3

Physical Resources: Computers and Connectivity

Although full access to information and communication technology (ICT) requires more than just the presence of devices and conduits, there still remain pressing issues concerning physical access to computers and the Internet. Examining data that indicate who does and does not have physical access reveals a number of interesting trends, as does an analysis of strategies and approaches put in place to enhance people's physical access through more affordable computers, Internet access, and public access centers.

Who Is Connected?

As of August 2001 an estimated 513 million people around the world had Internet access ("How Many Online?" 2001). That represents some 8.4% of the world's people.[1] Even though Internet access has been increasing rapidly in some developing countries, access remains highly stratified by region. The number of people with Internet access—defined as those who have been online in the last three to six months—ranges from 57.2% in North America to 0.5% in Africa (table 3.1 in "How Many Online?").

The reasons for disparity in Internet access rates are multiple and involve issues of economics, infrastructure, politics, education, and culture. Several studies have been conducted that analyze the principal factors that correlate with differential Internet access rates. One of the largest, conducted by Kristopher Robison and Edward Crenshaw (2000), examined the interrelationship between number of Internet host computers per capita and several economic, social, and political variables in

Table 3.1
Internet Access Rates, August 2001

Region	No. of People with Internet Access (millions)	Percentage of Population with Internet Access
U.S. and Canada	181	57.2
Europe	155	21.3
Latin America	25	4.8
Asia	144	3.9
Middle East	5	2.4
Africa	4	0.5
World	513	8.4

Source: Adapted from "How Many Online" (2001); Population Reference Bureau (2001).

seventy-five developed and developing countries. They found that the strongest factor correlating with Internet access is teledensity; countries with more telephone lines per 1,000 people also tend to have greater Internet access. Other factors, in order of importance, include high levels of economic development (measured by energy consumption), a post-industrial economy (measured by size of the service sector), educational level (measured by number of secondary students per population), and political openness (measured by a composite of factors that include elective government and constitutional constraints on governmental power).

Another study, conducted by Ezster Hargittai (1999) examined international variation in Internet connectivity among eighteen member countries of the Organization for Economic Cooperation and Development (OECD). These countries are all relatively developed industrially, yet Internet penetration among them ranges from 881 hosts per 10,000 inhabitants in Finland to only 26 hosts per 10,000 inhabitants in Greece (figure 3.1).

As in the Robison and Crenshaw study, telecommunications was found to be the most important factor in terms of Internet access rates. In Hargittai's study, telecommunications was measured according to teledensity rate and the existence of a competitive (rather than monopolized)

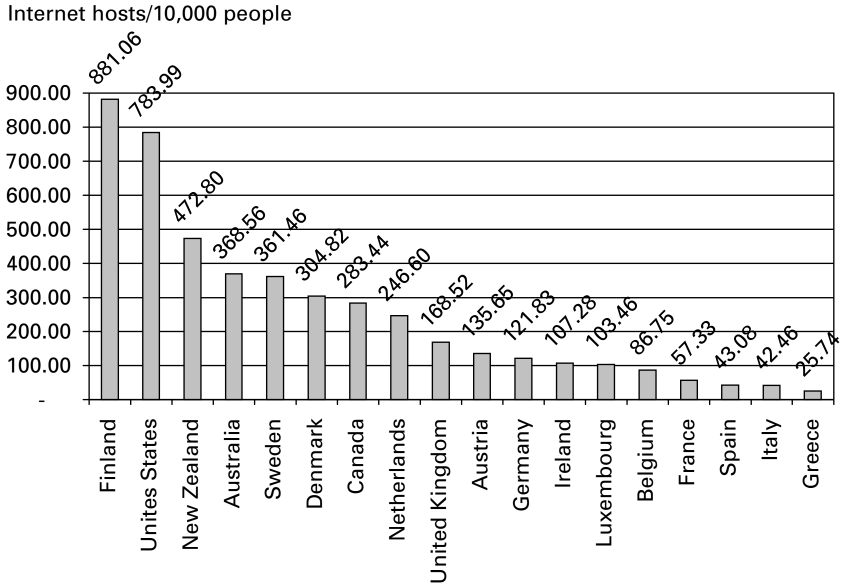

Figure 3.1
Internet host distribution in selected OECD countries, 1998.
Source: *Telecommunications Policy* 23 (10–11), "Weaving the Western Web: Explaining Differences in Internet Connectivity among OECD Countries," by Eszter Hargittai. Copyright 1999. Used with permission from Elsevier Science.

telecommunications industry. Other factors, in order of importance, included English language proficiency (measured by number of secondary students studying English), education (measured by combined primary, secondary, and tertiary enrollment rates), national wealth (measured by Gross Domestic Product, GDP), and equality (measured by the Gini coefficient).

Finally, the OECD has gathered information on the relationship of Internet access costs and Internet host density as a measure of accessibility. While there is not a one-to-one correspondence between the two variables, in general the OECD study found there is a strong correlation between cost and density (figure 3.2).

Without question, there are a wide variety of variables associated with Internet penetration. Given this context, the question remains as to what countries can do to promote greater physical access to computers and

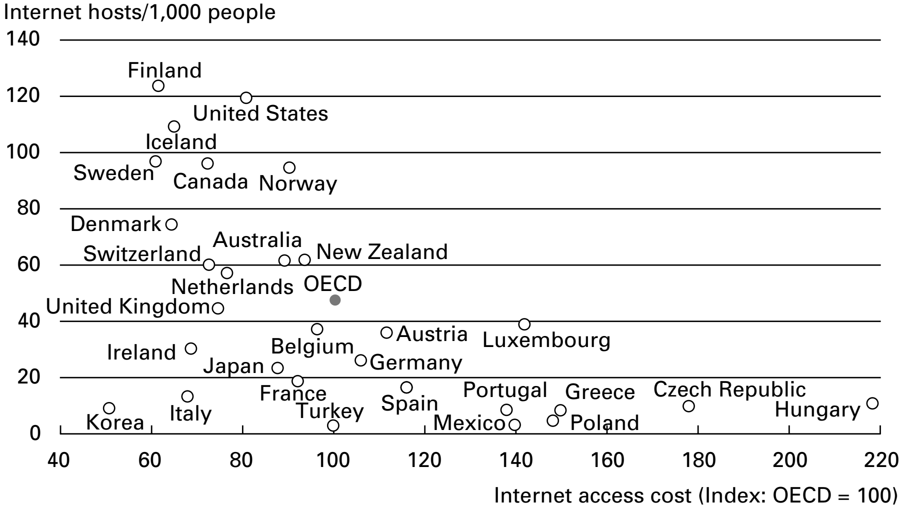

Figure 3.2
Internet access costs and Internet ost density, 1999.
Source: Organization for Economic Cooperation and Development (OECD 2000). Used with permission.

the Internet. A close examination of responses made by developed and developing countries to issues pertaining to computer and Internet access reveals much about the tenaciousness of inequality where ICT is concerned, and suggests that developed and underdeveloped countries each face very different challenges in helping promote ICT access.

Physical Access in Developed Countries

As shown in figure 3.2, there is a great deal of disparity in Internet access rates among developed countries. Hand-in-hand with this disparity comes the vexing issue of inequality *within* developed countries, with access to the Internet generally stratified by socioeconomic status and race. Consequently, developed countries face two specific and interrelated challenges regarding physical access to the Internet: the need to improve the *quantity* of access (increasing the general level of Internet penetration in the country) and the need to provide *more equal access* among their citizens.

To illustrate this point, it is useful to look at some examples from developed countries. As Hargittai (1999) has pointed out, Finland occupies a striking position as being the "most wired" nation. There are several reasons for this, including Finland's competitive telecommunications sector; its correspondingly low Internet access charges, its flat-rate Internet access charges (at least during off-peak hours, in contrast to the per minute charges in many countries); its high per capita information technology production; its high level of English (the dominant language of the Internet; see chapter 4); and the country's implementation of a ground-breaking national information society strategy in 1994 (Hargittai 1999).

In contrast, countries such as Greece, Italy, Spain, and France all have very low rates of Internet access. Particularly striking is the great disparity between Internet access in Finland and France, because the two countries have approximately equal GDP per capita (*World Development Report 2000/01*). Possible explanations for this difference include the less open and less competitive nature of France's telecommunications industry in comparison to that of Finland and higher Internet access costs in France (OECD 2000; 2001). In addition, fewer French people speak English than do people in Northern European countries like Finland ("Languages in Europe" 2002). And France has never embraced the Internet as ambitiously as Finland, partly because of its alternative and competing Minitel system. The difference between these two countries indicates that economic wealth is far from the only factor determining Internet access. Indeed, Italy has an even lower rate of Internet access than France, despite having a GDP approaching those of France and Finland. In developed countries (as well as in developing countries) telecommunications policy appears to be the major factor affecting overall physical access to the Internet, with competition, low rates, and teledensity all correlated with Internet access rates.

A second issue in developed countries is that of unequal access. This calls for an examination of the extent to which physical access to the Internet mirrors and contributes to other levels of inequity. Not surprisingly, this issue has received the most attention in the United States, the country where the Internet was first launched and where socioeconomic disparities are quite pronounced compared to other developed countries.

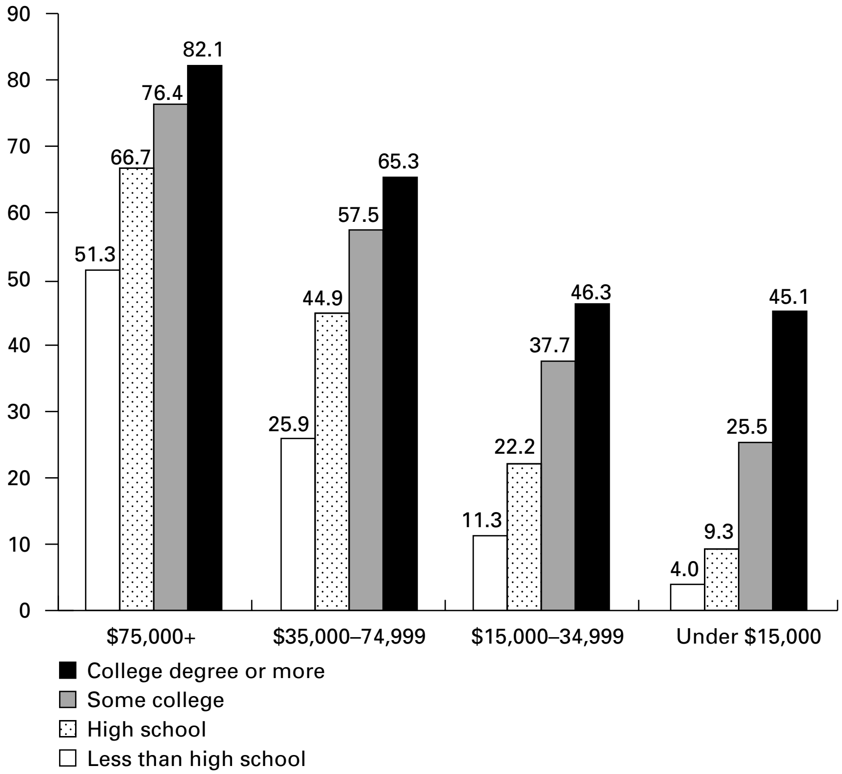

Figure 3.3
Percentage of U.S. households with Internet access, by income and education, 2000.
Source: National Telecommunications and Information Administration (NTIA 2000). Used with permission.

The most authoritative studies to date on this issue have been conducted by the U.S. Department of Commerce Telecommunications and Information Administration, in a series of *Falling Through the Net* reports. The latest of these reports (NTIA 2000) indicates several significant trends regarding computer and Internet access in the United States.

First, computer and Internet access remains highly stratified by race, income, and education. Income and education appear to be the dominant stratifiers; for example, high-income college graduates have Internet access rates over fifteen times higher than low-income high school dropouts (figure 3.3).

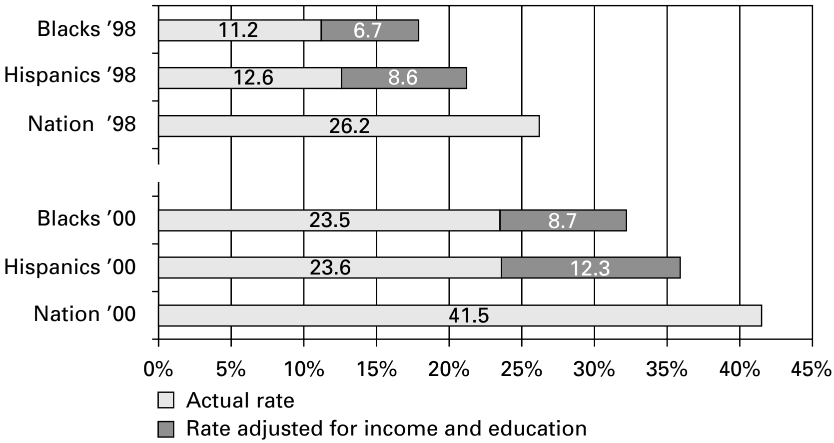

Figure 3.4
U.S. Internet access, contribution of income and education differences to racial gap, 1998 and 2000.
Source: National Telecommunications and Information Administration (NTIA 2000). Used with permission.

Second, race and ethnicity are themselves stratifying factors, exclusive of their intersection with income and education. Figure 3.4 shows that income and education account for only about half the gap between the national average and blacks' and Hispanics' access to computers and the Internet. This can be explained by a number of factors. For example, blacks and Hispanics have not only lower incomes and education but also lower assets and savings, lower literacy rates, and fewer personal connections with others who know how to use computers.

Third, Internet access among high-income groups is starting to reach saturation levels, with more than two-thirds of all households earning more than $50,000 USD connected to the Internet. On the other hand, Internet access among marginalized groups—whether by race, income, education, or geographic location—is growing the fastest (table 3.2).[2] This indicates that the classic S-shaped curve is occurring in the United States, with the early adopters and early majority now having access and the late majority starting to gain access now.[3] By a similar process, disparity by gender has already been overcome in the United States, with some 44.6% of men and 44.2% of women using the Internet by August 2000.

Table 3.2
Percentage of U.S. Households with Internet Access, 1998 and 2000

	Households (%)		Point Change	Expansion Rate (%)
	December 1998	August 2000		
Ethnic Group				
All	26.2	41.5	15.3	58.4
Black non-Hispanic	11.2	23.5	12.3	109.8[a]
Hispanic	12.6	23.6	11.0	87.3[a]
White non-Hispanic	29.8	46.1	16.3	54.7
Asian Amer. and Pacific Islander	36.0	56.8	20.8	57.8
Income				
Less than $15,000	7.1	12.7	5.6	78.9[a]
$15,000–$24,999	11.0	21.3	10.3	93.6[a]
$25,000–$34,999	19.1	34.0	14.9	78.0[a]
$35,000–$49,999	29.5	46.1	16.6	56.3
$50,000–$74,999	43.9	60.9	17.0	38.7
$75,000 and above	60.3	77.7	17.4	28.9
Education				
Less than high school	5.0	11.7	6.7	134.0[a]
High school graduate	16.3	29.9	13.6	83.4[a]
Some college	30.2	49.0	18.8	62.3[a]
College graduate	46.8	64.0	17.2	36.8
Postgraduate	53.0	69.9	16.9	31.9
Geographical Location				
Rural	22.2	38.9	16.7	75.2[a]
Urban	27.5	42.3	14.8	53.8
Central city	24.5	37.7	13.2	53.9

Source: Adapted from National Telecommunications and Information Administration (NTIA 2000).
[a] Above the average 58.4% expansion rate.

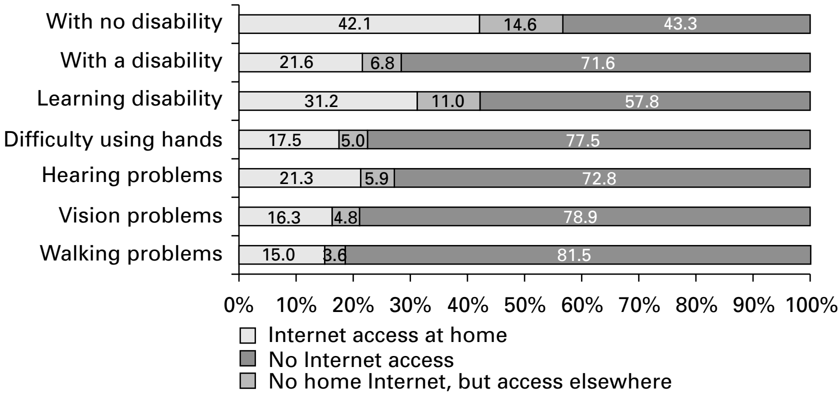

Figure 3.5
U.S. Internet access, by disability status, 1999.
Source: National Telecommunication and Information Administration (NTIA 2000). Used with permission.

Fourth, stark differences exist in access rates between the disabled and nondisabled. As mentioned earlier, only 21.6% of the disabled have home access to the Internet compared with 42.1% of people without disabilities. The discrepancy is even greater when rates of home access and access elsewhere are combined: 28.4% for disabled versus 56.7% for nondisabled (figure 3.5). All told, while just under 25% of people without a disability in the Untied States have never used a computer, close to 60% with a disability fall into that category.

In spite of the fast growth in Internet access among some disadvantaged groups, unequal physical access to the Internet in the United States is likely to remain a long-term concern. First, prior experience with other conduit services (such as telephone service) suggests that the expansion of the Internet will likely leave out at least a small percentage of the population for decades to come, and that this group will heavily overlap with those who are marginalized in other ways, such as by education, income, or disability. Second, even if discrepancies of access to basic Internet services are eventually overcome, the highly innovative nature of the computing and telecommunications industries indicates that new forms of technological disparities will arise in the near future. Research suggests that, in general, blacks and Hispanics, the poor, those with limited education, and those living in female-headed households are less likely to have advanced features at home such as broadband access, faster computers with modern peripherals, or multiple home computers (Becker 2000; NTIA 2000). While these services might seem like luxuries to many at present, the changing nature of the Internet may make them necessities sooner rather than later.

Finally, equal physical access itself does not imply equal ability to use ICT, which is affected by factors other than physical access, such as education and literacy (see chapter 4), content and language (see chapter 5), and social capital (see chapter 6).

Physical Access in Developing Countries

Physical access to the Internet is at a much lower rate in developing countries. Whereas wealthy countries face the challenge of providing universal service (ensuring everybody has the opportunity to have Internet service in the home), developing countries face the more limited but nonetheless pressing goal of providing universal access (ensuring that everybody has the opportunity to make use of the Internet somewhere—at home, work, school, a community technology center, or a rural telecenter). In terms of examining key challenges faced by developing countries in providing Internet access, three countries—Egypt, India, and China—provide useful examples.

Egypt

The Internet first entered Egypt in 1993, when a small university network was established in Cairo (*Information Technology in Egypt* 1998). The following year, the Egyptian cabinet's Information and Decision Support Center (IDSC) and the Regional Information Technology and Software Engineering Center (RITSEC) introduced the Internet more broadly, offering free Internet services for corporations, government agencies, nongovernmental organizations, and professionals. The Internet was commercialized in Egypt in 1996 and since then has grown rapidly, from about ten Internet service providers (ISPs) and some 20,000 users in 1996 to an estimated one hundred ISPs and 400,000 users in the year 2000, representing about 0.7% of the population.

The growth of the Internet in Egypt is constrained by many factors, the principal one economic. With a GDP per capita of $120 USD per month, few families can afford the $500+ USD costs involved in purchasing a computer, and fewer still can afford the flat rate of $15 USD per month Internet access charges. The economic strain is compounded by the fact that local telephone calls cost $1.00–$3.00 USD an hour, making frequent Internet use expensive even for the Egyptian middle class.

A second barrier is teledensity. At present, there are only about six phone lines per 100 people in Egypt, with less than two lines per 100 people in rural areas, which clearly places further restrictions on people's ability to access the Internet.

A third factor is literacy and education. Only 53.7% of the adult population in Egypt is literate, and few who are literate know how to use a computer.

A fourth factor is language skills. There is very little Internet content in Arabic, and most Internet use and computer-mediated communication in Egypt is in English. Only a small elite knows English well enough to use it on a regular basis for online research or communication, and few options exist yet for Arabic-language Internet use. (See additional discussion of language issues in chapter 4.)

Finally, uneven development and unequal distribution of resources also affect the growth of online access. Most of the wealth and resources of Egypt are concentrated in a few urban centers, principally Cairo and Alexandria. Most ISPs are also located in these cities. Egyptians living elsewhere usually have to pay long-distance connection rates, thus making Internet access even more expensive.

The bottom line is that Internet access is economically beyond the reach of Egypt's rural and urban poor, and can even become expensive for the country's middle class. People who log on cope with these expenses in a variety of ways, such as sharing Internet accounts or accessing the Internet via cyber cafés. Egypt is purported to have one of the highest rates of shared Internet accounts in the world, and the estimated total of 400,000 users throughout the country is based on only about 60,000 accounts. However, even beyond these individual and national economic factors, factors related to language, content, and education

Table 3.3
Internet and Mobile Phones in Egypt, 2001

	Internet	Mobile Telephones
First introduced	1994	1998
No. of users (2001)	400,000	2,000,000
Device	Computer (expensive, not very portable)	Mobile telephone (inexpensive, portable)
Monthly cost/ Basic account	~$15 USD (plus per minute charges for telephone use)	~$20 USD (plus per minute charges for telephone use beyond basic minutes)
Language	Principally English	Principally Arabic
Skill required	High skill level	No special skills

also hold down Internet use. For example, though mobile telephony can cost as much as or more than an Internet account, and mobile telephones were introduced five years later than the Internet in Egypt (in 1998), there are now some 2 million mobile phone users in the country, or nearly five times the number of Internet users. This outcome is the result of a number of causes, including, for example, the ease of use of a mobile telephone compared to the Internet and the fact that telephone communications can be conducted in Arabic instead of English (table 3.3).

India

No developing country has a more prominent information and communication technology sector than India, but actual access to the Internet reaches only a tiny fraction of the Indian population. On the one hand, the city of Bangalore alone has 300 ICT companies, including some world leaders in software and Internet design. On the other hand, 45% of the population cannot read or write, 44% of the people survive on less than $1 USD a day, and 370,000 villages in the country lack telephone connections (Hanson 2001; *World Development Report 2000/01*).

The Internet was first introduced in India in 1995. The number of users since then has risen from 10,000 that year to an estimated 5.5 million by 2001, which nonetheless represents only 0.5% of the population. As in Egypt, the use of the Internet in India is largely restricted to major urban areas; some 85% of users are found in eight large cities. In addition, 63% of users are under the age of 35, and 72% of users are male (Hanson 2001).

Factors restricting broader use of the Internet in India are similar to those in Egypt: low teledensity (2.2 per thousand) (*World Development Report 2000/01*); high rates of poverty; and limited knowledge of English outside of a small elite, combined with an as yet limited presence of Indian languages online.

China

China has the largest number of Internet users among developing countries and is expected within the next two decades to have the largest number of any country in the world. China first introduced the Internet in 1994 and now has some 26.5 million users, representing about 2% of the population (CNNIC 2001). The Internet in China has a broader geographic base than in India or Egypt, with network services reaching 230 cities throughout the country (Foster and Goodman 2000). However, there is still a strong geographic concentration of ICT service provision. The four wealthy Eastern areas of Beijing, Shanghai, Shandong, and Guangdong between them have some 50% of all the users in the country, whereas the impoverished Western provinces of Tibet, Qinghai, and Ningxia have less than 0.3% of the nation's Internet users among them (CNNIC 2000). Some 98% of Internet users in China have at least two years of college, a status achieved by only a small minority of Chinese people. As in India, the majority of regular Internet users in China are young (80% are 35 or under) and male (61%) (CNNIC 2001). Since most computing in China is done in Chinese—a language with a large number of Web sites—language does not pose the same barrier to Internet use as it does in Egypt or India.

While there is of course a great deal of diversity with regard to Internet access in developing countries, a number of significant patterns can be identified within the cases of India, China, and Egypt that appear to be typical for much of the developing world. First, Internet access only reaches a tiny percent of the population. Second, use is highly stratified and concentrated among a predominantly male, young elite based in major cities. Third, while there remains quite a bit of room for growth, none of these countries can expect to provide Internet service to the majority of citizens in the coming decades. Persistent problems of low teledensity, high poverty, rural underdevelopment, and limited education mean that the policy goal in the near future must be expanded service and universal access rather than universal service per se.

What Is to Be Done?

With these cases as a backdrop, efforts to achieve greater physical access in developed and developing countries are thrown into high relief. In particular, three issues are foregrounded in any analysis of formal moves to enhance physical access to ICT: affordability of computers, extension and affordability of telecommunications, and the provision of public access centers.

Affordability of Computers

The price of an entry-level computer has fallen steadily over the last several years and is expected to continue to fall in the coming years (table 3.4). For example, in the United States, the estimated entry-level computer price for 2002 is $577, an amount that is starting to approach what the average family might pay for a television set (Thierer 2001).

Given the high rate of innovation in the computer industry, the rapidly falling ratio of cost per computing power, the steadily decreasing cost of entry-level computers, and the continuous expansion of computers into

Table 3.4
Average Price of Base Model Personal Computer in the United States, 1996–2002

Year	Price (USD)	Annual Change (USD)
1996	$1,747	—
1997	$1,434	–$313
1998	$1,139	–$295
1999	$916	–$223
2002 (est.)	$577	

Source: Adapted from Thierer (2001).

larger numbers of households, there is not much to be gained by large-scale governmental provision of home computers in developed countries. Indeed, such programs can be counterproductive, either by draining resources from potentially more beneficial governmental initiatives, such as training programs, or by locking in particular hardware (or networking) infrastructures that end up slowing down innovation (e.g., the Minitel system in France has apparently slowed down the spread of more broad-based Internet service and access, thus undermining its laudable goal of providing socially relevant services online).

While general, large-scale governmental intervention in provision of computers is most likely unnecessary and perhaps even unhelpful, providing computers in particular circumstances tied to specific uses can of course be helpful. One example is "learn-to-earn" programs, whereby low-income participants in community development programs eventually get to keep a computer after going through a substantial amount of formally organized training (Clines 2001). Other examples include schools and school systems, where the educational goals necessitate that all students have access to a particular level or amount of technology, or workplace programs, where employers similarly find it beneficial to have all employees equipped with at least a basic computer.

In developing countries, the issue of affordability of computers is of course more critical. For example, twenty of the thirty-five least developed countries maintain statistics on personal computers per capita. Among these twenty countries, the median level of personal computers per 1,000 people is only 2 (UNDP 2000). In India, which is at the lower end of the next tier of countries (medium development), the level is 3 computers per 1,000 people. Even in China, where economic growth has created one of the largest information technology markets in the world, the level is only 9 computers per 1,000 people. These statistics are not surprising, given the low GNP per capita: $780 in China, $450 in India, and $410 in the low-income countries as a whole (*World Development Report 2000/01*).[4]

Innovator's Dilemma

The cost of computing power has fallen so dramatically that in theory even the poor should be able to afford computers. However, there is an important socioeconomic paradox at work here that hinders the ability of the unfettered market to function on behalf of the poor. This paradox is known widely as the innovator's dilemma (Christensen 1997). Simply put, companies and entire industries, as they become more successful, are driven to seek higher profit margins in order to survive. Once established markets become saturated, these higher profits are attained by means of adding new value to products, targeting the high-margin but narrow upper end of the market. In contrast, there is little incentive to create "disruptive technologies" (Christensen, Craig, and Hart 2001) that might bring entirely new product lines to as yet untapped but risky and low-margin mass markets.

One well-known example of adding new value to existing products was the path IBM took in creating more expensive and powerful mainframe computers for businesses while failing to see the potential of a brand new market for lower-cost, lower-performance personal computers. Similarly, today, the same computer companies that overtook IBM now devote their efforts toward making personal computers ever more powerful to achieve higher margins from U.S. business purchasers rather than initiating entirely new lines of inexpensive computers that would meet the needs of the poor in developing countries. This high-end emphasis is evident not only in hardware development but in software as well, with the dominant Microsoft operating system and office suite costing more than the annual income of most people in the developing world.

There are several compelling reasons that industries pursue the path of upper-market share rather than developing disruptive technologies (Christensen 1997). First, companies depend on customers and investors for financial resources, and it is the highest-performing companies in developed countries that are the largest and richest customers and investors. Investments and purchases by these companies strongly influence research and development within technology-oriented companies. Second, small markets don't solve the growth needs of large companies, and any brand new market is inevitably small to begin with (even though it may have the potential to become huge over time). Third, markets that don't yet exist cannot be analyzed or forecast, so planning new product lines for new markets is always a high-risk enterprise; note, for example, the ongoing financial woes of the Internet-based company Amazon.com, which first broke open the online shopping market. Fourth, products devoted toward the lower end of the market inevitably have lower profit margins. Hence, companies and industries spend far greater time, effort, and resources developing extravagant and expensive products whose full capacity is needed only by a small proportion of the world's population (think of anything from leather-interior sport utility vehicles to the bloated Microsoft Office software suite) rather than creating cheap, practical, mass-produced products that can serve the needs of hundreds of millions of people around the world.

The huge gap between the most developed countries and the rest of the world—not only in terms of income level but also in terms of physical, social, and legal infrastructures—exacerbates this dilemma. Once markets are saturated in developed countries, companies and industries do often seek to expand to the developing world, but they inevitably target the relatively small upper middle class in these countries. It is far safer—and, in the short run, more profitable—for Hewlett-Packard to sell its existing personal computers to businesses in Shanghai or Beijing rather than to try to develop an entirely new type of computer for China's, and the world's, poor.

What about companies in developing countries themselves? The largest and most successful ones are locked into the same dynamics as big companies in the developed world, pursuing larger profits through targeting the higher ends of the market in their countries and abroad. Smaller companies with social or economic motivations for developing products for the rural poor almost always lack the kind of venture capital that is required for major new technological product development. However, as Christensen, Craig, and Hart (2001) point out, the governments of large developing countries have greater resources than even the largest corporations. They are well able to lend an important hand in promoting the development of disruptive technologies that might serve the needs of their poor. Indeed, this is beginning to happen in some developing countries in the area of computer technologies.

Brazil's People's Computer One effort under way with governmental monetary and policy support is the development of a *computador popular* (people's computer) in Brazil.[5] Initiated by the national government, a Laboratory of Universal Access was established at the Federal University of Minas Gerais to build a low-cost, low-maintenance personal computer for the Brazilian masses. A team of professors, researchers, and graduate students has developed a prototype of a machine that resembles an ordinary personal computer with a 500 MHz processor, 64 MB of main memory, a color monitor, speakers, a keyboard and mouse, a 56 KBps modem, and extra modules so that a printer or disk drives can be added later. The main innovation concerning the device is a 16–32 MB flash chip that substitutes for a hard drive. This inexpensive nonvolatile chip has no moving parts, maintains its memory during power outages, and does not break down. The chip will come pre-installed with a free software package, including the Linux operating system and a Linux-based office suite and Internet browser. A portion of the flash chip's memory will be available for user data storage. Additional storage can be handled by local or remote servers.

Brazil's National Bank for Economic and Social Development is providing capital to manufacturers of the *computador popular*, and the government has already committed to purchasing 60,000 of the computers for use in schools. The people's computer will cost about $250 USD. Brazil's federal savings bank is establishing a special credit program for purchasers, who will pay approximately $10 USD per month for the computer over a period of three years.

India's Simputer A second, more ambitious plan is advancing in India for a Simputer,[6] or simple, inexpensive, mobile computer. The Simputer project was first conceived during the planning of an international seminar on information technology for developing countries held in Bangalore in October 1998.

One outcome of this conference was the formation of the Simputer trust by seven prominent Indian computer scientists in order to carry out research and development in the manufacture of low-cost computational devices, minicomputers, and computer- and Internet-related applications for rural, semirural, and lower-income people; to manufacture prototypes, simulations, and mock-ups of such devices and applications; and to encourage more widespread use of these technologies among the poorer sections of the country. The group launched a prototype of the

Simputer in April 2001 and is now seeking to license it to manufacturers for mass production.

Unlike the Brazilian people's computer, which is essentially a simplified version of a desktop computer, the Indian Simputer represents a radically new handheld computing device, with its hardware and functions planned in accord with the needs of India's working people. The machine looks at first glance like a slightly oversized Palm Pilot but is actually a pocket computer with 32 MB of RAM and a Linux-based operating system. Limited internal storage is available through flash memory, and a plug-in smart card allows the Simputer to connect wirelessly to a local server. The device is powered by regular AAA batteries, rechargeable batteries, or via a cord to a power outlet. The primary output is by image or sound, with an extensive amount of audio available in the form of text-to-speech or prerecorded audio snippets. The primary form of input is through touch, with items selected by touching them on the screen, but users can also tap in characters on a "soft keyboard" (that can be brought up on the screen, Palm-style) or trace the characters in a manner similar to Palm's graffiti system. Input and output are available in several of India's main languages. Thus neither knowledge of English nor literacy in any language is a prerequisite for using the Simputer. Finally, an especially rugged case offers protection against harsh environments.

The Simputer is designed to be sold for $200 USD, which is still beyond the reach of most of India's poor. However, it is also specifically designed to be shared by a collective of users. For example, the smart cards developed for use with the Simputer can contain personalization information required to log on to a community server that maintains personalized data about the user. A rural community could thus own several Simputer devices and rent them out for use to individuals who own the inexpensive smart cards. In this manner, a farming collective, artisan group, or rural telecenter could purchase Simputers for cooperative or public use.

The major projected uses of the Simputer include communication (e.g., checking if somebody in the next village is available for a meeting); transportation arrangements (e.g., reserving train tickets in the nearest city); microbanking (e.g., making utility payments and getting on-the-spot electronic receipts); rural health (e.g., collection and sharing of village health statistics and information); e-governance (e.g., accessing land records); and literacy development (based on features such as high-resolution text displays combined with audio files and text-to-speech in local languages).

Also innovative is the licensing plan proposed for Simputer products. Drawing inspiration from the open source software movement (e.g., Linux), the Simputer Trust plans to release the product through what is being called open hardware licensing. Manufacturers will be given the nonexclusive rights to manufacture the Simputer for a nominal fee and, if they wish, to modify and extend the Simputer's specifications. After a one-year window of development and marketing opportunity, the hardware design that they create will then revert to the public domain. The Simputer Trust members hope that this arrangement provides sufficient incentive to innovate while keeping the Simputer as a publicly accessible tool that can be further developed by many while still remaining affordable.

The Simputer has generated a great deal of anticipatory excitement in both India and other developing countries. It has also been met with some skepticism, especially in the West. As one U.S. high-tech entrepreneur wrote in a spirited discussion on Slashdot (the main Internet forum for computer discussions, with 30 million postings a month), "Why does the 'poor illiterate farmer' out in the fields need a computer? Just because you can mass-produce an inexpensive computer for the masses, doesn't necessarily mean that everyone in the masses actually needs one. Or wants one for that matter."[7] A reply by an Indian correspondent tried to convey the more complex reality of India and the role that information and communication technologies could play for rural development:

> In India the development is very uneven. So, there are a few states which are very poor and most which are OK and some really well off. What's happening out there currently is that the OK and the well off states actually have started giving computer access to people in villages. As to what they use it for—an example from actual usage—a soybean farmer finds out the price of soybeans in Chicago, because the price in Chicago affects the price in India in a few months, so, he can decide how much to sow. Also, when he is ready to sell his soybeans, he finds out which market gives him the best price and rents a truck to sell there. A widow is not getting a pension for her husband because of bureaucracy, she

goes to the village computer and pays about 10 cents to send an e-mail to a high up official. He responds and she starts getting the money.[8]

Whether the Simputer will ever fulfill the ambitious visions set for it is yet to be seen, and indeed, there remain many challenges to move the Simputer from prototype to mass production, let alone to integrate it fully into the kind of rural development uses suggested in the previous posting. Nevertheless, a significant number of these types of rural computer uses are already occurring in India (see chapters 4 and 6) and if the Simputer is successfully manufactured and distributed, it will likely contribute to the expansion of these extant practices. In the meantime, the very existence of the Simputer Trust and project has focused the energy of many leading engineers in India on trying to develop a device and infrastructure that fit the social, economic, and linguistic context of Indian society.

Telecommunications

The second arena for potential intervention, both in developed and developing countries, is telecommunications. Two issues of access provision are involved: the first is extending the telecommunications infrastructure throughout the country, and the second is making telecommunications and Internet accounts affordable to individuals. Again, for purposes of discussion, I address these issues separately for developed and developing countries.

Developed countries have, for the most part, solved the problem of extending basic telephone infrastructure throughout the country. In most developed countries, however, infrastructure inequality still exists in the area of broadband access. High-speed Internet access through cable modem and DSL lines is generally most available in urban and suburban areas, with limited availability in rural communities. It will be important in the future to monitor the issue of broadband infrastructure and see if urban-rural gaps are sufficiently met by market forces or if a persistent gap requires some kind of policy intervention. It is also worth noting that broadband access is expanding most rapidly where competitive services exist (e.g., cable modems vs. DSL providers, or multiple DSL providers with their own infrastructures; see OECD 2001). A highly competitive market helps account for the rapid expansion of broadband in South Korea, for example. In contrast, where there have been no competitive alternatives, the rollout of new broadband services has been much slower.

In the meantime, a more immediate problem for developed countries is the affordability of regular Internet access via telephone modems. The obstacle here is not the cost of the monthly Internet account, which is in most cases relatively inexpensive and often can be had for free, but rather the cost of metered telephone use charges. The OECD has calculated the cost of a monthly "Internet Access Basket," consisting of the cost of a phone line, forty hours of peak time phone usage, and an Internet account, in the thirty-one OECD countries. The variation in cost is great, from a high of $175 USD in the Czech Republic to only $25 USD in the United States. Unsurprisingly, those countries with greatest competition among telecommunication services tend to have the lower service rates, in large part because of the existence of unmetered telephone calls (or, alternatively, low per-minute costs).

As mentioned previously, developing countries face much more serious challenges in the area of telecommunications than do developed countries. These include extending existing wired telecommunications infrastructure and services throughout the country, making these wired phone services more affordable to individual users, and potentially leapfrogging to new forms of wireless connectivity. As is the case with telecommunications in developed countries, a key factor in addressing these challenges is telecommunications competition.

Scott Wallsten (2001) studied telecommunications performance in thirty African and Latin American countries. The study examines the impact of three factors—privatization, competition, and regulation—on telecommunications performance. Wallsten found that of the three factors, competition was the most effective agent of improved performance; greater competition was significantly associated with increases in the per capita number of telephone mainlines, the number of payphones, and general connection capacity, and a decrease in the price of a local phone call. Interestingly, privatization in and of itself had little benefit for users. Indeed, its only positive correlation was with an increase in the number of payphones available to consumers, and it was actually associated with a decrease in general connection capacity. However, when privatization was combined with the existence of a separate regulator, it had several positive associations, including increases in connection capacity, labor efficiency (measured by number of mainlines per telecommunications employee), and number of mainlines per capita. Wallsten's research refutes the view that privatization alone will bring improved communications service. His data show instead that competition, not mere privatization, is the real goal in any efforts to promote telecommunications diffusion and that competition is accomplished best through a combination of privatization plus effective regulatory reform.

However, increased competition alone will not resolve the telecommunications problems in the least developed countries. To do so will require leapfrogging via disruptive wireless technologies. Leapfrogging in a developmental context has been defined as the use of new technologies to either speed through or jump over stages of development (Singh 1999). It also can refer to skipping over a technological frontier or product cycle. In the context of telecommunications and the Internet, it can mean skipping to a more technically advanced telecommunications system in order to overcome the lack of land lines and thus assist a country in reaching a more advanced communications infrastructure. Ashkok Jhunjhunwala (2000), director of the Telecommunications and Computer Networks Group (TeNeT) at the Indian Institute of Technology, Madras, has put forward a convincing analysis of why telecommunications leapfrogging is necessary in a country like India. According to Jhunjhunwala, a telecommunications company in the United States, receiving an average of $360 per year ($30 per month) from a typical household account, can easily afford to invest $1,000 for each new line it installs. Therefore, the focus of research and development in the United States has been not so much on reducing per line cost but rather on providing a larger basket of services at a higher cost.

However, in a country such as India, assuming that a household is able to spend 7% of its income on telecommunications, only 1.6% of households would be able to afford a telephone at the cost of $350 USD per year (table 3.5). With current technology it actually costs about $800 for a telecommunications company to install each telephone line in India. With a need for a 35% return per year (based on 15% finance charges,

Table 3.5
Percentage of Indian Households That Can Potentially Afford Telephone Service, 2000

Annual Income	Households (%)	Affordable Annual Expenditure on Communications (USD)	Cost Per Line Investment Supported (USD)	Total Households Reached (%)
>$5,000	1.6	>$350	$1,000	1.6
$2,500–$5,000	6.3	$175–$350	$500–$1,000	7.9
$1,000–$2,500	23.3	$70–$175	$200–$500	31.2
$500–$1,000	31.8	$35–$70	$100–$200	63.0
<$500	37.0	<$35	<$100	—

Source: Adapted from Jhunjhunwala (2000).

10% depreciation, and 10% operation and maintenance), Indian telecommunications firms would actually need a monthly income of $280 USD per year per line, which is affordable to only some 3% of Indian households (corresponding closely with the current teledensity rate in India). If the cost per line installation could be brought down from $800 to $200 per month, then telephone service would be affordable by some 30% of Indian households, multiplying home phone access tenfold. However, an installation price drop of that scale will never be met through increased competition alone, since the wiring of individual homes is an expensive proposition anywhere in the world, and especially so in India.

In response to this conundrum, TeNeT has developed a wireless local loop system (Jhunjhunwala 2000) that can skip over the cost of wiring each household—the so-called last mile cost that is the plague of telecommunications development all around the world and that accounts for some two-thirds of the per line cost of installing phone lines. The wireless loop system can provide simultaneous Internet access and voice communication telephone services using satellite-based connections to 200–2,000 households within a 10–25 km radius at a current cost of roughly $375 USD per line per year in urban areas and $425 USD per line per year in urban areas. Jhunjhunwala believes this price can be driven down still more—to approximately $250 USD per new line—by creative use of the large informal labor sector in India. For example, cable television services already make use of self-employed people to visit individual homes, sell and install dishes that connect to cable television, and revisit cable-connected homes regularly to collect monthly charges (all at an operation cost of less than one-third of that which would be incurred if the organized corporate sector took on the same tasks). This strategy has provided livelihood to large numbers of self-employed people while driving down the cost of cable television to less than $4 USD per month in India, thereby contributing directly to its extremely rapid growth rate (from 0 in 1992 to 40 million households in 2000) (Jhunjhunwala 2000). It is reasonable to assume India's large numbers of self-employed people could be similarly effective in providing wireless local loop telecommunications connectivity, especially because the technology connects via a dish and thus requires less expertise than regular phone line connections (or even cable television).[9]

The wireless local loop system has been licensed for production to several manufacturers in India, Tunisia, and Singapore, and is already being deployed in Argentina, Brazil, Madagascar, Nigeria, Tunisia, Kenya, Angola, Yemen, Fiji, and Iran. Pilot use in India includes the built-up business district of Delhi (thus providing the "last mile" in an area that already had main phone lines) and a rural network of sixty-five villages in Andhra Pradesh, which previously lacked telephone and Internet access but now has both.

There are still many technical obstacles to further driving down the cost of wireless local loop systems, improving their capacity, and producing and installing them widely. More important, however, there are also large social, economic, and political barriers to developing and implementing this kind of disruptive technology on a mass scale. Telephone networks in India, as in other countries, are controlled by a handful of large companies (including the national government company and a few large international companies), none of which has put much emphasis on serving rural areas where population density is low and establishing new lines is expensive. However, neither do these companies like to see new competitors come onto the scene that could eventually challenge their current market dominance. At present, market control by a few major players is ensured by the prohibitive cost of new licenses to provide telephone lines, with no exceptions made for smaller companies that primarily or exclusively serve rural customers. Large telecommunications companies also have huge amounts of capital, which they use to provide all sorts of generous vendor financing. In contrast, local franchisees in India have little capital, so they depend on up-front vendor financing to get started, thus providing another important advantage to the major companies.

The major telecommunications companies currently operating in India are developing their own wireless networks, but these are designed to add value to existing telecommunications services and are aimed more or less exclusively at the already connected urban population, through, for example, expensive mobile telephone service as an adjunct to home or business connections. There is no indication that these companies have yet devoted significant research and development effort to the rural market. The Indian government, which itself owns the largest telecommunications company in the country (and also has amicable relations with the other large telecommunications companies), has yet to back the wireless local loop system. Ironically, at this point the government may actually be encouraging obstacles, for example by excluding smaller and newer telecommunications companies from bidding for large governmental contracts.[10]

The case of telecommunications development in India is a compelling example of the innovator's dilemma. Adding to this dilemma is the fact that the cost of installing new telephone lines, unlike that of producing computers, has not fallen significantly in recent years. This is a clear example where a disruptive technology is required to meet the needs of the hundreds of millions of people around the world who cannot afford telephone service. As I have already argued, the obstacles to diffusing such technology are not so much technological but social, economic, and political. Market-oriented systems reward and protect those that are developing products and services for the already existing market, especially the business sector and middle- and upper-middle-class consumers. In order to counteract this tendency, other kinds of support and incentives, most likely from governments, will be required to nurture technologies that meet the needs of low-income populations who only represent potential rather than existing markets.

Public Access Centers

Market expansion and decreased price of computers and telecommunications are essential to increasing Internet access around the world. At the same time, however, it will be decades before nearly every household in developed countries has Internet access, and much longer than that before universal home Internet service is reached in developing countries. It is thus necessary to enhance the provision of Internet connectivity through the establishment of public access sites.

Public access centers go by many names. The most common names used internationally are cyber café, telecenter, and community technology center. Other names have sprung up in particular countries or regions, such as computer kiosk (India) or *cabína publica* (Peru). Regardless of name, public access centers have many common features. They offer opportunities to use computers and the Internet without home ownership of a computer or a telephone line. In many places, the quality of computers and the speed of Internet access are higher than that ordinarily available in most homes. Many centers also offer forms of hands-on guidance, support, or training to users.

Public access centers also differ significantly along a number of axes (table 3.6). The first axis concerns management type. Centers can be run by commercial institutions, governments, schools, universities, and nongovernmental organizations. In some cases they are individual centers, in other cases, individually operated but part of a network or franchise, and in still others, multiple individual centers under the same administration or ownership.

A second axis pertains to location. Centers can operate in dedicated buildings, cafés, schools, universities, government offices, libraries, and community organizations and centers. They can be found in both urban and rural areas.

The third axis of difference relates to function. All centers offer some type of individual computer or Internet use, but some also offer training, community content production (e.g., flyer production for announcing forthcoming events), broader public services (e.g., mail service or utilities payment), or broader private services (e.g., banking activities or equipment rental). Centers also differ as to whether their main goal is to provide individual access to computers and the Internet, to train people in computer skills, or to assist community development.

6
in Internet Public Access Centers

Management		Location		Function	
	Administration	Site	Community	Service	Pur
cial	Individual	Café or restaurant	Urban	Individual computer and Internet use	Ind acc
l	Multiple	Dedicated telecenter	Rural	Training	Edu
y	Franchise	Public library		Content production	Cor dev
rnmental tion	Network	School		Broader public services (e.g., ordinary mail, utilities payment)	
		University		Broader private services (e.g., banking, office or equipment rental)	
		Community center			

Centers whose main function is to provide education or to assist with community development are discussed in more detail in chapters 5 and 6. For now, I focus on centers whose main purpose is to increase physical access to computers and the Internet. As in other issues related to connectivity, important differences exist between centers located in developed and developing countries. In developed countries, cyber cafés—coffee shops that include computers and Internet connections in their offerings—originally served primarily university students and young urban professionals. The emphasis was often as much on the café as it was on the cyber. Subsequently, and with Internet access becoming more common in developed societies, public access centers have in the past five years migrated toward serving the poor. Today, one is likely to find commercial cyber cafés with a clientele of immigrants writing home rather than of students keeping in touch with friends (Colker 2001). In addition to the rise of cyber cafés, long-standing public institutions, especially public libraries, are seeking to provide Internet access to the general public. In general, these public institutions target users who cannot otherwise afford to use the Internet. Community technology centers (CTCs), many of which see their goals as explicitly focused on community development rather than merely on individual access (see chapter 6), have also embraced the need to provide underserved communities and social groups with free or cheap access to telecommunications.

In developing countries, on the other hand, only a small percentage of the population can afford home use of computers and the Internet. Thus, public access centers in many locations are not an auxiliary method of accessing the Internet but the main method. A great deal of attention has gone into their design, implementation, and evaluation, especially in Latin America and the Caribbean, where many countries have sufficient resources to provide some telecommunications infrastructure but are not yet wealthy enough to allow for majority home access to computers or the Internet. Public access centers, generically referred to as *telecentros* (telecenters), are relatively widespread in Latin America and have been studied and discussed extensively (e.g., Gómez, Hunt, and Lamoureux 1999; Hunt 2001). A study by Proenza, Bastidas-Buch, and Montero (2001), based on direct observations in Peru, Panama, El Salvador, Guatemala, Brazil, and Chile with additional data collected from the remaining Latin American countries, is especially insightful in relation to telecenters. Their conclusions are as follows:

- A telecenter can be a powerful instrument for development but, to be effective, it must be part of a comprehensive economic and rural development strategy that also includes other institutional reforms to broaden the work opportunities and social and economic participation of traditionally excluded sectors of the population.
- Market incentives are important for the success of telecenters, but are not sufficient; particularly in remote and sparsely populated areas, government subsidies are required to make public access centers viable. This is already being done in some countries by means of government subsidies for public telephone services that help defray Internet connection costs for telecenters. The benefits of these investments should be maximized by extending them to Internet service as well as rural telephony.
- Telecenters can provide an important complement to formal education reform by providing support for students and teachers in relation to after-school computer and Internet use and by increasing Internet access for teachers, parents, recent graduates, and the community at large outside school hours. The educational impact of telecenters will be maximized if governments work simultaneously to strengthen the formal education system so that it routinely incorporates the effective use of new technologies.
- The impact of telecenters is multiplied if governments also give priority to the development of online content and public services aimed at meeting the economic and social needs of low-income populations, including portals and Web sites that use simple language and that broaden labor and self-employment opportunities.
- One of the main benefits of telecenters can be the promotion of virtual activism with real effects as a means of empowering low-income populations to be able to address their own problems constructively and effectively. This can be facilitated by the development of low-cost software tools for interaction and collaboration over the Internet and by telecenter administrators' supporting forums and projects that promote citizen interaction and social coordination.

• Successful telecenters must target a low-income population; retain strong commitment to self-sustainability and adopt a business model consistent with that commitment; and be backed by a leader who has a strong personal commitment, is willing to contribute his or her capital and time, is knowledgeable about the initiative's technical and financial requirements, and is willing to address the community's needs and investments.

Several of these points—such as education, community empowerment, and content development—are discussed at length later. I now turn specifically to the issue of content.

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Rethinking the Digital Divide

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