13 Ways of Looking at the Mobile Phone in Rural Marakaru, Kenya:

Social Science Insights into the Study of Technology

Hybrid Technologies Project Working Paper #3
by Laura L. Murphy, PhD

Illustration (Figure 1), to follow

This is the third working paper from the research project: "Hybrid Technologies in the Era of HIV and AIDS: The Hoe and the Mobile Phone in Rural Africa" (Murphy, PI).

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Author's Biosketch

The author, Laura Murphy, PhD, is Clinical Associate Professor in the Department of International Health and Development (with a joint appointment in the Stone Center for Latin American Studies) at Tulane University. She has worked on population, environment and development issues on three continents over two decades. After undergraduate training (a BS in Mechanical Engineering with a minor in Values, Technology, and Society) she worked with the Indonesian Environmental Forum, CIDA, WWF and other agencies in Jakarta (1983-1988). She administered Canadian government small project funds in Kenya (1988-1991). Graduate training in City and Regional Planning (Phd, 1998, UNC-Chapel Hill), involved research on agricultural colonization and deforestation in the Amazon (1992-2000). She then helped start the scholarly, international, internet resource www.populationenvironmentresearch.org . Now at Tulane University (since 2001) she teaches graduate courses on population-environment, development, the social impacts of AIDS, and applied social sciences for both public health and Latin American Studies. Her current research focuses on the implications of HIV/AIDS for rural livelihoods in Africa and the social shaping of technologies such as the mobile phone and kitchen gardens in Kenya. This research has been funded by the John D. and Catherine T. MacArthur Foundation (Research and Writing Grant) and the National Science Foundation (Science and Society Program).

Abstract

This paper surveys 13 academic ways of looking at the process, content and impacts of technology change for society, applied to the topic of mobile phones in rural Kenya, and how they are being adopted, used, and affecting lives. The objective of this working paper is two fold: (1) to communicate my ideas with colleagues, research assistants, and students; and (2) to work out ideas of my own towards formal academic publications. I would like to start a dialogue with other researchers interested in understanding these processes and welcome feedback.

These 13 lenses reflect the different academic and practical schools of thought about science, technology and society content, diffusion, adaptation, and impacts in and on "society" and development studies (modernization, human rights, human development). These lenses draw from the sociology of science, social history, economics, communications, feminist theory, cultural anthropology, human-centered product design, systems engineering, human-centered design, political ecology, and post-development scholarship. These varyingly emphasize the larger societal level (innovation, consolidation of technologies, social change, industrial forces in society) vs. the smaller personal level (practical use, barriers, design, ergonomics, as well as symbolic meaning and identity).

Multiple lenses provide insights that help us appreciate what "mobile phones" mean to rural Kenyans and the changes we might see in the village, larger region, and Kenyan society. The presence, prevalence, use, and implications of phones (as with AIDS medications or new crops) can be best understood as an endogenous component of complex processes of social change unique to the "developing" context of each African country. The mobile phone is now an integral part of this process, thus helping to shape the landscape of continued technological change.

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Thirteen Ways of Looking at a Blackbird

Wallace Stevens

I
Among twenty snowy mountains,
The only moving thing
Was the eye of the blackbird.

II
I was of three minds,
Like a tree
In which there are three blackbirds.

III
The blackbird whirled in the autumn winds.
It was a small part of the pantomime.

IV
A man and a woman
Are one.
A man and a woman and a blackbird
Are one.

V
I do not know which to prefer,
The beauty of inflections
Or the beauty of innuendoes,
The blackbird whistling
Or just after.

VI
Icicles filled the long window
With barbaric glass.
The shadow of the blackbird
Crossed it, to and fro.
The mood
Traced in the shadow
An indecipherable cause.

VII
O thin men of Haddam,
Why do you imagine golden birds?
Do you not see how the blackbird
Walks around the feet
Of the women about you?

VIII
I know noble accents
And lucid, inescapable rhythms;
But I know, too,
That the blackbird is involved
In what I know.

IX
When the blackbird flew out of sight,
It marked the edge
Of one of many circles.

X
At the sight of blackbirds
Flying in a green light,
Even the bawds of euphony
Would cry out sharply.

XI
He rode over Connecticut
In a glass coach.
Once, a fear pierced him,
In that he mistook
The shadow of his equipage
For blackbirds.

XII
The river is moving.
The blackbird must be flying.

XIII
It was evening all afternoon.
It was snowing
And it was going to snow.
The blackbird sat
In the cedar-limbs.

Part I. Introduction

What is a "mobile phone" when it is neither mobile, nor even at times a reliable telephone? What do these devices really mean to rural Kenyan men, women who lack maize seeds to plant, much less electricity, computers, and telephone landlines? How do phone uses vary for men, women, youth, and elderly? They make a living from tilling the soil with a handhoe—what possible use is this luxury consumer device? People who don't have much cash choose to purchase airtime just to "stay in touch": how can we account for that? How is HIV/AIDS, the pandemic reshaping African societies, driving or mediating the adoption of mobile phones and its impacts on rural, agrarian communities? What might be the implications of these personal, portable and increasingly ubiquitous digital devices for Kenyan society in coming decades?

These questions are among the larger theoretically informed, empirical topics of my research project. The original research questions listed in my February 2006 proposal to the NSF were oriented towards appreciating how novel, complex mobile phones and old-fashioned, simple hoes (gardening and farming) evolve as a "hybrid technology" for livelihoods.

I originally asked: "How are local and global technologies converging and being adapted by rural AIDS-affected communities? How are the hoe and mobile phones being used and changing the use of the other, and becoming integral parts of new rural livelihood strategies among HIV and AIDS affected? How does HIV/AIDS influence these technology changes? What are useful entry-points for external actors to influence technology uptake and adaptation in ways that enhance human capabilities?" (See endnote 1 for the full questions, and Murphy, 2007a, 2007b, 2008 for some partial, preliminary answers.)

To help reach more informed answers to these and other questions, this paper surveys several lenses for viewing technology change. This paper lays out 13 such academic lenses and applies each briefly to the general topic: how mobile phones are being adopted, used, and affecting lives in rural sub-Saharan Africa. (See Table 3, page 24, for a summary of the 13). I identify some key principles, scholars and authors, provide examples. I suggest how they influence the way we think about innovation, relevant actors, and what constitutes technology in a "Sub-Saharan African" study site.

These "13 ways of looking" reflect the different approaches to studying science and technology: innovation, content, diffusion, adaptation, and impacts in and on "society". These lenses draw from sociology of science, social history, economics, communications, feminist theory, cultural anthropology, systems engineering, human-centered design, and political ecology. These disciplines tend to place different emphases on the societal level (innovation, consolidation of technologies, social change, industrial forces in society) vs. the personal (practical use, barriers, design ergonomics, as well as symbolic meaning and identity).

These 13 ways also reflect insights from the field of development studies, since my gaze centers on technology change in sub-Saharan Africa, a disparate, large geographic area characterized by chronic income poverty. It remains the arena of intentional, planned social, technical and economic change under the auspices of "development". I thus draw from theories about economic growth and human and social development spanning the decades from post-WWII modernization to appropriate technology to human rights and the Capabilities Approach, as well as critical (Foucaultian and Habermasian) post-development schools. These lenses are not commonly brought into US-based academic studies of "technology and society" but are relevant for this project.

Why 13? This paper could have listed 3 or 8 or 18. I acknowledge the influence of an article by James Nations and others (1999) on "13 ways of looking at" the sub-tropical forest of northern Guatemala, integrating biological, social/anthropological and economic perspectives on nature and deforestation. This article in turn was inspired by other authors and the original Wallace Stevens poem printed above. I chose these 13, rather

than another 13, because they are distinctive, complementary, and have been influential in my conceptualization of this study in Kenya.

For lack of time, this list leaves out narrowly ethical perspectives, such as debates around the morality of rationing of scarce technologies, or more deeply philosophically grounded reflections on the significance of biotechnologies such as transgenic species for society. Human rights, however, does enter the list: the "right to information and communication technologies" is included in #6 on capabilities and human development. The order reflects roughly chronological progression from older schools of thought focusing on long-term history to contemporary insights.

The objective of this working paper is two fold: (1) to communicate my ideas with colleagues, research assistants, and students; and (2) to work out ideas of my own towards academic publications. I would like to start a dialogue with other researchers interested in understanding these processes and welcome feedback and questions.

Background to the study

The languid red-plaid-draped Masai pastoralists of Safaricom advertisements, the industrious small-farmers of Kenya with their sacks of maize, the ambitious tycoons of global cities of Nairobi (or Mumbai, Shanghai or Lima) --these are among the diverse new mobile phone adopters around the world. We hear almost daily how these consumers buy and use mobile phones: evidently, they are growing their economies, finding new market niches, and changing the course of elections and disaster responses. Such reports are based on a few economic studies or anecdotal observations, which pepper the BBC, Guardian, and NY Times and circulate through cybernews channels. Yet, little rigorous and observational field research can tell us about what, how and why mobile phones are actually being used, and not used, by ordinary people in the developing world. We do not know what wide-ranging impacts these devices might have on households, communities, and lives, as well as economies and market transactions. (Note: There are a few anthropological and sociological studies, but little on Africa. A thorough, critical review of the academic and journalistic literature on mobile phones in the developing world is the subject of the next project working paper.)

This paper reflects on these 13 different ways of thinking about how "the mobile phone" is being received and use in a single Kenyan village, where life is still visibly dominated by hand labor in maize fields, gardens, and pastures. Reliance on bimodal rains engenders chronic vulnerability, mitigated by migratory work for cash.

Project fieldwork in a Bukusu-speaking village in Bungoma District 2007 (Endnote 2) documented all households, their livelihood activities, and technologies (farm tools, garden crops, and the mobile phone). A census of the village was complemented by in-depth individual interviews and group interviews with mobile phone owners, village elders (about the history of the village) and HIV/AIDS affected individuals (Endnote 3). Most of these data on phones are summarized in two earlier working papers (Murphy 2007a:summarizes the census data, while Murphy 2007b interprets transcripts of interviews with individual users. Information about changes in kitchen gardens with HIV/AIDS is published in Murphy, 2008.)

The Study Site: Bungoma District, Kenya

The village, located in northern Bungoma District, Western Kenya, lies on the foothills of Mt. Elgon at an elevation of 4000 feet. The first Bukusu-speaking clans to settle here in the 18th Century lived in fortified (mud and timber) compounds. Based on the project census, the current population is now about 5200 people in nearly 900 households, reflecting natural population growth, especially rapid since World War II, and more recently, in-migration. Education levels are low (primary school) and housing simple mud walls and thatch roof (for most: a few have cement block homes with glass windows). Like most Kenyan villages, the site lacks electricity and paved roads. The village also lacks

Kenya TelKom landline or community-managed wireless public phone ("simu ya jamii"). The nearest public phone (wireless simu ya jamii) is found in Mayanja, a one hour walk, and/or 20 Ksh bus fare. The nearest landline is in Chwele, a walk plus Ksh 40 fare round-trip. The nearest health facility is seven kilometers away, a one-hour walk.

Livelihoods are dominated by own-farm production of cash and food crops: maize, beans, sweet potatoes, cassava, yams, tomatoes, kales, onions, and local green vegetables and fruits. Coffee, tobacco, and sunflower are principally cash crops. Cattle used to be more common, but herds are small now. Farm activities and income are supplemented by casual wage work (at US$2-3/day) the sale of home-made products, small businesses, trading, remittances, donations, and exchanges of labor or services and goods.

The village has three (overflowing) primary schools, three small market centers comprised of simple kiosks, grain mills, and beer-halls. Water comes from one functioning borehole (built mid-1990s), seven public wells, seasonal springs and a small stream. Over 20 distinct community organizations include self-help groups, church associations, and HIV/AIDS support groups. Residents rely on lay home-based care workers, traditional birth attendants and herbalists/traditional healers, and community-based support groups.

HIV arrived in the village in the 1990s, and by now HIV/AIDS is estimated to have cumulatively, over the years, affected about 15-20% of households: i.e., someone is currently infected, has experienced "chronic illness" lasting over a month, is on anti-retroviral therapy, died due to AIDS, or is burdened by care for AIDS-related orphans. (see endnote 2: This is not a measure of current adult infections, a rate which is bound to be much lower. (Endnote 3) The original study design called for appreciating the role of HIV/AIDS in shaping mobile phone and hoe use (i.e., for field crops and kitchen gardens). These are topics investigated through analyzing village survey data (Murphy 2007a), in-depth and group interviews (Murphy 2007b), and tracking individual, AIDS-affected gardeners in the village over time (Murphy 2008).

Trajectory of Technology Change in the Study Village

The mobile phone, while remarkable and photogenic, is simply the most recent of centuries of "new" technologies and social innovations arriving in this evidently still somewhat "traditional" village, where Bukusu is the dominant language, polygyny is still found, land inheritance and division is often customary, religion is syncretic, many indigenous crops still grown, and male circumcision is still performed at home on teenage boys. Table 1 presents a timeline of village context, livelihoods, and technology change in the study village.

Since the early 17th century, with various African, Portuguese and later British colonial influences, new technologies have been arriving and being adopted, tried and rejected (cotton, tobacco at least—others not known) and absorbed. The notion of "hybrid" technologies in the project proposal (Murphy, 2005) appreciates that these people have been integrating indigenous and exogenous knowledge and artifacts for generations. Portuguese exploration brought maize, now the staple food and cash crop, from the Americas. The most recent modern adoption is anti-retroviral therapy (ART) brought via US PEPFAR-funded health programs.

Table 1. Timeline of Technology Change in Marakaru Sub-Location (Kenya) Study Village

Era	Village context	Technologies in Use	New Technologies
18th – 19th Centuries	A few large extended households (clans) live in widely dispersed fortified compounds, cattle raising, shifting cultivation	Women managed gardens, indigenous plants using cow dung fertilizer. Metal axes and hoe-heads made by local blacksmiths from local ores. Fuelwood for cooking on three stone fire with clay pots, gourds. Mud and thatch huts. Hides and skins. Water from streams and springs.	Crops and livestock inter-breeding (East African varieties). Bananas, sweet potato and maize arrive from outside. Biomass, fuel, fiber locally produced.
1900-1950	Wage work and migration (mostly males) to pay poll tax. Salvation Army, Quaker, Colonial authorities arrive. Enclosure of lands by British authorities to rationalize land use.	Mixed farming of indigenous plants (millet, sorghum) and maize, tomatoes, onions on more permanent plots. Still dominant pastureland and cattle herds. Sisal rope (?). Charcoal production for towns.	Maize varieties (scientific, from SA & Zim). Manufactured hoe. Tailored Clothing. European vegetables, "Irish" potatoes. Cotton, coffee (cash crops). Motorized vehicles in region. Foreign technical advisors. Bicycles. Donkey carts. Kabuchai health center.
1950s-1980s	Trucking (Mombasa to Uganda, interior) and sugar industry grow. Population growth. Bungoma town established with new District (1950s); Development, Public Health and Family planning projects	Increasing commercialization of produce, deforestation for tobacco and charcoal to sell. More emphasis on formal schooling. Children (girls) less available to help on farm, gardens. Men plough fields, work for wages; women weed with hoe	Male condoms (with family planning programs). Tin ("mabati") roofs. Paved roads. More improved maize varieties. Tobacco (cash crop). "Victory" plough from Europeans in Kitale. Commercial fertilizer, chemical herbicides. Telephone in Bungoma town.
1980s	Structural adjustment policies reduce agricultural & social services; Land fragmentation accelerating	Increasing commercialization, survival strategies based on resource extraction and wage work; Neglect of native greens	More maize varieties. 1-2 vehicles owned in village Television.
1990s	El Nino rains (1997) destroy roads, fields, cause hunger; In-migration from densely settled areas. AIDS arrives in village (~1994); Government response to HIV/AIDS intensifies.	Mixed subsistence and commercial farming on smaller plots. Gardens cultivated by men and women for cash, food. Ox-Ploughing and hand-hoe. Plastic jerrycans for water. Cook with aluminum pots.	Borehole (Finnish aid). Computers in Bungoma town. Electricity along main highway. Solar panels (few households).
2000 – 2007	NGOs established in Bungoma for HIV/AIDS, sustainable agriculture (include ACE-Africa in 2003, World Vision, Sacred Africa). Local "OVC" & Widow Group (2001), HIV/AIDS Support group (2002)	Improved kitchen gardens are now growing cassava, banana, local sweet potatoes, improved sweet potatoes, soya, ground nuts, fruits, and indigenous leafy and medicinal plants Agriculture and Nutrition training given to local residents. Support for herbal remedies.	"VCT" (2004). "ART" (2004), Free ART (2006) through "PEPFAR"-funded programs. Mobile Phone (2001) Cellphone masts (2005) New Kenyan (KARI) sweet potato varieties.

Notes:

1. Marakaru Sub-Location encompasses the smaller village study site in Bungoma District, Western Kenya.
2. Acronyms used:
   - ART: Antiretroviral Therapy
   - VCT: Voluntary Counseling and Testing
   - PEPFAR: Presidents Emergency Fund for AIDS Relief (US Government)
   - KARI: Kenya Agricultural Research Institute
   - OVC: Orphans and Vulnerable Children
   - ACE: Action in the Community Environment, Africa (www.ace-africa.org)
   - NGO: Non-governmental organization
   - CBO: community-based organization

New technologies have made the community increasingly dependent on external sources of seeds, spare-parts, fertilizer, tin roofing (as native thatch disappears), plastic containers, machine stitched school uniforms, Bic pens, and more. Now add: mainline or diesel generator-produced electricity for charging phone batteries, only found in market towns, along with the actual scratch cards, SIM cards and handsets to operate the most rapidly spreading technology yet known, the mobile phone (*simu ya mkono* in Swahili).

Two working papers (Murphy 2007a, 2007b) summarize findings from interviews and census (visits with every household in the study catchment area of about 15 sq km). Phones were owned by only 15% of households (or 7% of residents by population). They collectively owned over 200 different mobile phone handsets. Their ownership since 2000 actually predate the physical presence of the cellphone masts necessary for their use in the village. Cellphone signal arrived in the area in 2005 (with Kencel, the company bought by what is now Celtel). Cellular signal access has improved steadily since then as towers are visibly spreading through the countryside.

In the Marakaru study site, the mobile is often the only telephone being used; its mobility seems secondary. Voice is more useful and appreciated than text messaging. Rural households use phones for personal, community and work/farm-related activities. The boundaries between strictly "economic" and family, social and other activities are not distinct. Convenience and time-saving are top benefits to phone owners, and the high purchase and running costs the most common complaints. Non-phone owners would generally like to have mobile phones, but lack cash: it is the relatively high cost of a phone (rather than dislike, worries about abuse, or disinterest) that is the over-riding barrier. A number of users, particularly older women, had never seen or made a mobile phone call by the time of the study. At the same time, one (professional) household was accessing the internet through their GPRS-enabled high-end Nokia.

These differences in ownership and use in the village roughly parallel differences within Kenyan society, although penetration rates are lower than for Kenya (based on subscribers) of 33%. This global aggregate disguises the distinct urban bias of ownership. In urban areas, many users own more than one line and handset.

The mobile phone in this "traditional" village is both alike, and different from, other technologies that have been introduced over the centuries into Bukusu-speaking (Luhya) communities. The "mobile" is alike, but different from, "cellular phones" that we depend on yet also loathe and need to control, in our affluent, urban industrialized cities. The "mobile phone" has modest visible impacts so far in a single village as a whole; yet the devices are profoundly important to users. They remark on the sense of freedom, independence, and peace of mind it brings. It is likely changing lives in the village, and eventually Kenyan society, in profound ways, but How? Why? Is this good or bad or a little of both?

Part II. 13 Ways of Looking at Technology

1. Technological determinism (US, 19th – 20th Century)

Technology is a driving force of history (Smith and Marx, 1995) with a momentum which inevitably brings long-term social changes. The printing press, say some historians, promoted literacy and lead to the Protestant Reformation in 16-17Th Century Europe. Mechanical instrumentation led to exploration of the New World by Continental European explorers, with world-shattering results. Mechanized agriculture inevitably displaced labor who migrated to the northern US states (19th-20th Centuries), reshaping race and class politics. Images of these powerful, mythical machines are represented in Currier and Ives lithographs of the 19th century.

Critics highlight the negative impacts of industrial transformations of the landscape (noted by Lewis Mumford from the 1930s), the environment, women, and the poor (critics of modernization, such as the sustainable development movement of the 1980s). Academically this scholarly movement has been displaced by the more nuanced and flexible model of the social construction (or shaping) of technology (see number 10 below). Technological determinism's emphasis on the powerful role of new technologies in reforming society is seeing a comeback, however (Schroeder, 2007).

The mobile phone is seen as the inevitable outcome of innovations in computers and other machines driving societies into the post-industrial Information Age and the transformation from traditional agrarian to modern, machine and computer-based capitalist economies. Just like the printing press spread the bible and promoted reformist thought, the mobile phone eases communication of ideas, money and data. It transforms rural agrarian Africa into modern, globalized market-based economy with secular, individualistic values. This process has an unstoppable momentum, is an inevitably positive process for good. Methodologically, this approach calls for the long-term, societal level perspective of social historians. From this point of view, the possible implications of mobile phones as always on, connecting devices will not be fully visible for decades.

2. Technology for Modernization (Development Economics, US, mid-20th C)

US economist Walter Rostow's landmark "Stages of Growth" for developing poor economies was published as a Non-Communist Manifesto in 1960, epitomizing the mid-20th Century American hubris and faith in capitalism, modern technology, Western values, and the application of formal, Western, scientific knowledge. This scientific knowledge was applied through presumably benign, non-political, rational engineering, planning, and industrial (large-scale, systematized) manufacturing. Advanced (Western) machines, chemicals, fossil fuel energy, industrial process, and biomedical diagnoses and drugs were assumed to be necessary to lift the developing world out of its technologically backward and culturally, socially and economically hierarchical morass –visible in chronic poverty, low productivity and blamed on communitarian and traditional norms. Technology was needed to provide the impetus to mechanize, modernize as well as to urbanize, educate, and make more mobile and market-oriented the nations of Africa, Latin America and Asia. Technology could transform them from low-productivity subsistence agricultural communities into efficient, stratified, secular, civilized places. Technology **transfer from** West to South could accelerate this process of getting countries to the 'take-off' stage. This job became the respected work of government, non-governmental and technical assistance agencies involved in international development. Donors, governments and technical assistance aid agencies were to provide the missing elements of built infrastructure and services (government, education, banking) needed to guide this process of modernization.

The 1950s and 1960s saw the "Green Revolution" increase yields in agriculture through applying modern agronomic science to plant breeding, irrigation, fertilizers and

chemical pesticides and mono-cropped grains. Similarly, (Western) digital technologies can connect farmers and manufacturers to global markets, knowledge, and democratic governance. Modern digital communication devices can help transform sub-Saharan societies from agrarian livelihoods to post-industrial knowledge-based industries and livelihoods (Non-traditional agricultural exports, i.e., niche coffee). The mobile phone is thus part of the modernizing infrastructure that will help the take-off. This mindset is still apparent in the rhetoric of US economist Jeffrey Sachs (Sachs, 2006). Others tout the amazing benefits of mobile phones for leading an inevitable transformation of rural lives out of poverty. (sources: Guardian, other news sources reporting on the MDG and the Nokia/Celtel internet project for Millennium Villages).

Unfortunately, the Green Revolution exacerbated inequalities in land and wealth distribution and market access, and undermined indigenous farming systems (tuber, native greens and indigenous grains). It also had environmental harm: reducing diversity, polluting the waters, and salting the soil (through over irrigation). Similarly, high expectations for mobile phones might disappoint. As an approach to poverty alleviation, the approach has been criticized by feminist, environmentalist and post-modern scholars who value local knowledge, protecting the environment, and participatory processes. The model is an artifact of a cold-war anti-communist ideology, although still influential in thinking about the actions of international development (including public health) actors. Furthermore, this conventional model of "technology transfer=modernization" is problematic for appreciating how the mobile phone is changing rural lives in Africa. The mobile phone industry has spread widely through private sector initiative, down to the construction of towers, delivery and pricing of handsets, and provisions of accessories. Government and external development agency (donor and technical) assistance is recent, and government taxes considered a barrier (inhibiting uptake). Over time, we might find that the capitalist, market-oriented, technologically-based "modernization" approach might ironically be a relevant framework for economic growth, structural change, and the assessment of large–scale, historical trends, but it is not useful in the short run at the level of local, adaptive uses by individuals.

3. Technology Change as the Diffusion of Innovations (US, 1960s→)

The communications scholar and researcher Everett Rogers introduced this model in the 1960s, which became the dominant paradigm for the adoption of innovations, both social and technological. his focus was on the adoption process: Who, Why, When, Why, and (less importantly), Why not?

Individuals are seen as more or less receptive to new ideas, varying along a now widely accepted spectrum from "innovator" to "early adopter" all the way to the technologically hesitant "laggard". Not only the users but the technologies have characteristics that can be classified and understood anywhere. The framework can appreciate the role of the messenger of "innovations" in affecting the potential adopters' perception of the technology, whether it be water-boiling (in a classic example in Rogers, 199X) or HIV prevention methods such as behavior changes or the condom (Bertrand, 2004) or the mobile phone. "Traditional" norms (conservative, risk-averse) are generally perceived to be barriers to adoption of new ideas. The model is useful because it captures attributes of new technologies that do help explain and predict differences in uptake in the village. Furthermore, the model suggests that diffusion occurs in a social setting and that the messenger matters: a few charismatic and influential people can affect change in a large region.

Technology adoption can be explained by reference to concepts such as the perceived "relative advantage" to any individual adopter. Table 2 summarizes these characteristics for three technologies of interest in rural Kenya: "kitchen" or home gardens cultivating herbs, vegetables, fruits, grains and tubers for the household; the mobile phone, and (conventional PC computer) internet, accessed through a tele-center or "internet café" in a nearby urban center (in this case: Bungoma town).

From the vantage point of the users, the perceived advantages of the mobile phone are significant. It is not too complex, relatively easy to try out, and easy to see results right away (i.e., making a phone call). Kitchen gardens are similarly accessible and relevant to people whose lives revolve around the land and agriculture. Conventional internet, however, offers often irrelevant content (much of it Western, urban, consumer-oriented). Internet, even email, is inconvenient, complex, and logistically difficult to access in relatively expensive, private internet cafes in towns with 9-6 hours. Kenyan post offices around the country boasted "free" internet access to the public starting in mid-2005, but this public service was withdrawn by 2006. Evidently, someone forgot to pay the phone bill (to the satellite ISP).

Table 2. Attributes of Three Technologies (from Diffusion of Innovations: E. Rogers)

Attribute	**Kitchen Gardens**	**Mobile Phone**	**Internet (telecenters)**
1. Relative Advantage	High: Cheap and diverse source of food	High: no alternative for voice or text, cheaper than walking or bus	Low: content not perceived as relevant given costs, remote location in towns, restricted hours
2. Compatibility	High: Good fit except for some crops and techniques	High: no cultural barriers and meets a clear need	Low: Neutral, uncomfortable, requires literacy
3. Complexity	modest: intensive gardens require some new tasks & knowledge	Modest to high: Complex system and costly, requiring some training, but some uses are easy	Highly complex system which requires electricity, computers and phone lines, special knowledge. Of increasing interest to youth
4. Trialability	High: Users can easily try and adapt any component (technique, crop) step-by-step without. Lots of local demonstration sites	High: Mobile phones can be rented in shops, borrowed, seen in use in the village and in towns	Low: Expensive and hard to find in rural districts, although increasing in visibility
5. Observability	Moderate: Users can observe many results in the short term (months/ a season)	High: Results often immediate, faster than alternatives (i.e., foot, bus, "snail mail")	Moderate: Information retrieval faster than mail, post, print , but often fails

Weaknesses of the DOI model include the over-emphasis on the initial adoption stage, neglecting the dynamic process of eventual adaptation, rejection, and/or re-adoption. The model has little to say about the origins of innovations, assuming they come from outside the social setting under study and are generally positive. The model has little to say about the potentially mixed benefits and larger societal significance of a new technology on class, poverty, identity, and quality of life; as well as negative income and environmental impacts. The technology "content" itself is thus not contested: a new maize variety or the phone is what it is, i.e., an inevitably ingenious innovation, a solution to a practical problem and not a marker of modernity, source of hegemonic western oppression, shackler to modern commercial enterprises (Monsanto and GM) or destroyer of indigenous ways of life.

4. Appropriate Technology (AT) and the Intermediate Technology (IT) Movement (UK, 1960s, US, 1970s)

Modernization approaches of development (integrated rural development, basic needs, the Green Revolution) led to many imported Western technologies and then

graveyards of heavy equipment, abandoned laboratories, broken water pumps. Devices and machines lacked the needed, imported spare parts, inputs (i.e., lack of basic electricity or fuel supply), cash (for purchased parts and inputs) and expertise. This led to a search for technologies that are "cheap, simple, and non-violent" (Schumacher, 1975, page X), where ordinary rural and/or poor people can appreciate and use the technology in ways that make sense to them and the local economy) and which they can produce, use and maintain with their own resources. The Appropriate Technology (AT) movement in the US and the Intermediate Technology (IT) movement in the UK and Europe believed that the appropriate technology, rather than western high-technology, could lift people out of poverty, improve food security, generate income, provide decent shelter, etc. Technicians and extension agents promoted fuel-saving stoves, local construction techniques, bicycle transport, and other simple, low-tech options. "Technology" according to the practical AT/IT school is not applied formal science, but more broadly, "the science and art of getting things done" in terms of local concerns, needs and priorities.

E.F. Schumacher (*Small is Beautiful, 1976),* founder of the British NGO Intermediate Technology (now Practical Action, www.practicalaction.org) is the primary intellectual influence on this diverse social movement. Robert Chambers writing in the 1980s and 1990s (*Putting the Last First*) is another famous author, known for criticizing the conventional Modernization, technology transfer model and the work of international "experts". Other writers in this vein are Ian Smillie (*Mastering the Machine*). ITDG press still publishes monographs, books and reports on practical devices and solutions (i.e., Gamser, et al 2001).

The technicians and experts of ITDG and other NGOs were mostly Western trained male engineers and technicians. The AT/IT school and practitioners have thus been criticized for ironically, demeaning traditional knowledge systems by inserting affluent international (often male) experts into the role of designers of "appropriate technology" for (Crewe and Harrison, 1999), and privileging male technical, hardware solutions. Women's technologies are often seen as mere "cultural practices" (i.e., cooking, healing and food preservation) not worthy of attention. The Sustainable Livelihoods model promoted by british Aid and NGOs (www.livelihoods.org) is a legacy, building on local assets and survival strategies, reflecting fundamental values of the AT/IT school.

To the early AT movement, the mobile phone, like many other western innovations, would have been seen as another unnecessarily complex, expensive and irrelevant gadget too dependent on imported, expensive, foreign technology; too delicate to tolerate rough rural conditions; and too reliant on non-existent electrical infrastructure. The AT school emphasized "local" to the exclusion of international, global markets and networks, and thus would not be able to accommodate to the scale of diffusion and transformation as well the communication benefits across distances.

The AT/IT school could, however, appreciate (and expect) the ingenuity of individual entrepreneurs and self-taught technicians who craft the phone handset repairs, accessories, and battery charging kiosks visible in market towns throughout rural and peri-urban (=slum or shantytown) Africa--often out of recycled roofing material, spare parts, car batteries, and a poached electrical line. Practical Action (www.practicalaction.org) promotes "ICT4D" (= "Information and Communication Technologies For Development"), including internet centers and complementary rural charging and micro-electrification schemes, which would support rural adaptive uses of mobile phones. A logical extension would be local recycling/trade in of handsets, decentralized cellphone networks, and village phones. These are predominantly technical and design interventions, rather than social or cultural innovations. The influences of AT/IT investments in local technology persist, adapting to the realities of globalization and the digital world.

5. Indigenous Knowledge Systems (IKS) (US, UK, EU, 1980s)

Technology is not the results of modern science, but practical "know-how" or knowledge systems about food production, shelter, health care, tools, navigation, ways of

life, and ways of being in the world (worldviews). Indigenous, "traditional" developing country as well as first-world (Native American) groups have this valuable knowledge: it belongs to agricultural, pastoral, and hunter-gatherer communities who have long-established, locally relevant systems of knowledge for food, health, shelter and spiritual practices. These forms of knowledge and know-how serve functional and symbolic purposes (the two often cannot be separated out as is the case for Western science and technology). This knowledge is part of a social system that is handed down through generations and helps form a holistic, integrated, indigenous world view distinctive from western, elite, individualistic, modern, secular, urban worldviews.

This knowledge is sophisticated: it might be possessed by elite healers (i.e., Shamans or medicine men), can rival western scientific classification schemes (see Peter Worsley's book *Knowledges* on Australian aboriginal classifications of plants), or be a subtle, less visible element of "traditional cultures". This domain is appreciated by the interdisciplinary, growing academic field of ethnobotany. Ethnobotany and indigenous plant knowledge is gaining mainstream respect. Other valuable aspects of indigenous knowledge systems are more often dismissed as "cultural practices" of women and even "cultural barriers" to development: this includes food preparation, reproduction, and child care.

Scholarship in this vein: Paul Richards (1985) highlights the rich knowledge of indigenous farming and land management systems in western Africa; anthropologists James Fairhead and Melissa Leach (1996?) reveal profound misunderstandings of the causes of deforestation by conventional geographers; Arturo Escobar (1995) revalues knowledge systems of Colombian indigenous communities around land and useful plants, knowledge which is important in driving forest conservation movements. Environmental historian William Denevan revealed sophisticated land management technologies (involving knowledge and practical tools) of ancient civilizations of the Andes and Amazon, helping to revise understandings of "pristine" nature. Mark Plotkin has studied Shamans and their traditional healing practices and indigenous knowledge of plants, as well as helped map these Amazonian tribes detailed geographical knowledge of their forest/land (world) to help enforce their land rights with the Brazilian government. Josep Gari (2004) has recently highlighted the value of indigenous agro-ecological knowledge in selected Tanzanian and Ugandan ethnic groups that he deems useful for promoting food security, local health care, and livelihoods; and which are possibly threatened by the impacts of death and illness related to HIV/AIDS.

Indigenous knowledge systems have become somewhat trendy but the term seems to be misused (i.e., the World Bank's Indigenous knowledge website pages on HIV/AIDS refers to the Ugandan government response to HIV/AIDS involving abstinence and partner reduction as "indigenous knowledge"). Owing to recognition from anthropological studies, mostly and the potential profit in capturing the efficacious compounds in indigenous plants for medicine and genetic diversity of food crops.

Consequences for our thinking about technology change in rural Africa are diverse:

- We need to protect and conserve the wide range of indigenous knowledge systems as intrinsically valuable (like biological diversity) as well as instrumental for human well-being locally and globally. They can teach us how to produce "traditional" medicines, foods, and other goods while maintaining balance with the ecological system.
- Modern science can (and has) misunderstand the causes of social problems such as deforestation and suggest inappropriate policies. These can marginalize the communities and suppress or wipe out relevant local knowledge systems.
- Imagine rethinking sources of "poverty" or determinants of "health", and reinforce local knowledge systems that sustain local conceptions and solutions.

Applying this school of thought to the arrival of the mobile phone in western Kenyan Bukusu society:

- mobile phones might be irrelevant for many, if they cannot fit into the local knowledge system and do not provide locally useful functions;
- they might threaten local knowledge systems: they can be used by powerful, externally-oriented elites (wealth politicians, businessmen, transnationals, big pharma) to further marginalize traditional practices already displaced by western religions and values (i.e., "traditional healers" have already become labeled and feared as witches.)
- furthermore, the mobile phone and associations with worldly influences might bring dramatic social changes that can threaten the continuity of knowledge systems and their relevance to youth, thus undermining diversity of knowledge and values.
- Conversely, phones and digital communications (data, SMS, MMS, internet) might be beneficially integrated into and used to enhance, enrich and preserve traditional knowledge systems; used to promote knowledge sharing and transmission. (i.e., Phones could facilitate organizations of traditional healers, gardeners, and organic farmers who can preserve threatened plants, lands and practices.)

The ethical imperative is that we should appreciate, seek out, and document diverse local knowledge systems (for communication, information management, food, health, land management). These will likely change, if not be lost, with the spread of mobile voice and data communications as part of on-going globalization and integration of societies.

6. Capabilities Approach & Human Development (CA/HD) (UN, 1990s)

This paradigm supersedes and incorporates both the mainstream, multidisciplinary Modernization model (linear "stages of growth" towards Western-style society and mass consumption) and the narrower, economically-focused, market-based neoliberal schools. This paradigm shift is found in many international development agencies, not only the UNDP, but also the World Bank and NGOs. In this approach, "Development" is not about increasing incomes or economic growth (GDP), but enhancing fundamental human capabilities "to do more and be more in ways that people have reason to value" (HDCA, 2006). The philosophically grounded concept of capabilities are associated with economist Amartya Sen (since the 1980s), popularized in his 1999 book *Development as Freedom*, and institutionalized by the United Nations Development Program (UNDP, 1990). The "HD" paradigm is most visible today in the reliance on the national-level, multi-dimensional Human Development Index (HDI, which integrates capabilities for life, knowledge, and well-being) rather than GNP or GDP as measures of progress.

The Capabilities Approach has implications for project and policy assessment, such as of technology choices and other decisions of government, donors and NGOs. The appropriate "evaluative space" for policy actions is not income or "utility" (in welfare economics), but how well the policy decision (technology) enhances the real, valued freedoms of people. Investments in social services, health and education are justified because these enhance the most valued capabilities of life, bodily integrity, well-being and knowledge: not because the generate national income. An assessment of an Oxfam project in India using the capabilities approach revealed that Indian women preferred a rose-cultivation project over goat-breeding because, despite the slight economic advantages of the latter; the former sweet-smelling roses enhanced their quality of life in meaningful, non-economic ways (Alkire, 2004).

Similarly, we must assess the human development impacts of mobile phones: not just the economic impacts, but in terms of their wide range of enhanced capabilities to different users, including leisure, play and spiritual life. In contrast, narrower economic functions are more often touted in the mainstream and development literature, i.e.,

remarking on the benefits to traders and fishermen of getting a better market price by communicating to buyers. These measures are often easier to gauge.

Capabilities is closely affiliated philosophically with the integration of Human Rights principles into development work (IDS, 200?, ODI 200?: "rights-based approaches" to development). The universal human right to knowledge and participation in civil society asserts that access to internet and telecommunications is now a right. These technologies are not luxuries but legitimate and priority activities of the government to enhance human development (not just economic terms, but to enhance participation, knowledge, and sense of belonging, to name a few capabilities). This equates the "digital divide" as a development challenge equivalent to overcoming disparities in health and food security.

The CA does not specify the "business model" or ideological approach to promoting and protecting these rights and freedoms, leaving many details open to social and political negotiation. The government's accepted role could vary from provide minimum basic conditions such as physical infrastructure, functioning and open markets) for a reasonable private sector response (i.e., the "neoliberal" approach); to state-subsidized and supported telecenters, e-learning, business incubators, and research and design to more actively promote the right of "access to ICT" (the social-democratic response). The "jury is out" in terms of how government should respond to be effective. The history of "ICT4D" (ICT "for development": see item #? below) suggests that government and international aid agencies do not always choose well. Public-sponsored (government and NGO) internet, personal computers and related ICT projects have not taken off the way mobile phones have as a private sector initiative. Most mobile phone systems were generally not been a development project in most of SSA, for example. (A recent exception is a "Millennium Village" project mobilizing Ericsson, Zain, and Celtel investments to connect remote northeastern pastoralist village(s) in Kenya to cellular voice and EDGE data networks.)

The CA approach does suggest, however, that *evaluating the benefits* of these programs and policies (opening markets, minimizing tariffs, building masts, buying equipment) should be more participatory and less narrowly economic. The "Voices of the Poor" reports by the World Bank (1999) is one example of a qualitative, participatory, rights-based, but rigorous study of poverty around the globe.

7. Innovation and Entrepreneurship (E) (19th C, 1990s→)

The 19th Century Austrian economist Joseph Schumpeter's challenged linear models of economic growth with notions of the "creative destruction" (a term he borrowed from Marx) power of innovative individuals; Mohammed Yunus's Grameen Bank model of peer-lending and microfinance spread the developing world in the 1990s: Entrepreneurs and other risk-oriented business people stimulate technological innovation and in turn utilize it to generate wealth. The individual entrepreneur is a creative, innovative, forward-looking person who can both use and generate the technological dimension of this for-profit business model. Producing, creating and trading goods and services in markets is intrinsically good and helps drive further innovation and wealth creation in (capitalist) society. Now, in the new millennium (21st Century), the new markets are found in the "Bottom of the pyramid" of the billions of poor consumers around the world. Entrepreneurship as a solution to poverty, through micro-enterprise and other strategies, derive from the failure of conventional strategies of modernization and development economics (section 2 above), such as integrated rural development, structural adjustment, technology transfer, industrialization, import-substitution, etc.

Technology can generate the productivity edge, fill and or create a new market niche, and become intrinsic to new products and services offered for profit, as part of a commercial endeavor. This activity generates employment and creates new economic opportunities in/around technological change, such as mobile phone accessories and charging stations in rural Kenya, SSA and India. This model helps explain the rapid uptake of phones in urban areas among business community, the turnover in design of handsets for growing markets among the poorest in India, China, and Latin American and African

nations. The model appreciates that technological innovation and diffusion will respond to powerful market incentives (supply and demand) as well as idiosyncratic creative efforts of individual entrepreneurs. The Grameen Bank has invested in village phones, using cellular technologies to distinct advantage to the entrepreneur-manager, as well as otherwise unconnected rural users.

Social entrepreneurship is a related theme, an expression of the recognition of individual creativity in promoting social (vs economic or profit-oriented) innovations. These can be technology-rich, such as the work of mobile phone activist Ken Banks and Kiwanja.net. Such social entrepreneurs spread the power of ideas and help mobilize resources to promote what they perceive to be social goods, such as mobile phone applications in the developing world.

The entrepreneurial model does not attempt to understand the larger significance of phones for individual consumers, non-owners, and society: it tends to assume that good will come, and tends to ignore negative impacts of technological change. The importance of phones for staying in touch with family or as they reshape social norms are not interesting in themselves: only the fact that people are willing to pay something, however little, and thus form a market niche to be tapped into and a new creative endeavor.

8. The Network Society (N) (US, 1990→)

Information and communication technologies (ICT) comprise the computers (and their chips), internet, phones, telecommunications, and related digital technologies that are changing our world. They are historically unique, transformative, and powerful forces transforming global societies and economies. Manual Castells (Spanish born sociologist, UC Berkeley faculty in Planning and Sociology) is one noted academic observer of the growth of the global Network Society and its impacts on urban places, economic systems, social movements. Many other scholars are assessing and incorporating new models of social networks oriented through and around "ICT" to study urban places (Wheeler et al2000; also Saskia Sassen), social movements (Susan Stonich, 1999: how SE Asian shrimp farmers use ICT to mobilize with environmentalists in Latin America). Thomas Friedman, NY Times columnist and author, is one well-known non-academic observer of globalization through technology as a way to overcome poverty.

According to Castells, these technological changes are special, different from pre-information age, industrial manufacturing. Unlike other technologies, they are more democratic, accessible, physically more mobile, and can enable flexible new networks of exchange and production. Products are information-based (i.e., advertising, tourism, finance), rather than processing of raw materials (timber, oil: although that continues).

The Knowledge Society or Information Society functions through these exclusive new global networks. Castells introduces the concepts of the "space of places" and the "space of flows" to emphasize the ability of ICT to span conventional geographic bounds of the city or nation-state, but at the same time be grounded in real physical places through fiber optic cables, the electricity grid, paved roads, and water supply and waste management. (This physical basis of the wonderful cyberworld is obvious to East African residents who lack any hard-wired fiber optic connection to the internet, reliant on much more expensive and unreliable satellite ISPs.) Hallmarks of this new era are new forms of manufacturing, based on "just-in-time" (computer/digital) communication allowing the coordination of complex components across geographic distances to be assembled for delivery to consumers. These networks are fluid, flexible, fragmented, dynamic, and often hard to see using country-level data (since they involve flows between countries, yet data are still gathered at the country level).

New configurations of flows of power (financial, information) allow power to span administrative, national bounds. Elite residents of Nairobi, London, New York, Lima, and Sao Paolo are increasingly more connected to each other as world citizens, than to their own hinterland and nation. This trend, coupled with transnational corporations, foreign-

direct investments, and flexible-manufacturing, has led to predictions of the declining importance of the nation-state in social, technological, and economic affairs.

Academically, it is interesting to document and understand how ICT are helping to reshaping the world we live in: the global city, the content of information flows—such as human rights movements, financial markets, technologies (biotech and GM), and other resources. The Zapatisa rebellion, Philippines political demonstrations, and Kenyan national elections (2002) were organized using internet and mobile phones to bypass government-controlled communications.

Ethically, it has become a development imperative to provide individuals with reasonable access to these technologies and the opportunities they provide: i.e., spanning the physical and virtual "digital divide". The ICT4D movement is a practical wing of the Information Society, and involves various international NGOs and research agencies (PANOS, 2004; www.PracticalAction.org, ALIN, www.idrc.org "AcaciaNet" sponsored by Canada's International Development Research Center, IDRC). CBOs, NGOs, Development actors are part of this network of global flows of resources, information, ideas, money, and influence. Acts of resistance, democratic movements, and campaigns (such as the Alliance for Essential Medicines of MSF and Action Aid) are part of this change. The smallest grass-roots organization can open email accounts, establish a website, and interact with funders, advisors and constituents.

Mobile phones are an intrinsic part of this transformation of societies around the globe. Rural Kenyans are able to "leapfrog" conventional landlines and electricity grids, using phones to access networks (of credit, jobs, influence). They don't have to own a phone, but know someone who does. How they use and share phones represents not just a consumer preference or choice, but an active participation in increasingly global networks for responding to HIV/AIDS, for example (in the study village) and organizing family affairs across district, national and international boundaries (i.e., communicating with family members in Uganda and the USA). Claude Fischer, author of a landmark study of the telephone (1949?) would not be surprised that mobile phones in rural Kenya today, similar to landlines in rural America in the 1930s, are used by women (and men) for socializing and connecting to families, church associates, and friends; and not just used (by menfolk) for contacting the grain brokers to buy the harvest as telecommunications planners seem to have intended.

9. (Good) Design (2000s→)

Design magazines in US supermarkets have already made product and industrial design a household name, where the emphasis has shifted from aesthetics to "green" (environmentally sound) design. For the developing world, mobile phones have received attention from Nokia, the Finnish mobile phone handset company (Jan Chipchase is Nokia's itinerant observer of users around the world; Lindholm et al 200X represent Nokia in-house design teams). Independent researchers (Jones and Marsden, 200X) improve the hardware as well as mobile device software. These experts in ergonomics and "mobile devices" design and engineering are paying attention to the needs and preferences of the rural, low-income, non-professional users in developing countries. Mobile device designers eager to promote user-friendly, relevant and appropriate design for this growing, fragmenting, and different mobile phone market. The ULHC (ultra low cost handset) collaboration of GMC and Motorola was one industry collaboration to improve handset design for the poorest markets.

Northern markets tend to favor individualism, aesthetics, and luxury models: new ones every month, available with long-term contracts, marketed to the road warrior, young man, soccer mom in the Americas, Europe or Japan. The southern markets include such fancy handsets but also includes handsets for prepaid users with little cash, long-battery life for those without electricity, multiple SIM cards (SIM=subscriber information module) for those with more than one "line" (Samsung has a new dual-SIM card phone on the market now). Aesthetics and looks are still important, but different functions are

valued and poverty precludes trading up every year. In rural, western Kenya, these distinct market niches are still evolving.

This "design" oriented product and industrial design movement intersects with the AT/IT movement, where interest settles on ingenuity, local adaptation, and electricity charging stations. The tone of writings is enthusiastic, respectful and practical.

Well-intended and oriented toward often poor users, such intentional expert designs are increasing the range of options for the poor, but can misfire. Motorola produced a handsome, slim black $30 handset called the MotoF3 for SSA with a large outdoor-readable screen and a friendly Swahili voice explaining menu choices (i.e., for the illiterate—no dense screen instructions). It minimized costly features like games, extra ringtones, and alarm clocks. It does not seem to have sold well since released in early 2007 in Kenya (we tried it out with users in the study site who were not that impressed—text message is hard; one rarely sees it in use). Other ULCH do find a market. The Nokia 1100i series, with long battery, the Nokia 1200 (?) with built-in flashlight are popular. Low-end motorola now run under Sh. 2000 in June 2008.

The value of this perspective for thinking about mobile phones is the recognition that mobile phones are changing intentionally, by design. Kenyans no longer have to settle for the second-hand rejects of the US, East Asia, and Europe that they were a few years ago (whose batteries are old and failing). Users have an increasing voice in the design of these products, both through industry focus groups and by voting with their shillings (i.e., rejecting the Moto F3 in favor of the Nokia 1100). Handset designs are proliferating, and new handsets becoming affordable—this means that the batteries are new, and people appreciate what it means to own and use a brand-new device that works well. This trend will very likely change the way mobile phones are used and valued in the village, as they become more affordable, user-friendly, durable, and useful to rural users "off-the-grid".

10. Social Construction/Social Shaping of Technology (SCOT/SST: 1980s→)

In contrast to 'technological determinism' school, in which technology inevitably reshapes society: the SCOT/SST approaches reveal the content of technologies, how humans shape the technologies we have, and argue this is the outcome of the workings of a "seamless web" (Bijker 1989, 1995) of social-political-technical systems.

Decisions in the research, manufacture, diffusion and consumption of technological systems as shaped by a broad range of "social forces". These include politics, social norms, economics, geography, technical developments, scientific knowledge (through the sociology of science), environmental/ecological setting, and cultural context (norms, aesthetics, religious practices). Acting through various human institutions and actors, these diverse social forces shape the development, consolidation, and use of technologies.

Technology is not simply applied science, but represents complex, interacting systems. Technological systems are not 'rational' and the successful technologies are not necessarily the "best" but the outcome of a negotiated, social process. Similarly, failures are not because the technology was inherently worse. Technology is results from many actors, interacting and creating a system with its own emergent properties, which in retrospect often seem self-evident. Technologies don't provide their own explanations (teleological fallacy). In other words, we cannot assume that the functions provided by a specific technology now is the reason it was created, or the purpose for its development.

One important concept in this school is that of relevant social groups (RSG) involved in creating technological systems. These are not just the producers or experts (i.e., the engineers and manufacturers) but the range of users and non-users, as well as social groups, non-governmental organizations, politicians, and journalists. For the case of mobile phones in Kenya: one relevant social group includes development NGOs and their uses of phones for health, project planning and data management (these actions help create new awareness, designs, and investments in some technologies over others). Another RSG includes social movements using text messaging to mobilize people for

political action (these can lead to government crack-downs on SMS or phone ownership, as well as increasing use of SMS).

In the case of mobile phone handset designers: What constraints did they have in mind (i.e., in the US, Japan, Korea – no real constraints on electrical power, but batteries were a problem from the 1980s-2000s). Furthermore, one looks back to the history of the infrastructure and regulations of wireless signals, to appreciate the differences between US cellular and Kenyan mobile phone services. US services are metropolitan based, fragmented, and decentralized (i.e., with roaming and incompatible services a problem for years); these reflect the 1980s origins as a new complement to universal fixed landlines. Kenyan mobile companies established national services in the late 1990s when cellular technologies was more advanced and in a context of incomplete telephone (fixed landline) services even in the Capital (Nairobi) much less extending to rural locations.

Another concept integral to SCOT/SST approaches is that of the "interpretive flexibility" of design: Mobile phones might be seen by some observers as a single technology: i.e., through Western lenses of Modernization: a telephone that moves around with a mobile businessman making commercial activity more profitable and efficient. The SCOT/SST school reveals the diversity of "mobile phones" as they are used by women and men of different ages and walks of life for different purposes (emotional, communal, economic) using different functions (wireless telephone, text messaging service, internet/data access, data storage device, personal entertainment center, personal organizer dates, alarms, clocks, timers) reflecting different personal/private, public roles.

"Design flexibility" is an attribute of technological systems that are shaped by various humans: alternate designs (of handsets, computers, automobile engines) can exist simultaneously while various social groups navigate choices. Eventually, closure is reached and one technological systems emerges as dominant (but not necessarily because it is "best" technically, but because the RSG coincide). The diversity of small digital devices (made in a flexible manufacturing environment: it is easy to alter components), plus their converging functions for internet/data, personal data management, entertainment, and even voice mean that the idea of closure is less relevant. Not only are handset designs are not closed; the international specifications are changing (from WAP to GPRS to 3G), but not consolidated. (In Kenya, one can use WAP and 3G). We expect new and better functions all the time. This is true of Marakaru sub-location, as in Tokyo.

Methodologically, the SCOT/SST researcher must attend to political, legal, economic, organization as well as technical and scientific factors in understanding failures as well as successes of innovation, manufacturing, diffusion, and use. We should investigate, for example, the assumptions that underlie the actions and decisions of designers, engineers, regulators, marketers. Classic examples of the SCOT/SST approach are studies of the evolution and consolidation of missile guidance systems, large-scale national electrical grid in the US, florescent lighting design in 19th C US, and bicycles--from extreme sport for young gentlemen on unwieldy, fast "Penny Farthing" cycles to the slower "safety bicycle" (Bijker, 1995).

Imagine research integrating the legacy of the 19th Century Army Corps of Engineers water management projects with 20th Century oil and gas industry and modernization of southern Louisiana, as well as 21st century US race relations to jointly explain diverse New Orleans levee wall failures in 2005.

Increasingly, this school of thought pays more attention to the role of users: i.e., how they can alter and adapt technologies ranging from phones and internet to razors and contraceptives (Oudshoorn and Pinch, 2003). Female condoms are being reused (Murphy, 2006). Mobile phones designed expressly for voice communication, with SMS functionality an afterthought (as SMS was intended for use by technicians for diagnostics); were adapted for text message/SMS in the mid-1990s by youth.

Actor-Network Theory (ANT), coming from the sociology of science (Latour, 1987). is a subset of SCOT/SST approaches. Actor-Network Theory (ANT, France and UK, 1980s→), associated with Michel Callon, Bruno Latour, and John Law). Technological systems are the creation of complex social systems, and that technology is not just the

neutral best result of scientific and technological progress. Going beyond SST approaches, however, ANT attests that technologies themselves are non-human actors in these networks. Technologies have agency, helping to shape the systems and relationships between all actors. ANT studies material-semiotic relationships between things and concepts/ideas. This reflects the strong influences of French post-structural sociology, combined with US "social studies of science and technology". An example of this approach is Latour's analysis of the Aramis: a detailed case of a "failed" transport system in France in the 1980s.

SCOT/SST/ANT approaches offer a chance, and indeed demand, more active engagement with public policy in design and implementation of technological systems. As they don't view technology (production) and its impacts as inevitable, then we humans (individuals, social groups) can and should have a say in their development.

11. Identity, Media, and the Social (PC/PS/Literary studies, US/UK 2000s →)

Communications, cultural studies (i.e., of literature, and film), cultural anthropology treat new technologies such as the mobile phone as a force both shaping and appropriated by women and men through their own personal social/cultural lenses. Phones thus shape culture (norms) and are used to produce identity through enabling new forms of personal action and expression, private and public communication, and social mobilization and resistance. Scholars document such cultural phenomenon as the rise of text messaging among urban "Western" youth (Goggin 2006); how phones are used by men and women in negotiating sexual relationships, the changing norms of etiquette around cellular phones, and new conceptualizations of public and private space (see Goggin 2006, Kavoori and Arceneaux, 2006).

Cultural studies broadly can provide much insight into how we should think about phones even in rural Kenya—not just for their practical, technical functions, but for what they can mean to users as status symbols (even when they do not work) or markers of modernity, or other symbols we might not appreciate. Advertising, such as the enormous Safaricom and Celtel billboards along highways, becomes a "text" or discourse to interrogate and interpret as a representation of one among many mass-media messages (i.e., following condom and beer ads). Phone handsets can shape or enforce new kinds of relationships through their presence (sitting on the table, ringing and interrupting meetings, is the prerogative of important men). As well their absence (of charge or airtime) are significant—the expectation of being able to communicate changes the way we communicate, with consequent disappointment and/or changing behaviors. These trends may have little to do with economics or practical material outcomes (like better prices for maize), but can be significant to users, even in poor villages where material needs would seem to dominate concerns. In other words, cellphones create new cultural norms, shape culture, and form a new arena for expression that merits rigorous anthropological and sociological study. This has barely entered the "developing world" setting (Horst and Miller, 2006 report on their Jamaica case study) in part because the diffusion into poor country settings is so recent, and the phenomena more difficult to capture and study (involving different countries, languages, travel).

This broad school of study into the cultural domain overlaps with other feminist and post-developmentalist schools of thought, especially in appreciating user-based adaptation. Cultural studies more or less integrate/require feminist, post-modern, and post-colonial enquiries into the location of power, meaning, and resistance apparent through written and visual texts.

This approach does not contribute much, however, to helping us appreciate the sources of innovation in society; the structure and evolution of large technological systems; or the economics and practicalities of phone design and use.

12. Feminist Perspectives on technology (India, UK, US, 1980s→)

Disparate feminist perspectives on "technology" derive from the intersection of gender, race, class and power in the environmental movement, development studies, the social history of "female" domains (i.e., the home: Ruth Schwartz Cowan), and SCOT/SST research into reproductive and contraceptive technologies (i.e., Oudshoorn).

Critical eco-feminists view modern technology as a threat to women and nature (see post-colonial environmentalist Vandana Shiva, 19XX). Women have an inherent predisposition to nurture Mother Nature, and (modern, male) technologies are destructive. A related socialist-feminist view of technology emphasize the class and power aspects of technology innovation, control and diffusion. Technology has been largely a male domain and this idea is implicit in modernization models of international development; women's work in the home, farm and family has not been valued (Boserup, 1970) and often perceived as cultural practices rather than technology (Crewe and Harrison, 1999).

These lenses and others variously emphasize the potential differential (usually negative) impacts of technologies on women. They reveal gender biases in design and innovation of "appropriate technologies" in the developing world: Ian Smillie (2000?) and Crewe and Harrison (1999) critique classic "income-generation" schemes and energy-saving cookstoves targeted to women. At another level, women have often been left out of engineering and design processes, as well, as professional engineers and industrial managers: their absence has undoubtedly shaped the design of large-scale systems (electricity production and diffusion) and artefacts (stoves, bicycles) and development outcomes (Boserup). The often hidden role of women in actually shaping technology arises from increasing attention to both users and non-users (Oudshoorn and Pinch 2003).

Our conceptions of gender and science is shaped the emergence of information and computing technology and their applications for statistical sciences, discplines of socio-biology, and dominant themes of control (in science, politics and education) over bodies, nature, and society (i.e., Haraway, 1989). Gender and technology are thus "mutually constitutive" (Cockburn, 19XX: the case of the male typesetting industry and their displacement by computerized printing). How do we begin to think differently about men and women, humans vs animals, sex, reproduction, and power, human nature vs/and nurture, and our relationship to machines? Science is clearly a political, social process, as is technology. This has implications not only for how we think about human nature and our relationship to technology, but also what we think we can do to make the world better (Donna Haraway, 1989, 1991).

In the case of the mobile phone in rural Africa, such sophisticated feminist insights that are common in the US/European academic literature (SCOT, SST, ANT) are lacking. Most obviously, women suffer the "digital divide" unequally: this reflects narrow, Boserupian liberal modernization, an acceptance of the mainstream path to development. A deeper feminist critique would call for conceptually and methodologically distinguishing men and women and issues of power at all levels in the design, development, diffusion, use, impacts of phones. A strong critical feminist perspective would, for example, privilege local, poor, women's special knowledge of nature, nurturing, and reproduction and would investigate how the modern mobile phone threatens these traditional norms. This enquiry would help women appropriate and gain access to this predominantly male, commercial artefact. Can it be used defend women's rights, values, access to material resources, and traditional knowledge? Can women own, control and use phones for their own aims, or whether husbands, fathers and other male authority figures co-opt the phone in order to control women's bodies and income?

We should also look at "users" of different ages, expecting them to have different motives, values, and concerns: indeed this is found in the Marakaru, Kenya site. Furthermore, design and improvement of handsets should account for gendered concerns of users and non-users in different walks of life as they age—this is possibly happening (but I lack evidence). Similarly, most likely Nokia, Motorola, Celtel and Safaricom decide about who/where to invest, shaped by the predominantly male staffing in professional technical/design positions: this has not been a subject of enquiry yet).

qSo far, women in Marakaru do own phones but less commonly than men (usually as wives to the primary owner). They regaled us with stories of how phones are used by (someone else's) philandering husbands to carry on affairs. Overwhelming, women interviewed last year report that phones are freeing, convenient and desirable.

13. Side-effects of the Development Apparatus (1980s→)

In the 1980s, anthropologist James Ferguson (building on the work of Michel Foucault, the French post-structural sociologist) elaborated the workings of the "Institutional apparatus" of international development, which involves bilateral and multilateral donors, aid agencies, and host governments. His example was a World Bank and Canadian aid project in highland Lesotho from 1979-83. The agencies and individuals involved construct (through their language and expectations) and then engage with a "conceptual apparatus"—the preconceived assumptions and embedded, institutionalized ideas of the causes of poverty, ill-health, underdevelopment and its (apparently logical) solutions. The high-minded efforts to "do development" creates, reinforces, and receives "development" as a package of expertise and bureaucratic norms and institutions, disguising the often political nature of funding, project approval and hiring—in Lesotho, the projects ignored the labor migrant history and dependence on South Africa, as they crafted and implemented and elaborate "integrated rural development" project.

Together these agencies in the "development apparatus", as they implement their formal, written project plans, also manufacture and/or diffuse certain technologies (to the exclusion of other technologies). This is apparently taking place through a rational, technical process of choice and investment, but also happens through side effects and other "unintended consequences" of development apparatus that pervades sub-Saharan Africa and Asia (and to a lesser extent, Latin America). The modern "Development Apparatus" in this new, post-2000 era, persists as new alliances, mechanisms, and labels: public-private partnerships; civil society, NGOs, etc. promoting capitalism, democracy, globalization, freedoms, and human rights. (In other words, this is still happening, however well-intended and welcome the ideas and projects.)

These unintended effects are neither good nor bad, necessarily: they are, however, often hidden and unrecognized elements that are reinforcing patterns of social change in the "developing" places. The Green Revolution promotes packages of seeds and chemicals which do sometimes produce more food; the process also disseminates and reinforces ideas about land, crops, management, productivity, gender roles. It leads to exclusion and greater difference, outcomes often noted by critics of modernization. Fish farming was partially adopted in rural Zambia (Crewe and Harrison, 1999 note) not to produce food or income, but to ally one-self with the project organizers for future benefits.

Meanwhile any projects 4WD vehicles, fossil fuel energy dependence, computer-based technologies, and financial accounting and M/E standards (often run by expatriate or foreign-trained experts with external funding) subtly reinforce technology change. Actions and standards establish conventions (for powerpoint presentations, Windows, Toyota). These are rarely commented upon.

Modernization (Item 2 above: encompassing standard Keynesian development economics, basic needs, and sustainable development approaches) have been criticized by many observers for, in the end failing to provide roads, electricity, conventional telecommunications, and health care (Sachs, 200X is simply the latest). The reasons for failure are many: bad implementation, corruption, "cultural barriers", etc. Regardless of their failures or even successes (by project indicators): they succeed in bringing in "experts", perdiem, and financial capital. These can buy mobile phones and airtime, spreading phones (new and used) and awareness of their uses throughout the landscape of "development". Mobile phones, an outgrowth of private-sector global technological developments, are thus one of the unintended "instrument effects" of an unwieldy apparatus. They spread despite the lack of official promotion through "development project". They spread because of the widespread lack of physical infrastructure: they are

an improvement on travel by foot or "snail mail". While imperfect, they are at least marginally better than what is currently available.

Part III Conclusions

The above 13 lenses provide various sketches of "technology" as a subject of social sciences and of the "mobile phone" as a specific new technology in rural Kenya. This paper necessarily simplifies and consolidates sophisticated scholarly insights. Still, the above paragraphs highlight distinct yet complementary ways of perceiving technical innovations, individual adoption, and social changes. The context is western Kenya, but this can indicate what we might see, ask, or predict elsewhere in rural Africa.

Table 3 summarizes these lenses and their insights into technology and labels each of the 13 with a short-hand label used here. "Technology", as an arena for study, is alternately seen as predominantly:

- the specialized work of experts in the engineering profession building on modern, Western science (TD, M, E, DOI, D), as well as:
- indigenous know-how, practical and historically grounded (AT/IT, IKS).
- as part of a complex social system (a seamless web) of inter-related social, political, economic and technical actors (SST, ANT, ICT4D, Network),
- an opportunity for expression of human qualities and creative forces that add meaning to life and enhance valued freedoms (C, F, CA/HD, E)

Normatively, "technology" is seen as

- a positive force bringing benefit: witness modern medicine, agriculture, and industrial manufacturing (TD, M, E), and conversely as a negative force, hurting the most marginalized and vulnerable sub-populations such as women, minorities, and the poor (AT/IT, Feminist, IKS, C). It is a "double-edged" sword that can harm society and needs to be managed (AT/IT, SST).
- the outcome of social (human, political, i.e., quirky and unpredictable) processes, negotiated by real people and institutions; it's ambiguous merits must be determined relative to the social context and the technology-users (SCOT/SST, ANT). Thus we can't know whether it is necessarily good/bad (or both); all outcomes are likely for different users, contexts and times.

Finally, the "end-users" of technology are seen alternately as:

- beneficiaries of Western science and development (TD, M) who vary in understandable ways that can be easily modeled and are predictable (DOI, TD, M), as well as passive victims of oppressive western hegemonic force acting through science, modern technology and international development (F, C, PD)
- Perhaps they are much more complex: idiosyncratic, varyingly empowered agents of social change (IKN, SST, Network) and an often neglected, but important actor in techno-social systems (SCOT/SST, ANT).
- For some, they remain simply consumers buying into a new market/industry: look at the potential revenues even among the "bottom of the pyramid" (E, D, M, DOI)

Looking at "Mobile phones" as particular technologies, these are seen as:

- A logical, inevitable extension of Western, science-based R&D that can be rationally improved upon (with advances in hardware, software, batteries, infrastructure, and standards) since they are the same "modern technology" (a phone and data device), whether in Korea, Japan, Finland, the US or Kenya (TD, M, DOI).

- A growth industry. Many practical problems can be tackled with ingenuity, expert ergonomics, user-interface engineering, and solar power systems (E, D, AT/IT) bringing value-added and peripheral enterprises. This prospect is enhanced as they are unique, contingent, and flexible in use, meaning and design, depending on the social context (D, AT/IT, F).

Different aspects of their use and adaptation in the village can be more clearly revealed and appreciated (or, conversely, disguised), depending on our lens as well as the focal points: is the phone, the user, the industry, or "technology" in focus? What is our depth of historical perspective? What is our normative perspective? Are we selling a product, improving (women's) lives, developing economies, or observing trends?

- Mobile phones reflect a long-standing and seemingly inevitable process of technological modernization, in which better, improved, expert technologies are introduced from outside and diffused locally in predictable ways (TD, M, DOI)
- They are, however, a special form of technology part of, and creating, the globalizing world of the 21st century that is different from what has come before (N, ICT, PD, F). They have emancipatory, equalizing potential—but acting through the new network model of change, not the old nation-state model of power and wealth accumulation.
- Furthermore, the mobile phone in rural Africa is a hybrid: each community integrates local, and specialized knowledge systems (grounded in a specific natural and social context) –i.e., for phone sharing, applications for self-help groups--with more this recent import (IKS, AT/IT, F). The mobile phone is not the same technology in western Kenya (owing to the hardware, use and context) as in New Orleans or NY.
- Thus, beyond the initial 'adoption' phase most talked about in the popular press, there is ongoing adaptation and novel uses of phones by creative, intelligent and resourceful users—sharing among friends and family and adapting to shortage of electricity and lack of cash are hallmarks of rural African phone use. Changes to phone use reflect that users learn. The network grows and as the socio-technical system changes. (N, IKS, SCOT/SST, ANT)
- Still, in any household, these remain gendered artefacts, captured by men and the powerful, and as such their diffusion and use will reflect and reinforce pre-existing inequalities (based on class, race, income, gender) (F, PD). We have to act to ensure equal access to mobile phone technology.

These patterns of use, change, access intersect with local and national politics and industry policies, too. Where will these intersections of mobile phone technology, consumer adoption and adaptation, industry trends, and advances in useful accessories (i.e., charging stations) take Kenyan society?

A potential user in western Kenya can buy a SIM card now for Sh. 50 -100 (about US$1.00), borrow a friend's handset, buy airtime for only Sh. 20 (30 US cents) and with almost no investment, no application, no credit rating… join the global network. It is no longer a "Western" technology: handsets, tariffs and ways of use are distinctly Kenyan. The connectivity and benefits it provides are as rich and diverse as we see in other mobile phone markets.

Imagine divergent trajectories of handsets and communication technologies now on the market, ranging from the simplest $20 Motorola (black and white screen, no data access) to the sophisticated Blackberry (retailing for nearly US$1000 in Nairobi). Will decentralized solar and wind power provide reasonable alternatives to inadequate mains electricity? Then phone ownership and use will spread as more phone owners create more markets (while rising oil prices increase incentives to find alternatives).

Socially, such diversity in the basic technology and what it can actually do for people might well lead to better access to regional and global markets, information, and

social networks for all, with “good enough” connectivity (i.e., SMS and EDGE vs email and 3G for many rural users). Alternately, the technology might fail with over use, poor maintenance and poor inter-operability. Failures could disappoint and aggravate present high levels of social and political exclusion. Poverty and inequity now visible as “rural” vs “urban” divides might reform along “connected” vs “unconnected” networks.

Can mobile phones provide meaningful and sustained local/global (“glocal”) networks? We might see increases in intra-national and intra-regional trade. Or will the technological change elsewhere (i.e., US, Europe, Japan), coupled with inadequate Kenyan infrastructure simply frustrate and further isolate locals from global exchanges? Will Safaricom (with 80% of market share now) take over Celtel (despite anti-monopoly regulations)? What will that mean for users? Or will new a new French cellular operator provide useful competition, new phones, prices, and services? As landlines and fiber optic technologies continue to lag in Kenya vs. the rest of the world, and with oil prices high and sugar prices and international tourism struggling: Will cellular demand in Kenya outstrip the capacity and motivation of industry and government to maintain towers?

Table 3. 13 Perspectives on Technology Change in 21st Century Rural Kenya

Label	School	Emphasis on	Useful for appreciating …
(1) TD	Technological Determinism	Technical change as large-scale social force	the long-term implications of innovations for social and political change: i.e., the printing press in 16th C Europe
(2) M	Modernization	Development Planning For modernizing poor countries	conventional international development efforts introduced many technologies throughout the developing world since 1950s: transport, agriculture, communications. Many failed due to cost, inadequate supply chains, lack of training and cultural barriers to innovation.
(3) DOI	Diffusion of Innovations	Diffusion process	innovations spread in predictable ways through any social system based on characteristics of the technology and people in the system
(4) AT/IT	Appropriate Technology/ Intermediate Technology	Appropriateness for the poorest, vulnerable	social movements help promote "cheap, simple, non-violent" solutions to everyday problems of the poor, through new designs for energy, food, transport, housing, communications
(5) IKS	Indigenous Knowledge Systems	Knowledge: Know-how and historical values	traditional, local, place-based, culturally specific knowledge of agriculture, healing/medicines, resource management, etc. are valuable but are seriously threatened by imported, cheaper, western technologies and modern values
(6) CA/HD	Capabilities Approach / Human Development	Human Development: technologies enhance freedoms	technologies (of any sort) can have important non-economic, emotional, spiritual and other liberating benefits. Access to modern technologies is a human right, essential to fulfilling other rights.
(7) E	Entrepreneurship	Entrepreneurial business and innovation: individuals in realizing the potential of innovations	An organic, individualized, market-based process is effectively promoting and diffusing technology-rich products in the developing countries to meet consumer demand. the Bottom of the Pyramid represent $ billions.
(8) ICT	Information, Communication and Technology (ICT)	Network: the social, spatial, and economic consequences of ICT	Computer-based (post-industrial) technologies are fundamentally different from industrial innovations and are reshaping global-local interactions around the world, but tend to leave the poorest out of critical networks and access to power.
(9) D	Design perspectives	Hardware and software	End-users can have more to say in the design and use of consumer devices, computers, machines, products; experts can make products work better for the rural poor
(10) SCOT/ SST	Social Construction of Technology, Social Shaping of Technology	System approach to technology	Dominant technologies and infrastructure that we have today are the result not of rational application of science, but the workings of the (biased) "seamless web" of social, political, economic and technical systems.
10b ANT	Actor-Network Theory	Actants	technology is also an actor in this system of technology development; it is not just the outcome of negotiated, political processes
(11) C	Cultural studies	Norms, values, relationships	Technology is adopted, adapted and used to create meaning and identity: handsets are not just about functions but have symbolic value to users
(12) F	Feminist and Critical perspectives	Power, impacts (modern)	powerful resistance to western technologies is based on often negative experiences with exported technologies (esp. oil, chemical, energy). Modern technologies often have negative impacts on environment, women, the poor, minorities: manage or resist
(13) PD	Post-Developmental Thought	unintended Effects	technology diffusion and uptake is an unpredictable, often unplanned (good and bad) side-effect of the development apparatus as it "tackles" poverty, poor health, etc; the actual technology content of changes might be an unintended consequence of the project/program (i.e. 4wd vehicles, phones for staff communication)

Summary

The remarkable spread of mobile phones throughout sub-Saharan Africa today—and the long run impacts--are phenomena that merit investigation from many perspectives, such as the 13 lenses provided here.

Mobile phones are not the result of planned "development" efforts raising incomes so that people can afford the luxury. In fact, the technology's spread results in part due to the failure of previous intentional efforts to modernize, and maintain infrastructure throughout the developing world: roads, electricity, landlines and basic computing capacity are lacking. Nor does the popular "diffusion of innovations" model suffice to explain adoption (although it sheds some light). The mobile phone is not just new, but it offers flexible infrastructure and a clear improvement over relatively costly road travel and the psychic cost of "not-knowing". The spread of phones through private sector efforts mirror the increasingly business-oriented approach to development since the neoliberal era of the 1980s with increasing attention to the poorest of the poor as viable markets.

In terms of what the mean to people: The potential wide-ranging impacts of mobile phones in everyday village life will be simultaneously mundane and profound. The significance of mobile phones to any Marakaru resident is more than as a practical tool—they enhance a sense of well-being. Understanding this impact can usefully draw from feminist, post-modern and post-development standpoints, as well as the global network metaphor—people are connecting in specific ways through their virtual, digital ties, formed by jobs, church groups and NGOs.

How should we think about technology change in sub-Saharan African more generally? The presence, prevalence, use, and implications of phones, as with AIDS medications or new crops--can be best understood as an endogenous component of complex processes of social change unique to the "developing" context of each African country. The mobile phone is now an integral part of this, thus helping to shape the landscape of continued technological change, and these processes are taking place over increasingly globalized networks of communication and interdependence.

Furthermore, the handset (like ARV drugs or a new sweet potato variety, as in Table 1) is really only the most visible and tangible part of a much larger evolving socio-technological system. This system is grounded locally in Kenyan realities and rural poverty, yet globally shaped by companies such as Nokia, big Pharma and agri-business. These act to give Marakaru location its unique technology stamp.

Development is not a linear process, and the leapfrogging might lead to disappointments as much as to spectacular economic growth and visually remarkable social changes. The social, economic, and even physical landscape of rural Kenya will, most likely, be subtly (in some ways) and dramatically (in other ways) continue to be shaped by every day phone use, national policy decisions, technical developments, and macroeconomic forces. The extent to which the mobile phone will cause these changes (i.e., technological determinism) is not clear. Many forces can lead people to change crops, livelihoods and labor activities and sense of well-being. High food and fuel prices are now aggravated by drought which wilts the maize in the fields this season.

Endnotes

1. Original Research Questions in the 2006 NSF proposal: "How are local and global technologies converging and being adapted by rural AIDS-affected communities? This study tackles this larger question through observing how the hoe and mobile phone are used in a specific AIDS-affected setting. Specific questions are: (a) *How are the hoe and mobile phones being used and changing the use of the other, and becoming integral parts of new rural livelihood strategies among HIV and AIDS affected?* What are specific end uses (food, family support, income), what are new livelihoods? What actors and actions are left out of this network of diffusion, use, and adaptation? (b) *How does "HIV/AIDS" influence these technology changes?* How does the presence of HIV (the desire to avoid HIV infection or to live positively as an HIV positive person) and AIDS (burden of care for the ill, support for orphans, etc.) affect hoe and phone uptake, use, and adaptation? Does the stigma around HIV/AIDS prevent some from participating? What relevant resources are channeled through networks of institutional actors responding to HIV/AIDS? (c) *What are useful entry-points for external actors to influence technology uptake and adaptation in ways that enhance human capabilities?* Given unpredictable outcomes of the development apparatus, how can external agencies act to broaden the network, ie. remove barriers to participation and enhance local innovation and adaptation of technologies?"

2. Study Site Census. The Bungoma field site was selected in 2005 during another study of technology change in rural, AIDS-affected Africa, through a host agency (ACE-Africa). Local innovations in kitchen gardens and many other arenas in response to the epidemic were reflected in the study village. Fieldwork in 2005 mapped the village, identified HIV/AIDS affected households, and documented gardens innovations. At this point, 6 Mobile Phone handsets were known in the village, the only service provider was KenCell (later CelTel), and signal coverage did not span the whole village. The second round of data collection in 2007 (funded by NSF) was comprised the entire village catchment area with a household survey, thus providing a census of households and mobile phones. A simple household level questionnaire was developed, translated and administered from February 3 through March 10, 2007 by trained, Bukusu-speaking enumerators. They interviewed a responsible adult male or female head for every family grouping that "eats from the same pot" within the catchment area. These numbered 878, including 28 cases of non-response due to the family being away, incapacitated, or refusing to participate. A household composition roster gathered standard data on age, sex, education of current members and those who left in the past five years (through out-migration or death). Other questions enquired about livelihood activities, land, crops, tools, housing, and assets. The census effort included an "individual-level" questionnaire to investigate mobile phone use among adult owners identified through the household-level instrument, gathering information around handsets, SIM cards, expenses for charging and airtime, benefits, and problems. Non-phone owning households were asked about reasons for not owning, ever use of a mobile phone, and perceived benefits and problems.

The research protocols were approved by the Tulane University Institutional Review Board (IRB). The study received research authorization from the Kenyan Ministry of Education, Science and Technology (MOEST). All participants were invited to take part using approved oral consent procedures, and interviews and activities were conducted in Bukusu or Swahili, translated by local research assistants.

This study is an academic effort, not associated with any mobile phone company, agency or government institution. It aims to help fill a glaring gap in contemporary studies of technology adoption in rural Africa characterized by a dearth of objective research independent of specific development or health projects, social marketing campaigns, or commercial marketing. Here, furthermore, a single village is mapped, studied, and appreciated in greater detail than is normally the case for research on "information and communication technologies." Eventually, follow-up data collection will tell us about trends over time.

3. HIV/AIDS Data and Indicators. Several "proxy" or indirect measures of HIV/AIDS were used, rather than expensive biomarker data to capture actual HIV positive status. It would have been logistically, ethically, and financially impossible to test even adults for HIV, and would have alienated informants. Furthermore, current HIV infection does not capture the full range of AIDS-affectedness that are the proper concern of this study. Thus, indirect measures capture illness, death (related to AIDS), and presence of foster children. Specifically: a standard household roster was administered to every household in the study site (848 responded out of 878 listed). This roster asked for information about each current household member's health status and the experience of

"chronic illness" (lasting more than a month) and symptoms of weight loss, fever, rash, and diarrhea, which are generally associated with AIDS-related illness. Similar information was asked of "prior" members, which captures adult deaths (rare) and out-migration (much more common). Orphans and foster children can also be identified in household rosters. Discussions with local home-based care workers (2005, 2007) enabled a separate tally of AIDS-affected households, perceived trends in infections, access to anti-retroviral treatment. This conversation and others also provided examples of specific applications of mobile phones by these lay health care workers in their HIV/AIDS outreach—communicating around patient/client care, organizing support group activities, and the like. Finally, Focus Group Discussions (four, two each with men and women) revealed local experiences of HIV/AIDS. These data lend themselves to quantitative and qualitative insights around HIV/AIDS, but these have not yet been properly analyzed and presented for the public. Two working papers (Murphy 2007a, Murphy 2007b) and a published manuscript (Murphy 2008) present some of the findings on the HIV/AIDS situation.

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