Development, Democracy, and the Village Telephone

by Sam Pitroda

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Modern telecommunications makes as big a difference to the Third-World poor as literacy or high-yield agriculture.

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I was born in 1942 and raised in a poor village in one of the poorest areas of rural India, a place with kerosene lamps and no running water. In 1980, at 38, I was a U.S. citizen and a self-made telecommunications millionaire. By 1990, I was 47 years old and nearing the end of nearly a decade back in India as leader of a controversial but largely successful effort to build an Indian information industry and begin the immense task of extending digital telecommunications to every corner of my native country, even to villages like the one where I was born.

That effort persists today at an increased pace, but it remains controversial. Some of the controversy has centered on me and my methods. Most of it focuses on the efficacy and logic of bringing information technology to people who are in global terms the poorest of the poor.

Common sense and accepted thinking about economic development have long held it ridiculous to supply Third-World villages with state-of-the-art technology. What subsistence farmers need is not high-tech science and complex systems, the argument goes, but immunizations, basic literacy, disease- and drought-resistant cereals and oilseeds, simple pumps, deep-drop toilets, two-phase electrification – all the "appropriate" technologies that the unsophisticated rural poor can use and understand.

I agree with this argument as far as it goes. Third-World farming villages need water, hygiene, health, and power, and the need is usually great. But the argument falls short in its definition of "appropriate." It ignores technology's profound social implications. And it comes dangerously close to consigning the Third-World poor to a life of third-rate capacities and opportunity. The policies of development agencies like the World Bank too often limit "appropriate technology" to the two-dimensional, twopenny solutions that bring the poor to the doorway of the modern world but not actually across the threshold.

For me, three facts about Third-World development stand out with great force. First, high technology is *already* an essential element in effective water sourcing, sanitation, construction, agriculture, and other development activities. Geohydrologic surveys are carried out from satellites. Bioengineering has revolutionized crop production. Appropriate technology has moved well beyond the water screw and the inclined plane.

Second, modern telecommunications and electronic information systems are thoroughly appropriate technologies even in those regions of the world that still lack adequate water, food, and power. The reason is simply that modern telecommunications is an indispensable aid in meeting basic needs. If a U.S. community needed, say, widespread immunizations or replacement of a power grid, would the telephone seem a vital or an irrelevant tool in getting the job done? Would the telephone seem more or less critical if the job were tied to a natural calamity such as flood or drought and required the mobilization of diverse resources over a broad area?

Third, as a great social leveler, information technology ranks second only to death. It can raze cultural barriers, overwhelm economic inequalities, even compensate for intellectual disparities. In short, high technology can put unequal human beings on an equal footing, and that makes it the most potent democratizing tool ever devised.

In 1942, the village of Titilagarh in the Indian state of Orissa, southwest of Calcutta, had a population of 6,000 or 7,000 and no electricity or

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telephones. My early education took place in one-room schools, and most of my classmates had no shoes or books. My family was of the *suthar* caste – lowly carpenters – yet my father was an ambitious man. He never learned English until I brought him to the United States to enjoy his retirement, but he did business with the English and used what opportunities he had to build a prosperous trade in lumber and hardware and to send most of his eight sons and daughters to high school and on to university. For 12 years, I lived with one or more of my brothers and sisters in towns and cities far from home and studied hard to get the kind of grades that would outweigh my origins. In 1964, I succeeded. I was only 21 years old, and I had never used a telephone. But my masters degree in physics, specializing in electronics, from Maharaja Sayajirao University in the city of Baroda in Gujarat state, gave me membership in a new technological caste that superseded the one I was born to.

My older brother and I decided that I should apply to a university in the United States to do postgraduate work, and my father readily agreed to give me $400 toward this education, expecting me in return to bring my brothers and sisters to the United States one by one as I made my way in the world. I applied to the University of Oregon and the Illinois Institute of Technology but did not apply for scholarships, on the theory that an expression of need might reduce my chances of getting in. I was accepted at both schools and chose Illinois. The state of Orissa gave me a travel grant of $600, just enough for a taste of every form of transport: a boat to Genoa, a train to London, an airplane to New York, and a Greyhound bus to Chicago.

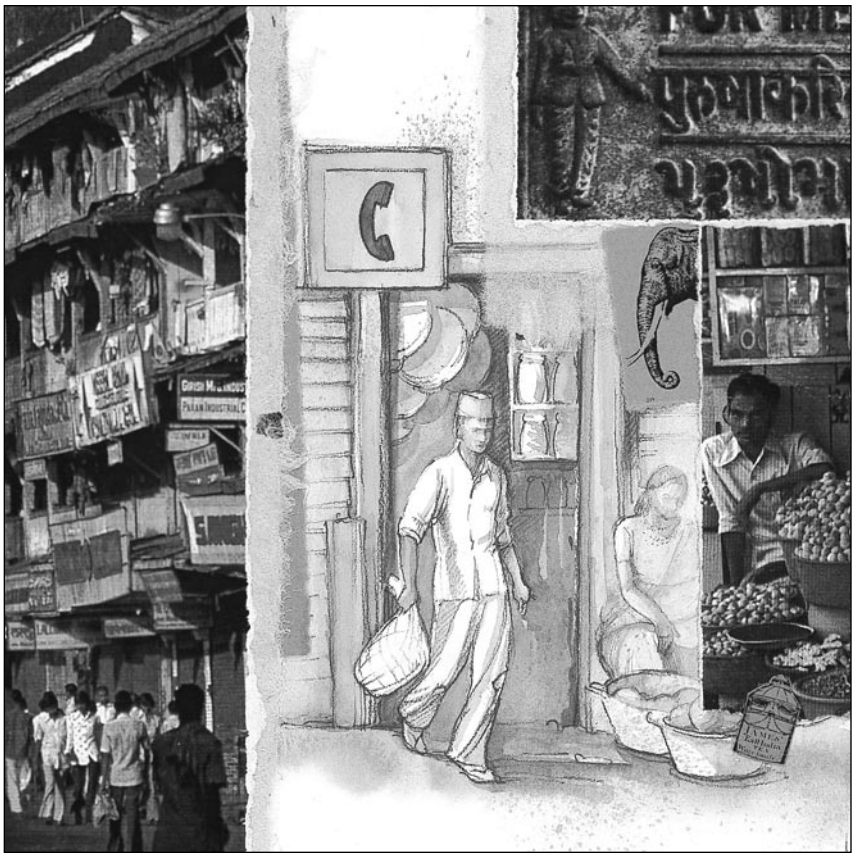
I arrived in December, 1964, with my father's $400 in my pocket. Tuition for the first semester was $700. I paid half on account, found a cheap apartment to share with another Indian, and landed a job in a physical chemistry lab to earn my keep and the rest of my tuition. A year later, I had a master's degree in electrical engineering. I had not only learned to use a telephone, I had, in essence, learned to make one. More important still, I had learned enough to design an electronic telephone switch.

Telephone switching is what operators used to do by hand in the early days of the century. Using a board with cords and plugs, the operator created a manual connection between the telephone in the caller's hand and the phone being called across town. Voice transmission then took place by means of analog electrical signals derived from a vibrating diaphragm in one handset and translated back into sound waves in the other. The system was marvelously simple, but, by technological standards, dreadfully labor intensive. If all the calls in the United States were handled that way today, every U.S. citizen would have to be a telephone operator.

Telecommunications was not closing but *widening* the gap between the First World and the Third.

Fortunately, electromechanical switching appeared in the 1920s, allowing the system to locate and connect two phones entirely by means of electrical signals opening and closing metallic contacts. These switches were automatic, but they had moving parts, and any device that moves wears out. So, while they required no operators, they did need people to carry out routine maintenance and regular replacement.

Finally, in the 1960s, I myself was involved in the invention and evolution of digital electronic switching equipment, which has two huge advantages over its analog predecessor. First, without moving parts and able to perform its own automatic maintenance, it never wears out. Second, it uses microchips as its basic building blocks and therefore takes up very little space. A large metropoli-



DRAWINGS BY NARDA LEBO

tan switching station for 50,000 phones once occupied a six-to-ten-floor building and needed hundreds of people to keep it operational. The same capacity can now be housed in one-tenth of the space and requires a staff of perhaps ten people to operate its computer and software controls. Indeed, the only serious remaining drawback is that digital switches still produce heat and must be air-conditioned to prevent overheating.

Over the next few years, I worked for GTE in Chicago, designing and refining digital switching equipment and analog-to-digital conversion technology. I was responsible for nearly 30 patents and enjoyed a prominent position at GTE's annual patents banquet in the late 1960s and early 1970s. I married an Indian girl I had met at the university in Baroda, started a family, brought my parents and most of my brothers and sisters to the States, and began to become a middle-class American.

But my father kept telling me I was too young to get into the habit of working for other people, and I was beginning to tire of pats on the back for the patents I'd won, so I quit. In 1974, with two local telecom entrepreneurs, I founded Wescom Switching Inc. – their money, my technical expertise – and we began manufacturing digital switching equipment that I designed. In 1980 – six years and more than a dozen patents later – we sold out to Rockwell International. As part of the deal, I agreed to work for Rockwell for three years and undertook not to compete in telecommunications for five years. My 10% of the company came to roughly $3.5 million in cash.

I left Titilagarh in 1951 to go to boarding school in Gujarat; I left India in 1964 to go to graduate school in the United States; now, in 1980, I was a millionaire, and to my own surprise I felt nearly as much guilt as satisfaction. All my life, I had dreamed of wealth and success, but now I suddenly confronted the fact that I had walked out on India. The sheer immensity of India's problems, the huge gap between my luxurious U.S. suburb and the struggling poverty of villages like the one where I was raised, the selfishness of my own success so far, all of it weighed on my mind and set me off in pursuit of another American dream: the exploration of a new frontier and challenge. In my case, that challenge was to use telecommunications as an agent of change – a bridge between the First World and the Third.

As I began my new job as vice-president at Rockwell, I began observing telecommunications at work in underdeveloped countries. What I saw disturbed me. On the whole, telecommunications was not so much closing as *widening* the gap between the rich countries of the north and the poor countries of the south. The First World, inventing and deploying new technology as if it were fast food, seemed headed in the direction of unlimited and universal information access. Even in the Second World, information technology had penetrated far enough to destroy the information monopoly that supported totalitarianism and to launch Eastern Europe toward the West. However, in the Third World, telecommunications and information technology remained an urban luxury, and an unreliable one at that. India had fewer than 2,500,000 telephones in 1980, almost all of them in a handful of urban centers. In fact, 7% of the country's urban population had 55% of the nation's telephones. The country had only 12,000 public telephones for 700,000,000 people, and 97% of India's 600,000 villages had no telephones at all.

To survive, India had to bring telecommunications to its villages. To thrive, it had to do so with Indian talent and technology.

What was worse, India, like most of the Third World, was using its priceless foreign exchange to buy the West's abandoned technology and install obsolete equipment that doomed the poor to move like telecom snails where Europeans, Americans, and Japanese were beginning to move like information greyhounds. The technological disparity was getting bigger not smaller. India and countries like her were falling farther and farther behind not just in the ability to chat with relatives or call the doctor but, much more critically, in the capacity to coordinate development activities, pursue scientific study, conduct business, operate markets, and participate more fully in the international community.

Worse still, I was perfectly certain that no large country entirely lacking an indigenous electronics industry could hope to compete economically in the coming century. To survive, India had to bring telecommunications to its towns and villages; to thrive, it had to do it with Indian talent and Indian technology. In other words, there were two goals to work toward: telecommunications and other information technologies could not only help Indians create wealth in every walk of life, a telecom and information industry could also create wealth of its own. Unless we had both, we had no future as a nation.

Worst of all, I began to see that information technology played an indispensable role in promoting openness, accessibility, accountability, connectivity, democracy, decentralization – all the "soft" qualities so essential to effective social, economic, and political development. India needed the capacity to network people, ideas, and initiatives. Telecommunications was as critical and fundamental to nation building as water, agriculture, health, and housing, and without it, India's democracy could founder.

I began looking for an entry into Indian telecommunications, a rigid bureaucracy with about a quarter of a million employees: one for every ten telephones.

In 1981, a friend in Bombay sent me a newspaper clipping reporting that Prime Minister Indira Gandhi had set up a high-level committee to review telecom development. I wrote to its chairman and asked for an interview. From my name and location, he concluded that I was an Italian-American with telecom products to peddle. I wrote back at greater length to say I had nothing at all to sell except the conviction that India possessed all the talent necessary to pursue telecommunications modernization on her own. He invited me to India. He could not absolutely promise me an appointment – and I would have to pay my own way – but he did ask me to come. Ultimately, I spent two hours with the entire high-level committee.

My message was that India should abandon electromechanical switching and move immediately toward digital systems for switching and transmission. My reasoning was twofold. First, electromechanical switching was ill-suited to the Indian climate and to Indian conditions. With few available telephones, most lines were intensively used, and electromechanical equipment was much more likely than digital to malfunction from overuse. (We later discovered that some public phones in India generate as many as 36 calls per hour at peak volume, compared with maybe 10 to 12 in the United States.) Electromechanical switches are also more vulnerable to dust and moisture. Analog transmission, finally, suffers over distance, while digital transmission is what gives those astonishingly intimate connections halfway around the world. In a country with low telephone density like India, distance – and therefore static – were nearly unavoidable.

Second, the development of digital technology would help build native industries in electronics, software, and related fields. Moreover, India needed one piece of digital equipment that no other country manufactured but that many developing nations could use: a small rural exchange. In the United States and Europe, the smallest exchanges built will accommodate 4,000 to 10,000 lines, and, in small towns and rural areas, these exchanges are installed and then deliberately underutilized. This kind of waste may be tolerable in a country where the number of small exchanges is tiny. In India, exchanges with a vast overcapacity would have to be installed in hundreds of thousands of villages, and waste on such a scale was unthinkable. Development of an efficient exchange for 100 to 200 telephones would not only solve India's problem, it would give the country a valuable high-tech export.

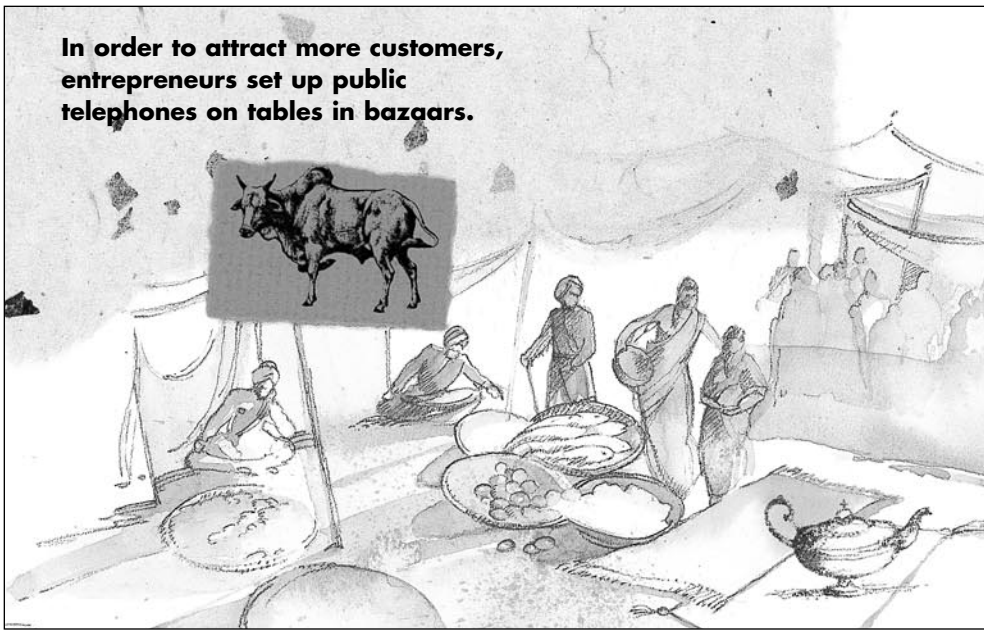
The committee was impressed – by my enthusiasm if nothing else – and suggested I meet the prime minister. Two weeks later, Mrs. Gandhi's office agreed to give me ten minutes of her time. Because I needed at least an hour to get my message across, however, I turned the offer down. New Delhi was full of people who had been waiting *years* to get ten minutes with the prime minister, but I really did need an hour. By pushing what few connections I could muster, I eventually got my background papers into the hands of two advisers to Mrs. Gandhi's son Rajiv. One of them spent several hours studying the file, and in November, after five months of trying, I got an hour with Mrs. Gandhi, her senior cabinet colleagues, the chief ministers of several Indian states, and Rajiv, whom I met for the first time that day but who was already an advocate for my point of view.

I began my slide presentation almost as soon as Mrs. Gandhi walked into the room. There was a lot of ground to cover, and I covered it as swiftly as I could. I summarized world telecom statistics and correlated telephone density to productivity, efficiency, prosperity, and gross national product in about 50 countries. I pointed out that only a handful of countries had achieved universal service and raised the possibility that it was not so much wealth that created telephone density as telephone density that created wealth. I reminded them that Indian telecom was characterized by high unsatisfied demand, low accessibility as well as density, poor connectivity, lack of dependability, substandard maintenance, superannuated technology, overcentralization, bureaucracy, bad management, and limited capital. I underlined India's reliance on imported equipment of traditional, not to say obsolete, design, and tied that equipment to poor service and system inflexibility. I laid out a program that emphasized rural accessibility, customer service, digital switching, and large-scale technological innovation and integration, all of it accompanied by privatization, deregulation, and organizational restructuring. I outlined plans for design, production, installation, networks, fax, E-mail, telex, and more. At the end, I spoke of resources and management and then offered three alternatives.

I wanted to set India on the path to universal telephone accessibility by the turn of the century.

The first alternative – obviously unacceptable – was to do nothing at all and let the system limp along until it failed completely. The second was to pursue the present development plan, using imported technology to address some problems and ignore others. But the present policies meant that India would fall steadily farther and farther behind the developed world, with dire consequences for India's economy, government, and people.

My third alternative was to adopt radical new technologies, products, and programs, hire new people – in particular, a core group of young research-and-development engineers to develop new hardware and software – and set India on the path to universal telecommunications accessibility by the turn of the century. I suggested the creation of new organizations with the power to issue bonds and sell stock to raise



In order to attract more customers, entrepreneurs set up public telephones on tables in bazaars.

massive sums of capital. I talked about large-scale manufacturing plants to meet domestic and export demand. I proposed a telecom commission to oversee regulatory requirements. I spoke of the need for a generational change in telecommunications thinking.

Prime Minister Gandhi listened attentively to the entire presentation, and when it was over, I answered a number of questions. In the days that followed, the word went out that the prime minister was interested in a plan to modernize Indian telecom, and I began three years of commuting between Chicago and New Delhi to put together a strategic framework, plan the program, give shape to an R&D entity for developing human resources and new technology, and lobby it all through India's parliament and intricate governmental bureaucracies.

Living in the United States for the most productive years of my life had altered my values and perceptions beyond recognition. My approach to business, and for that matter to life, had become performance oriented. But every few weeks I left Chicago for New Delhi and a set of standards and values that were feudal, hierarchical, and complex beyond belief. From my now thoroughly American point of view, India was in desperate need of modernization. And my frustrating efforts to install some of the modernizing mechanisms only underscored how badly the country needed technology to organize, simplify, economize, and create the infrastructure to meet basic human needs. I saw so much potential for technology's problem-solving capacity that even as I struggled through quagmires of social and political confusion, I was near to drowning in ideas and excitement.

Every few weeks, I flew to a culture that was feudal and complex beyond belief.

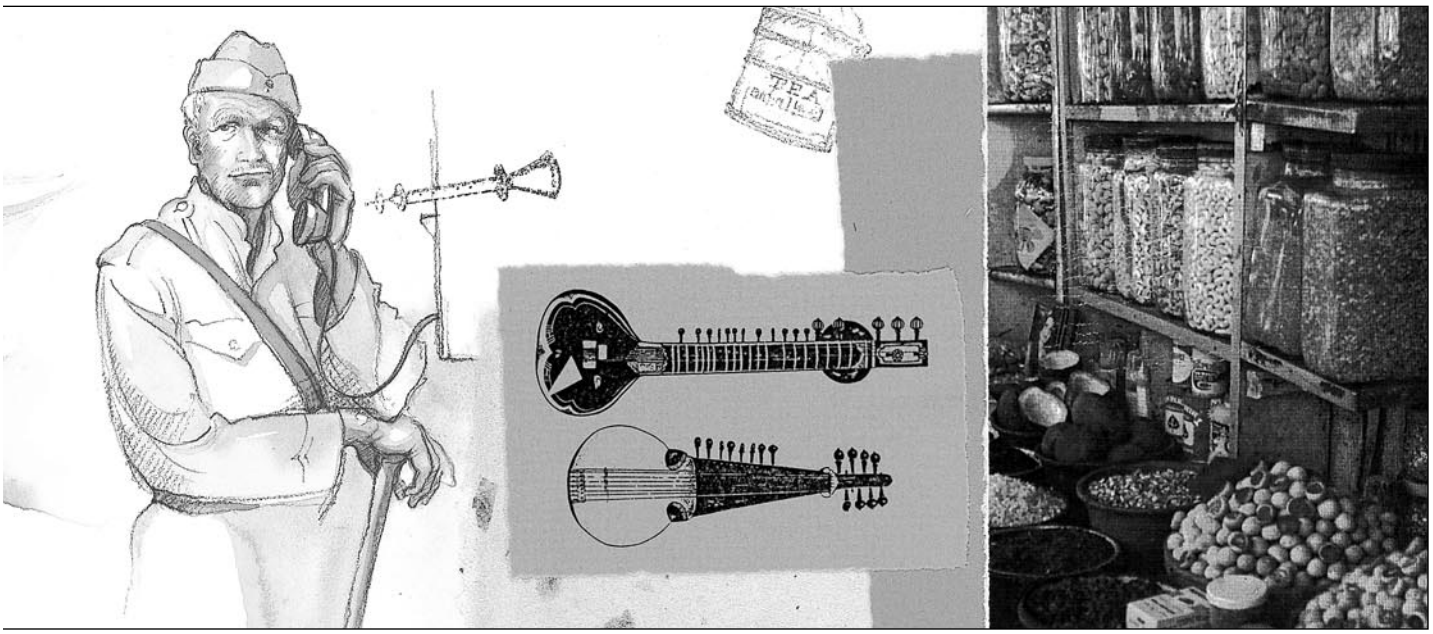
Through all of it, Rajiv Gandhi was my ally. I saw in him a young, energetic, modern man, direct and honest, eager to explore telecom's role in Indian development. He and I had clicked at our first meeting and quickly became friends. Over the next few years, we fought together for dozens of administrative experiments and reforms using information technology – computerization of railways, for example, and of land records, which was vital to the progress of land reform. At the moment, however, we worked together for the creation of the Centre for Development of Telematics, C-DOT as it came to be known.

The battle was uphill. Every important decision had a political as well as an economic impact. For example, a few months after my meeting with Mrs. Gandhi, India signed a deal with a French multinational to manufacture a digital switching system, so those who stood to profit from this arrangement opposed our concept of an indigenous digital industry and labeled it redundant. One European CEO wrote a strongly worded letter to Mrs. Gandhi pointing out that his company had already spent $1 billion developing digital technology and questioning the wisdom of so massive an investment by the Indian government. Given India's limited resources and the vast needs of its people, that argument had wide political support.

In 1984, the breakup of the U.S. Bell System set in motion a process of deregulation and privatization around the world and gave our proposals the extra boost they needed. In August, C-DOT was registered as a nonprofit society funded by the government but enjoying complete autonomy. Parliament agreed to give us $36 million over 36 months to develop a digital switching system suited to the Indian network. An executive director was appointed, we found five rooms in a rundown government hotel, and we went to work using beds as desks.

A few months later, in October, 1984, Indira Gandhi was assassinated, and her son Rajiv became prime minister. He and I decided that I should press the initiative for all it was worth. Since I could not simply pull up stakes and move to Delhi – back in Chicago, my father was dying of cancer – I began spending about half my time in each city. I did not finally move to India with my wife and children until August, 1986, after my father's death. In the meantime, I continued to commute, now more often than ever.

From 1984 on, I was a principal adviser to C-DOT with a salary of one rupee per year, an arrangement I



modeled on Roosevelt's dollar-a-year men during the New Deal. I wanted the chance to work for a cause, an Indian cause in particular, and I knew that in order to succeed, I had to place myself above the suspicion of greed or self-interest. In any case, what could I have earned? The top government salary at that time was 5,000 rupees per month – then about $400 – and I was spending more than ten times that amount of my own money just on plane fare and hotels. In any case, it was an arrangement that no one in New Delhi understood. One day the deputy minister for electronics took me aside and said, "Mr. Pitroda, what is it you really *want* out of this?" My answer, "Nothing," puzzled him. Whether or not he believed me, my motives remained a subject of discussion in New Delhi for the next six years, with eventual dire results for me.

Activity was bliss. Our engineers were very young and never seemed to rest.

For the moment, however, activity was bliss. Our engineers were conspicuously young, and they never seemed to sleep or rest. Most had been ready to leave India when this opportunity came along. Now they threw themselves into India's future and worked with an energy that the underdeveloped world is not commonly supposed to generate.

From the outset, C-DOT was much more than an engineering project. It did of course test the technical ability of our young engineers to design a whole family of digital switching systems and associated software suited to India's peculiar conditions. But it was also an exercise in national self-assurance. Years earlier, India's space and nuclear programs had given the country pride in its scientific capability. Now C-DOT had the chance to resurrect that pride.

From the outset, consequently, I was interested in process as well as product. Technology may be complex, but human motivations and interactions are even more so. I knew India had great young engineers, and I believed there was nothing they couldn't accomplish if we challenged them and gave them a proper environment to work in. Part of our mission was to inspire a whole generation of young talent and thumb our noses at the nay-sayers, the political reactionaries, and the vested interests whose prosperity rested entirely on imports. I set impossible targets. I cheered people on. Knowing as I did that young Indians did well in the United States, I tried to create an American work environment. I set about instilling a bias toward action, teamwork, risk, flexibility, simplicity, and openness. I was almost brutal in my determination to root out hierarchy and bureaucracy: I once shouted and made a thoroughly mortifying scene in order to get typists to stop leaping to their feet every time a manager entered their work space to use one of the two telephones we started out with. I did my best to shield our young engineers from bureaucrats, politicians, and business interests. At the same time, I opened our doors to the media, which responded with excitement, optimism, and the kind of hero worship that we hoped would attract more young people to technology careers.

By 1986, C-DOT had sprawling, chaotic offices, 425 employees (average age 25), and the drive, activity, and optimism of a U.S. presidential campaign. My methods had been highly unconventional for India and highly unpopular with a lot of the old guard, but within C-DOT we had accomplished wonders.

By 1987, within our three-year limit, we had delivered a 128-line rural exchange, a 128-line private automatic branch exchange for businesses, a small central exchange

with a capacity of 512 lines, and we were ready with field trials of a 10,000-line exchange. Better yet, the components for all these exchanges were interchangeable for maximum flexibility in design, installation, and repairs, and all of it was being manufactured *in India* to the international standard: a guaranteed maximum of one hour's downtime in 20 years of service. We had fallen short on one goal – our large urban exchange was well behind schedule – but, overall, C-DOT had proved itself a colossal, resounding success. In addition to the four exchanges, we had licensed some 40 public and private companies to manufacture and market C-DOT products, and more than 100 businesses had sprung up to manufacture ancillary parts and components.

Moreover, these rural exchanges were small masterpieces of "appropriate" design.

As I mentioned earlier, even digital switching produces heat, so switching equipment has to be air-conditioned in order to function dependably. But in the countryside, the Indian electrical grid is notoriously undependable, and we couldn't give villages exchanges that were certain to overheat the first time the electrical system went down. The solution was simple but ingenious. First, to produce less heat, we used low-power microprocessors and other devices that made the exchanges work just slightly slower. Second, we spread out the circuitry to give it a little more opportunity to "breathe." The cabinet had to be sealed against dust, of course, but by making the whole assembly a little larger than necessary, we created an opportunity for heat to rise internally to the cabinet cover and dissipate. The final product was a metal container about three feet by two feet by three feet, costing about $8,000, that required no air-conditioning and could be installed in a protected space somewhere in the village and switch phone calls more or less indefinitely in the heat and dust of an Indian summer as well as through the torrential Indian monsoon.

Our 512-line exchange was designed for the somewhat larger market town nearby, where it could handle intervillage and long-distance calls for a dozen villages or more. What now remained was to disseminate this new technology through the Indian telecommunications system and actually reach out to the towns and villages that needed it.

In 1987, I chaired a national conference that proposed the establishment of a new, streamlined, semiautonomous Telecom Commission to replace the old, heavily bureaucratic Department of Telecommunications. Before the government could act on that proposal, however, Rajiv Gandhi appointed me adviser to the prime minister on National Technology Missions, with the rank of minister of state. I had to give up my U.S. passport to take the job, but I couldn't turn down such a marvelous opportunity. The Technology Missions existed to marshal, motivate, and manage the efforts of more than ten-million people and lots of technology involved in meeting six basic human needs: drinking water, immunization, literacy, oilseeds, dairy production, and telecommunications.

Swept up in the romance of making a difference, I was working and traveling nearly around the clock.

Our specific goals were straightforward. Make clean, potable water available to about 100,000 problem villages in the amount of 40 liters a day per person and 30 liters a day per head of livestock. Immunize 20-million pregnant women and 20-million children every year. Teach 80-million people in the 15 to 35 age group – about 75% of adult illiterates – to read and write at a rate of 10 million each year. Increase oilseed production by as much as 18-million tons and reduce, eliminate, or reverse India's annual 10-billion-rupee import bill for edible oils. Increase dairy production from 44- to 61-million metric tons per year over eight years, raise dairy employment and incomes, and expand the number of dairy cooperatives by 42%. Last but hardly least, improve service, dependability, and accessibility of telecommunications all across the country, including rural areas.

The six mission directors worked for different ministries, so my job was to cheerlead, set agendas, and integrate the activities of ministries, state governments, national laboratories, and voluntary agencies. For two years, I traveled the country visiting tribal areas, villages, towns, cities, and state capitals. Every day I made two or three speeches, took part in half a dozen meetings, talked to scores of people, made dozens of phone calls (if a telephone could be found). I was doing my best to generate ideas, communicate goals and enthusiasm, fight red tape, clear obstacles, tie up loose ends, assess progress, mend bureaucratic fences, and bridge bureaucratic ravines. It became by far the most hectic period of my life, but I got swept up in the romance of making a difference and began working and traveling nearly around the clock. I saw enormous commitment from tens of thousands of people and solid resistance to change from entrenched interests. I began to sense an unholy alliance among many politicians, bureaucrats, and businessmen to stop people from taking power into their own

hands through literacy and community-based programs – and through communication.

I was learning the ropes of development in action, and everything I saw strengthened my conviction that telecommunications lies at the very heart of progress. This is true in the political and social sense – people must be able to reach out to government, media, institutions, and allies if they're to make their voices heard – and it is true in the more practical sense that development depends on communication for logistical efficiency. Let me give two examples of what I mean.

Politically, economically, socially, and logistically, telecommunications lies at the very heart of progress.

One of our greatest assets in the oilseed and dairy missions was Dr. Verghese Kurien, chairman of the National Dairy Development Board and winner of the World Food Prize in 1989. In the 1950s, Dr. Kurien started the farm cooperative movement in India and in 30 years built it into a multimillion-dollar enterprise with a membership of one-million farmers in 50,000 villages. Forgetting for the moment the added years and extra toil it took to build such an organization by word of mouth and personal recruitment, aided only by a postal system famous for incompetence, just imagine the task of galvanizing this organization into concerted action without the ability to computerize membership roles or to contact members by phone or telegraph. In spite of that limitation, Dr. Kurien has succeeded in stabilizing oilseed prices by buffer-stocking large quantities of oil and in building a cooperative milk-distribution system that reaches 170-million people. Telecommunications makes the efforts of men and women like Dr. Kurien incalculably less onerous and more effective, which is one of the reasons a dozen agribusiness lobbies in New Delhi oppose the spread of rural telephones.

Another example comes from the drinking-water mission. One group in the Rural Development Ministry was pushing for the purchase of 40 imported drilling rigs at a cost of several million dollars. Unfortunately, there were two vital pieces of information that no one seemed to possess: first, the number of drilling rigs already in the country, and second, the length of time it took to drill a well and how long it took to move a drill from one village to another.

We found a UNICEF official who was able to tell us that India already owned 1,200 drilling rigs, and several weeks of research revealed that, on average, it took about ten hours to drill a well and roughly ten days to move a rig. These were not ten days of travel time but ten days of bureaucratic wrangling and communication disarray in picking a site, negotiating political priorities, and getting the equipment on the road for a trip of a day or two. If a proper telecommunications network allowed the ministry to improve its planning and coordination even enough to cut that time to *five* days, India would gain the equivalent of 1,200 new water-drilling rigs without importing a single one.

Yet many of those who asked such questions and argued in favor of such solutions were accused of promoting technology *at the expense* of development and, to add insult to injury, of not understanding the plight of the drought-affected poor.

The fact was that no one in India had previously investigated and articulated the role that information systems play in development. Once we started, the practice and the insight grew and grew. After two years at the Technology Missions, I was given a chance to shape that practice even more directly.

In 1989, after two years of debate and study, the government decided to reorganize Indian telecommunications and create the Telecom Commission recommended in our 1987 report. Rajiv Gandhi appointed me the commission's chairman.

I met for three days with the heads of all telecom companies in the country: service providers, manufacturers, laboratories, C-DOT, and others. Then I met with the leaders of 37 telecom unions and the telephone white-collar bureaucracy. At the moment I took over, Telecom had 500,000 employees managing five-million lines, and it took me nine months to get their leaders to buy into my plan to quadruple the lines by the year 2000 without adding to the work force.

Once the unions were on board, we faced three fundamental challenges: connectivity, accessibility, and rural expansion.

First, we replaced all our existing electromechanical long-distance exchanges with digital equipment manufactured in India on license from a French company. We set up two factories to manufacture fiber optics and built high-speed fiber-optic highways to connect the four largest metropolitan areas: Bombay, Delhi, Calcutta, and Madras. We connected 400 district headquarters to automatic dialing, increased our population of digital switching exchanges by 50%, expanded the capacity of switching-system manufacturers, and increased automation at the operator level. We launched a multimillion-dollar program to computerize telecommunications operations nationwide. We introduced international direct dialing to more than 120 countries.

In a country the size of India with only five-million phones, it is difficult to have a significant impact on telephone *density.* Quadrupling the number of lines still means only one telephone for every 50 people, compared with more than one phone for every two people in the United States. *Accessibility* is another matter. By providing more phones in public places, we could put millions of people within reach of telecommunications.

In most areas, coin-operated phones seemed a poor idea for any number of reasons, including the fact that they cost a great deal to manufacture. Instead, we equip ordi-

nary instruments with small meters, then put these phones into the hands of entrepreneurs who set them up on tables in bazaars, on street corners, or in cafes or shops whose owners feel they attract customers. These telephone "owners," frequently the handicapped, take in cash from their customers but are billed only six times a year, with 20% to 25% discounted as their commission. The phones are in such constant use that, in most cases, the revenue is enough to support a family. We launched a drive to install 200,000 such phones in public places nationwide, creating more than 100,000 jobs along the way. Today, the small yellow signs indicating a public telephone can be seen all across India.

The third piece of the program was rural communication, close to my heart because of my own background, and I now set in motion an ambitious program that envisioned nothing less than universal telecommunications accessibility by the year 2000. For us, accessibility was to mean that every Indian citizen should live within three or four kilometers of a dependable instrument, a goal that may strike Westerners as trivial, though I believe it will alter the face of India.

Several years earlier, C-DOT had run a test in Karnataka state with hugely encouraging results. In one town of 5,000 people with almost no previous telephone service, business activity rose many times following installation of an automatic digital exchange for 100 lines. Suddenly, it was possible for a truck owner to chase his drivers, line up goods and labor by telephone, and monitor the movement of his vehicles. Local farmers could call nearby cities and get real prices for their produce. Artisans could speak to customers, machine operators could arrange for service and repairs, shopkeepers could order goods – all by phone and in real time. In the six months after the introduction of service, total bank deposits in the town rose by an impressive 80%.

There were also social benefits. The townspeople could call doctors and ambulances, order pumps and textbooks, call newspapers, speak to politicians, share experiences with colleagues, and organize community ceremonies and functions. One villager told me that when his father died seven years earlier, he'd had to send 20 messengers on trains and buses to inform relatives in nearby villages. More recently when his mother followed, the villager went to the local tea shop and phoned all 20 villages – instant, certain, and far less expensive.

One-hundred phones in a town of 5,000 is a laughable density to an American and a miracle by Indian standards. Among other surprises, we found considerable long-distance traffic not just to Delhi and Bombay but also to London and New York. The villagers, it seems, have relatives and friends in all four cities.

In 1989, we set a goal of installing one rural exchange a day. By 1993, Telecom was installing 25 rural exchanges every day, and the rate continues to accelerate. By 1995, 100,000 villages will have telephone service. By the turn of the century or very shortly after, almost all of India's 600,000 villages will be covered. Once in place, the village telephone becomes as critical as water, food, shelter, and health services. Once exposed, people in rural areas want a village telephone more than they want any other community service.

Countless Indian towns can bear witness to telecom's dramatic effect on business, employment, and the overall standard of living.

Of nearly equal importance for me, the community phone becomes an instrument of social change, fundamental to the process of democratization. With telecommunications networks now spreading across the Second and Third Worlds, I believe that no amount of effort can put information back in the hands of the few, to be isolated, concentrated, and controlled.

My own effectiveness with the Indian Telecom Commission ended in 1990. Rajiv Gandhi was defeated in parliamentary elections in November, 1989, and I came under political attack a short time later. Eventually I was accused of corruption. Businesses owned by my family in the United States were said to have profited by contracts I awarded while at C-DOT. A thorough investigation by the Comptroller and Auditor General of India turned up no evidence to support this allegation. Moreover, to my gratification, hundreds of scientists, colleagues, academics, and thousands of citizens came to my defense. But the strain was very great. My family moved back to the United States, and in October, 1990, I had a heart attack. A few months after quadruple bypass surgery in Delhi, I went back to work as chairman of the Telecom Commission, with high hopes that Rajiv Gandhi would be returned to office in the 1991 elections. When Rajiv was assassinated in May of 1991, I resigned from my job as chairman and rejoined my wife and children in Illinois. The only post I now held was adviser to the new prime minister on Technology Missions, the same position I had held under Rajiv Gandhi but resigned when he left office.

Though I don't think of my telecom work in India as finished, I have begun to alter my focus somewhat over the last two years. Specifically, I've been struck by the preconditions that the First World has set for Third-World development. Europe and North America built their economies with the help of coercion, work-force exploitation, child labor, and environmental plunder, but the First World has announced to the Third that these and other violations of human and ecological rights are quite unacceptable.

The developed countries are forcing human rights and environmental sensitivity on the world's poor, set-

ting all kinds of new conditions and restrictions on economic growth. This is not fair, of course, but it is an excellent policy.

Still, the First World must understand that it is not likely to achieve this policy goal except with the help of telecommunications and other information technologies, for two simple reasons.

First, telecom makes abuses infinitely easier to monitor. It gives watchdog groups as well as the victims and witnesses of human and environmental outrage access to one another. Local stories become international news, and local events become global events. Just as information technologies helped make totalitarianism impossible in Eastern Europe, they can help destroy exploitation in the developing world.

Second, telecom helps to create wealth, and prosperity is everywhere a force for civilized behavior. Take child labor. It is poverty that puts children to work, and it is unskilled labor that children are able to perform. When telecommunications comes to the Third World, it brings with it new economic activity, new higher-paying jobs for parents, and new technologies that reduce the utility of unskilled child labor. Countless towns and villages in India can bear witness to telecommunications' electrifying effect on entrepreneurialism, employment, and the overall standard of living. On top of all that, of course, information technologies create their own skilled jobs.

The dreadful human and physical conditions that the industrial revolution created in the West are now avoidable. But it is not some fundamental improvement in human nature that makes such progress possible. Growth without freedom and responsibility can still take place. It is technology, and information technology in particular, that makes humane development feasible.

The fact is, the telecom revolution has hardly begun. In addition to new products, systems, and integrated services, we will soon have new information-based relationships with our society and environment. But if sustainable progress of this kind is not to be limited to the developed world, then there is one initial hurdle still to clear.

The Third World still lacks adequate investment in telecommunications. Telecom in the developing world needs about $30 billion a year, of which only $3 billion is presently available. The World Bank devotes only 2% of all its funding to telecommunications. Corporations are attracted by the prospect of immense long-term profit but frightened by political risk and the certainty of social and economic experimentation.

Along with a number of fellow telecom engineers and executives, I am now working to organize a special funding agency, similar to the World Bank, to support Third-World telecommunications. Without proper telecom institutions and infrastructure, sustainable development with freedom will be difficult to achieve. Without telecom development, we will never deliver 75% of the world's people to the civilization of the information age.

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