.microsoft.com/research/tem) in Bangalore faces these kinds of problems every day. The solutions, however, rarely come easily and require extensive time in the field, honesty about what does and doesn't work, and a willingness to accept technically simple solutions.

TEXT-FREE UI

One of our first humbling encounters was in a research project called Text-Free UI (http://research.microsoft.com/~indranim/text-free.htm). We started with the idea that of the one to two billion illiterate people on the planet, surely some of them would come into contact with computing technology. And when they did, it would undoubtedly be helpful to navigate the user interface even without the ability to read. Because regular UIs are text-heavy and designed for the literate (try navigating websites that don't use an alphabet you can read), our objective was to develop design principles for UIs that were free of text, to serve nonliterate users.

Lead researcher Indrani Medhi spent months in Bangalore's urban slums, Tablet PC in hand, befriending and interacting with women slum residents, most of whom were unable to read at all (see Figure 1). Indrani started with the obvious (voice annotations on everything); she learned what the women wanted to know (available housecleaning jobs); she experimented with graphical representations (hand-drawn cartoons worked best); she imbibed the culture (TV and word-of-mouth prevailed as information channels); and she uncovered the unexpected (everyone could read numbers). Armed with this knowledge, she designed the perfect UI for a nonliterate domestic worker … or so we thought.

We ran formal tests on a text-free Monster.com clone that included information pages for housekeeping chores. Formal test subjects were supposed to find the best-paying job for an imaginary friend. Despite our confidence in the UI, only 30 percent of participants completed the task, even with significant prompting and availability of the test administrator for answering questions. Thirty percent is better than zero, of course, but it wasn't what we hoped for. Interestingly, most of the 70 percent who didn't complete the task appeared to grasp the UI's mechanics—they understood the icons

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and could follow the voice annotations. They weren't stuck on the UI.

In-depth interviews after the study revealed that the subjects, for whom this was their first interaction with a PC, had other concerns: Would they break the PC by touching it? Wouldn't it be easier just to ask the local job broker? And how exactly did the little box know where the jobs were in the first place? We thought we'd answered these questions in the preface to each experiment, but the participants clearly didn't absorb the explanations. Barriers beyond illiteracy were at the heart of the problem.

Indrani thought back to her months of note-taking and realized that as valuable as her notes were, the circumstances in which she took them proved even more critical. So often, she'd sit in cramped living quarters, listening to women tell story after story, while the TV played some Bollywood soap opera in the background. Indrani's solution came to her in a moment of insight: Why not play a short movie that not only explained the UI but also the full context of the application—who created the information, how it was inserted into the computer, and what good it could ultimately do? She coaxed several lab members to act in an amateur production, and thus created the first *full-context video*, which provided exactly that information in a narrative format.

Armed with the video clip, looping at the beginning of the application, Indrani reran her experiments. To our delight, all of the new subjects completed the task of finding a job for their friend. Moreover, they were all puzzled that their friends from the previous study had had so much difficulty. It all seemed so obvious!

THE FIVE STAGES OF DESIGN

Over the past four years, the TEM group has found time and again that Indrani's experience isn't unique. In fact, we see a recurring set of five stages of design that ICT4D projects seem to experience:

- *Wonder:* Recognition of the size or severity of a particular challenge in development and wonder that the problem persists.
- *Exuberance:* Excitement at devising an initial technical solution.
- *Realization:* Discovery of ground realities when the initial solution doesn't quite work and realization that the real problem is elsewhere.
- *Adaptation:* Creation of a new solution that solves the real problem.
- *Identification:* An identification with the user that often explains the gap between exuberance and realization.

In the case of text-free UIs, wonder came at the possibility of millions of nonliterate PC users. Our initial

Figure 1. Indrani Medhi (right) spent months in the urban slums of Bangalore, befriending and interacting with women slum residents to gather data that would aid in the design of text-free user interfaces.

design ideas were accompanied by exuberance. Realization hit when we tried our first formal usability tests and in the posttest interviews. Adaptation happened through full-context video. And identification came after the experiments: All of us seek a cognitive model of any technology—even if at an abstract level—before we're comfortable using it. Imagine if aliens landed on your doorstep, put a glass box in front of you, and insisted that anything you wanted would materialize in the box if you spelled its name in your mind backward a hundred times. How many of us would actually bother? To the subjects of our text-free UI experiments, we were those aliens.

We find that projects go through cycles of the five stages, with lots of iteration. Sometimes, many small realizations occur, each followed by minor adaptations. In other cases, what appears to be a straightforward problem actually presents a large false summit that we recognize as such very late in the process. Thus, being in a later stage doesn't necessarily mean being any closer to project "completion," but it's rare for a mature project not to have experienced most of the stages at least once.

Active TEM research projects are at various points in the five stages. And while there's always the danger of believing that a particular solution is an adaptation in response to a realization, when in fact it's only exuberance at an insufficient solution, we can nevertheless see how the stages unfold through examples.

MICROENTERPRISE

Jonathan Donner is a sociologist who looks at human communication and technologies that support communication. He's an expert in the use of mobile phones in developing countries, with experience, for example, in Rwanda, ranging from working

to develop an AIDS/HIV public-health information system to identifying the mix of business and personal use of mobile phones by entrepreneurs. In India, Jonathan led work that examined microenterprises and their information ecology (http://research.microsoft.com/~jdonner/micros.aspx).

For the purposes of this article, we define microenterprises as those businesses that employ fewer than five people. Although very diverse, they tend to be informal (not registered with the government), family owned, and poor on the whole. Typical microentrepreneurs might sell vegetables on the street, run a paper-scrap business, or own a shop that sells mobile phones. The ubiquity of microenterprises in the developing world is impressive, and the numbers generate wonder in themselves: There are an estimated 500 million microenterprises worldwide. This is surely a group that faces certain consistent challenges and could benefit from the right application of technology.

We were interested, however, in deeper questions regarding their information and communication needs. Jonathan augmented our less formal observations with a survey, designed to reveal and describe more about the way things are now for those businesses. By talking to more than 300 microentrepreneurs in two cities in India, he obtained additional information on the structure of their businesses' social and economic networks—specifically, how they first recruited and continued to interact with their customers. From this relatively short survey, patterns across 900 customers emerged.

Customers overwhelmingly preferred face-to-face communication. Every one of the 900 customers came to the business either through a referral or as a walk-in; advertising wasn't a big factor, nor was the telephone directory. The informality of interactions with customers was both reflective of and appropriate for the informality of the businesses themselves; further, the neighborhood-centric nature of many of these microenterprises made face-to-face communication the natural way to do business.

Thus, our research revealed some interesting facts about this group: At a high level, we see the importance of both face-to-face versus mediated interaction and communication-centric versus information storage and processing behaviors. These studies excite the innovator's wonder about how technology might support these activities.

MICROFINANCE

Microfinance—bringing financial services to the poor—has lately received considerable attention. The United Nations declared 2005 "the year of microcredit," and the following year Muhammad Yunus, the godfather of microfinance, won the Nobel Peace Prize. Aishwarya Ratan, who has degrees in economics and international development, has been looking at how technology might aid this vast, worldwide movement (http://research.microsoft.com/~aratan/FSD.htm).

First, the wonder: The earnings of poor households are small and volatile. Although strong social networks allow the poor to use numerous informal mechanisms to save, borrow, and invest money at low cost (www.uncdf.org/mfdl/readings/PoorMoney.pdf), they tend to have limited capacity to cater to the heavy ongoing demand for financial services, and finance options, if available at all, are often at interest rates exceeding 60 percent per annum.

Microfinance institutions have gained prominence over the past three decades as intermediary agencies that offer lower-cost financial services, primarily credit, to millions of poor clients, at interest rates usually around 24 to 36 percent per annum. MFIs implicitly rely on the physical and social proximity of group members to enable reliable peer monitoring and support, thereby ensuring more than 95 percent on-time repayment of loan installments.[1]

The neighborhood-centric nature of many microenterprises made face-to-face communication the natural way to do business.

Could we enable further reductions in the interest rates charged by MFIs through improvements in operational efficiency by lowering transaction costs? Initial discussions with a young, rapidly expanding urban MFI in Bangalore identified the process of acquiring new clients as open to cost reduction. We explored the use of a mobile-phone-based application that would let the MFI's field officers enter a new client's information electronically at the source and transmit this information via short message service (SMS) text messaging or General Packet Radio Service (GPRS) to the head office, which would verify the client's data and, upon approval, add it automatically to the back-end database. It seemed like a textbook case of IT-enabled efficiency gains. We were excited!

However, our financial viability assessment suggested caution. By eliminating paper forms and a redundant process of data entry, we halved the per-form processing cost from $0.46 to $0.20. Yet the technology investment in a mobile phone per field officer resulted in the system being able to recover only 44 percent of the up-front technology costs over six years, resulting in a net negative present value for the investment. And this wasn't an isolated instance. Other MFIs had ended similar experiments after the pilot phase due to minimal gains and high cost.[2,3]

Conversely, field studies with MFIs led by Aishwarya in rural Orissa and Tamil Nadu revealed how manual front-end data management channels linked to a backend PC-based database are often highly cost-effective in conduct-

ing efficient microfinance operations. This results from a combination of several factors: the low cost of labor, the low cost of manual data transport, and the high cost of technology, which must be distributed over many clients to be financially viable—even apart from requiring reliable power and connectivity infrastructure.

In this case, our initial exuberance was met with a sobering realization, based purely on a cost-efficiency analysis. We've since reified these insights into a costing spreadsheet that lets MFIs evaluate the interaction of various cost components as they plan front-end data-focused technology interventions in particular environments. Further, as an attempt at adaptation, we're currently exploring the possibility of streamlining both cash and data flows simultaneously through a single front-end device, across multiple financial product offerings and transaction tasks, along the lines of mobile-phone-enabled payment channels, which are gradually becoming available even in impoverished communities. Time will tell whether this also leads to exuberance.

SOCIAL ENTERPRISES

Social Enterprises (http://socialenterprises.spaces.live.com) is a research project that seeks to provide small start-up business opportunities to India's poor and homeless. SE was initiated by Paul Javid, a researcher whose formal background is in computer science. Having had previous experience with technology-based projects in rural education and microfinance, Paul was already well-versed in the need to transcend technology to impact the poor.

Wonder came to Paul on the streets of Calcutta: Throughout the day, the roads are crowded with those who share stories similar to Michael, 21, who begs for a living and sleeps underneath a crumbling shop overhang on Park Street. Like others, Michael is in search of employment and frequently asks passersby for opportunities. However, in a city of 14 million with more than 2,000 people per square kilometer (www.pon.nic.in/open/depts/ecostat/census/HOMEPAGE.HTM), such opportunities are rare. Due in great part to urban sprawl, jobs are becoming more competitive, harder to find, and available only to those with access to a decent education or a social network with members capable of mentoring them through the process of finding their first salaried job.[4] Meanwhile, beggars, street youth, prostitutes, and other poor in developing countries' urban agglomerations seem to be stuck in a "cycle of poverty."

SE exuberantly began with the goal to help Michael and his friends become self-employed in India's low-skilled urban job market as a shoe-shiner and later as a cycle-rickshaw operator. Paul started with some direct stabs at the problem through loans and even a donation of a cycle rickshaw, but he quickly found that in the absence of a mechanism to ensure proper use, Michael casually liquidated these in favor of cash for perishables: food and, worse, drugs. One lesson learned:

Figure 2. A knife sharpener, and potential Social Enterprises mentor, on the streets of Calcutta.

We needed to work with partners who could provide a social scaffolding to both identify and check up on prospective clients of our efforts. We therefore partnered with several local nonprofit organizations that identified with our goals.

Other realizations ensued. Over time we learned that if SE is to successfully help poor job-seeking youth bridge the employment gap, we must focus on connecting them to larger socio-entrepreneurial networks. For example, while working with one nonprofit whose target youth members live and work in train stations in Malda, a city seven hours outside of Calcutta, we learned that they're unaware of the business opportunities that exist in the city proper, being generally afraid to venture there. But they're hard working—some labor 14-hour days, seven days a week, and they're flexible entrepreneurs by necessity.

Our current vision for SE is to digitally record live training sessions between local "mentor" entrepreneurs (see Figure 2) and "apprentice" job-seeking youth and distribute these to local nonprofits in Calcutta. Nonprofits would then use the system to teach relevant livelihood skills to jobless or unsalaried youth via workshops in which a mediator would periodically pause the video and engage the students in various activities based on what they viewed. SE also aims to connect such youth to a distributed online network of mentors and donors who could finance the first stage of their intended start-up venture: a combination of YouTube, Kiva.org, and Facebook built for an urban developing-world context.

We're now attempting to connect Malda's train-station youth with city-based mentors who can provide them relevant management and vocational skills and walk them through the basics of setting up their own small enterprise in the city. One thing is certain: We'll achieve additional realizations to which we must adapt as we go forward.

WARANA UNWIRED

In 1998, the state of Maharashtra, together with India's central government, proposed providing farmers in a sugarcane cooperative in the Warana district with access to information technology (www.mah.nic.in/warana/#About%20Wired%20Villages). The $500,000 project, billed as Asia's first attempt to "bridge the digital divide," placed Internet-enabled PC kiosks in the district's rural villages to connect farmers to agricultural information, provide access to telemedicine, and enable distance learning.

In the summer of 2005, Rajesh Veeraraghavan spent two months in Warana talking to farmers, co-op employees, and kiosk operators. He found that the project, at least as conceived, was all exuberance; farmers weren't using the Internet, and none of the far-reaching goals was close to being realized. The reasons were deep and systemic, having to do with farmer indifference, literacy levels, lack of online content in the native language, insufficient funds for software development, poor connectivity infrastructure (the kiosks all ran off a dial-up lucky to get 4 Kbps of data), lack of qualified training staff, and so on. None of these issues could be readily solved.

By the time Rajesh arrived, the sugarcane co-op had gone through its own phases of realization and adaptation and had repurposed the kiosks for a more practical task: allowing the farmers to request and retrieve information about their own harvests from the co-op's main processing plant, which was tens of kilometers away from most of the villages.

Figure 3. A sugarcane-cooperative employee (left) helps a farmer query about his harvest using Warana Unwired's SMS-based system.

Figure 4. Rikin Gandhi videorecords a farming demonstration for Digital Green.

But they were running into yet another problem. The PCs were deteriorating and increasingly expensive to maintain. The PC kiosks themselves were often set up in fertilizer sheds and storage huts. The structures were dusty and the PC cables were frequently chewed up by rats. There was talk of dismantling the entire computer network because the cost of maintaining it outpaced the co-op's ability to pay for it.

Although Rajesh's initial mission was simply fact-finding, the engineer inside of him leaped at the chance to make a difference. The challenge was simple: How to make the existing system less expensive? The adaptation was equally simple: Replace the computer kiosks with a network of mobile phones. The realization was that, since the co-op wasn't using the PCs' high-end capacity anyway, such sophisticated, expensive technology was pointless when SMS text-messaging on very low-cost phones would transmit the desired data.

Thus, Warana has become home to yet another "first": Warana Unwired (http://research.microsoft.com/~rajeshv/warana.htm) is the first project of its kind to replace an existing PC-based system in a developing-world context with a mobile-phone-based system that transfers relevant data to farmers via SMS text messaging[5] (see Figure 3). In an eight-month trial involving seven villages, Warana Unwired successfully replicated the critical PC-based functionality with a system that proved to be less expensive, more convenient, and more popular with farmers than the previous PC-based system. The co-op is currently considering extending the project through the remaining villages.

The identification here is with the sugarcane cooperative, which ultimately wanted the least expensive, most efficient technology that reliably meets their desired objectives—a classic instance of IT making an existing system more efficient.

DIGITAL GREEN

The Indian government targeted farmers in the Warana Unwired project because the country is still primarily agrarian. More than 60 percent of the population relies on agriculture as a means of livelihood, and most of these people are marginal farmers who earn less than $2 a day and often lack the knowledge to improve their farm's productivity.[6]

In the Digital Green project (www.digitalgreen.org), Rikin Gandhi worked with Rajesh to address this knowledge gap by using video as a medium for improving the speed and effectiveness of disseminating information about better agricultural practices to farmers at a reasonable cost, as

Table 1. The stages of design in six Microsoft Research India projects.

Project	Wonder	Exuberance	Realization	Adaptation	Identification
Text-Free UI	1-2 billion illiterate people worldwide	UIs for nonliterate users	No cognitive model of computers	Full-context video	"Why should I trust the technology?"
Microenterprise	500 million global microenterprises value face-to-face interaction				
Microfinance	Financial services to more than 100 million people on the planet	Mobile phones to streamline loan-officer work	Microfinance cost-efficiency hard to beat		
Social Enterprises	100-200 million estimated "street children" in developing world	Online donation site helps them start businesses	Users likely to liquidate donations for short-term consumption	Video-mediated instruction and work with local nonprofits	
Warana Unwired	800 million marginal farmers around the world	Internet for farmers brings education, telemedicine, and agricultural knowledge	Farmers unable to use Internet in its standard form; high maintenance costs	SMS-based inventory query	IT solutions should fit the need and be cost-effective
Digital Green	100,000 extension officers for 100 million Indian farming families	Video for agriculture extension	No obvious place to screen videos; farmers don't seek expert advice	Mediated video sessions; videos of local farmers	"Farmer Idol"

shown in Figure 4. DG was inspired by a rural education project, Digital StudyHall (http://dsh.cs.washington.edu), which went through its own phases of exuberance, realization, and adaptation, and we built on top of that. Using an iterative approach that combined an ethnographic investigation of existing agriculture extension practices with prototyping of both technology and its use in a village context, we gradually acquired a better understanding of the problems of classical agriculture extension[7] itself as well as the challenges of using video as a medium in rural areas.

In its mature form, DG consists of locally produced videos of farmers adopting good agricultural practices along with screening sessions in which farmers gather to watch the videos in the presence of a mediator who frequently pauses the video and provokes discussion. It complements the government's system by involving extension officers as key elements of the videos and mediation. On a per-farmer basis, DG costs are actually lower than the classical, government-supported model. In our current evaluation with 20 villages over the past 10 months, we've found the system to be at least 10 times more effective, per dollar, than traditional methods in converting farmers to use better farming practices.

What's most interesting about DG are the insights we've gained about farmers, which have turned out to be nothing other than identification with what's common to people everywhere. For example, the farmers' interest in video depended strongly on the content. Videos of classroom-style lectures and large events were perceived to be monotonous, and the farmers often requested a variety of more intimate content types that included concrete demonstrations, testimonials, and even outright entertainment.

The mediator's effect during screening was also significant. In particular, playing back the video unattended, no matter the content, frequently resulted in audiences leaving well before it was over. Because mediators make the content active through reiteration of concepts between clips, questions to gauge interest, and announcements of follow-up visits and subsequent screenings, more of an audience remains engaged.

Another observation was the degree to which farmers trusted videos featuring people like themselves. They made snap judgments about a person's background, apparently based on language, clothing, and mannerisms, and were more inclined to trust videos featuring their neighbors than information from government experts. Sociologists suggest that people tend to absorb innovations through homophilous social networks—when they perceive themselves to be similar to one another.

Finally, perhaps the most interesting identification occurred when we saw just how much farmers delighted in seeing themselves "on TV." In fact, we lured some into adopting better farming practices simply with the promise that they would be in the next video. This turned out to be a powerful incentive in a world with limited financial opportunities, and it perhaps echoes the enduring popularity of *American Idol* and similar TV programs. We have come to joke that DG is, in fact, "Farmer Idol."

LESSONS LEARNED

Table 1 summarizes our experiences with the five

stages of design in these ICT4D research projects. Blank cells indicate that the project hasn't yet entered into those stages and is still in progress, at least as far as applicable innovation.

Unfortunately, knowing that we might go through five stages of design doesn't mean that any of them can be easily skipped. Jumping straight to "realization" might save us the trouble of the first two stages altogether, but that's hard to do without hindsight. In fact, while our prior experiences have saved us from some of the more blatant irrational exuberances, they never seem to grant all-around immunity.

If we can't easily skip steps, maybe we can at least pass through them more quickly. What, then, are the lessons we can draw that help us design practical systems in the future? We believe that three elements are critical for progress in ICT4D research: time in the field, honesty about what works, and willingness to accept simple technical solutions.

Time in the field

Perhaps the most critical factor is to spend time with potential users in those circumstances in which the innovation might take hold. Spend time early, spend time frequently, and spend a lot of time. Members of the TEM group bring different attitudes and approaches to their work, and there's little in common in our formal backgrounds. But we all agree that time spent with users "in the field" is more valuable than just about anything else. For most of us, the communities we hope to impact are so different from those we were raised in that our first instincts are of little help; to turn our "subjects" into collaborators or empowered potential users, it's imperative that we establish rapport.

As computer scientists, many of us are used to designing technologies for people a lot like ourselves—people who sit in air-conditioned offices and use desktop monitors all day. If we're to contribute to populations for whom "work" means manual labor, we must get out more. One of the mottos of rapid prototyping is to "fail early and fail often," and we couldn't agree more that this is an effective means of achieving realization.

Most of the research we undertake is in partnership with nonprofits who share our goals. For example, Text-Free UI involved Stree Jagruti Samiti, a woman's empowerment organization in Bangalore's urban slums. Warana Unwired is a joint effort with a sugarcane co-op. Digital Green takes not only time and inspiration, but also its name, from our partner organization, Green Foundation (www.greenconserv.com), which supports poor farming communities several hours outside of Bangalore. Our partners are essential in helping us gain access to the target communities—they frequently have years if not decades of experience working with the communities and have earned a degree of trust we couldn't hope to build in a short time.

Honesty about what works

Another key to success in ICT4D research is honesty about what really works. For us, whether a system "works" isn't merely a technical question. Does it make sense economically? As Aishwarya found when considering a mobile-phone solution for front-end microfinance, a great technical solution that doesn't lower costs significantly might not be worth undertaking. Can the system fit into the community's sociocultural fabric? In displaying schedule information for jobs using graphical clocks, Indrani discovered that Hindu communities expected time to flow from left to right, while Muslim communities assumed the reverse—even though the subjects weren't literate, they still associated the flow of time with their script's directionality. Are all stakeholders likely to be okay with the system? In the design of Digital Green, Rikin was careful to ensure that existing agriculture extension officers were a key part of the solution, not entities to be replaced by new technology.

For technology projects, it often helps to have critics around, and social scientists make particularly good critics—perhaps because they're rarely attached to technology the way that engineers are. For this reason, half of the members of our group are social scientists with backgrounds in economics, sociology, and anthropology.

Social scientists can also provide insight into making a technology fit into a larger, workable system. Based on Indrani's investigations into nonliterate technology users, we're beginning to examine the psychological components of illiteracy. For example, if, as we suspect, those with less formal education are more comfortable with narrative explanations than deductive logic, how does that impact the design of UIs for the nonliterate?

Acceptance of simple solutions

Finally, ICT4D researchers must be willing to accept simple solutions. This is often the most difficult thing for an engineer to accept. After years of upbringing and education rewarding creativity and technical accomplishment, it's hard to let go of the need to do something complex when a simple solution will do. Rajesh's switch from PC-based kiosks to mobile-phone-based kiosks remains a simple technical innovation, but an inordinately effective one.

We offer three points of consolation for those technologists seeking ingenuity in the battle against world poverty.

First, it's frequently the case that simple solutions are hidden from view until the very instant of invention. At the very least, we can revel in that moment of insight. For example, research into the use of video in training and instructional material is filled with studies of their impact

and content design. Not one study, however, suggests that these videos should include short movies of the broader application context as we did with full-context videos.

Second, creativity is often required in setting up a larger system in which the technology does its part. For Digital Green, we began by taking the technology—digital video—for granted. The true innovations were how to set up screenings, motivate farmers, and make the content as meaningful as possible. Though not technical innovations, the novel solutions to these questions are what make DG what it is.

Finally, as researchers, our ultimate hope is widescale impact. Consider what made the Internet accessible to a large audience: The browser is, at heart, nothing more than a collection of document-fetching and -viewing applications stitched together within a single UI. So technically simple, and yet, its impact on the world has been enormous. If we have to exchange technical complexity for impact, that's a trade we're willing to make every time. Unlike basic technology research in which invention itself is often the goal, ICT4D work is necessarily applied—it is, after all, for development. Thus, a stress on impact isn't just appropriate, it's the sine qua non of our research.

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