G. PASCAL ZACHARY

A Program for Africa's Computer People

A little help from U.S. academics and business professionals could go a long way toward making the information sector an engine for economic development.

Jacob Aryetey has two personal computers on his desk, only one of which is connected to the Web. In his case, the Web-connected one is the anomaly. Aryetey is alone among the four computer science faculty at the University of Ghana to have Web access in his office. A native of Ghana, he is chairman of a computer science department that graduates about three dozen students a year.

A database specialist, the 48-year-old Aryetey is on the front lines of a little-known aspect of Africa: the drive to develop a home-grown cadre of software programmers and computer engineers who can make an African city—maybe Accra, Ghana's capital—a hub of information technology (IT) activity similar to India's Bangalore. Ghana, a country of 20 million people that is sandwiched on the coast of West Africa between the Ivory Coast and Togo, has a democratically elected government; has never had a

civil war; and has seen a vast expansion in the past five years in computing and communications capabilities.

Sub-Saharan Africa, of course, is better known for war, famine, natural disaster, and the HIV/AIDS pandemic. Many Africans have armed themselves with machetes and machine guns, not personal computers. But Aryetey is one African who is bent on disproving the stereotype that people from his part of the world cannot participate creatively in the digital world.

To be sure, being a computer professor in Ghana is daunting. Aryetey joined the department six years ago and teaches three classes a term, for which he is paid about $300 a month. His salary is large by the standards of his country, where nurses in public hospitals earn $50 a month and police officers even less. But good software programmers can earn twice or three times as much as a professor if they work in business. Demand for competent software programmers is high, so high that Aryetey struggles to fill open faculty slots. When he last found a competent, experienced person, he eagerly offered him a job. "I never heard from the person again," Aryetey recalls,

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"not even the courtesy to tell me he wasn't interested."

Aryetey says he could not remain in his university position were it not for his outside consulting activities. "My ability to work outside is what keeps me here," he says. There is no limit on the amount of time he can spend on other work; he even can cancel university classes (and has) if outside deadlines loom.

Without more faculty, Aryetey believes that instruction in the computer science department will remain inconsistent. "Some courses were designed ten to fifteen years ago," he says. Lecturers, gleaned from Accra's small community of commercial programmers and hardware engineers, bring more current practices into the classroom, but few volunteer to teach. The $5-an-hour salary, even though it does cover preparation and transportation, is not very appealing.

Isolated from the global intellectual currents in his field and short of help, Aryetey chiefly concentrates on maintaining a minimal standard for the seven to eight courses offered by the department each term. The university cannot offer a full-fledged bachelor of science degree because there are too few teachers, so students must double-major in another discipline such as math, physics, or chemistry. By senior year, about 35 students remain in the program. Aryetey, in addition to all his other activities, personally advises them all. He estimates that about five members of each graduating class are, in his view, "international class" in software and computer engineering skills. "Our emphasis is to give the fundamental principles in computer software," he says.

Gaps in learning, however, are significant. One afternoon, Kwesi Debra, the chief codewriter at the Bank of Ghana, visits campus to talk with computer science students about future careers. After explaining that he only the week before took over a class in the computer language C++ (from a professor who left suddenly for Scotland), Debra expresses his dismay that some of the third- and fourth-year students in his class had never even written or compiled a program in the computer language being taught and that in another class they are studying an assembly language from the 1960s. "I believe most of what you are learning here isn't relevant," he tells the students, then adds: "Your curriculum must be changed . . . It must be relevant to the needs of industry."

The better students in the computer science department recognize the most glaring inadequacies of their education. The department's computer lab has only about two dozen working PCs—none connected to the Internet. Some students write programs in longhand, then later type them into the computer. More determined students pay to use the Web café on campus, but at 50 cents an hour they can't afford much time online.

By their senior year, the best students often have exhausted the department's resources and are left to forage for knowledge on their own. They are not encouraged to get work experience and must search on their own to arrange volunteer internships. Students fret over "outdated material," such as "five-year old handouts," and lecturers who come to class unprepared or don't show up at all. "We wait 30 minutes and then we will go," says one fourth-year student. She adds: "Worse, the lecturers never offer to make up [a missed] class."

Students say they have no one to whom they can complain. "You are not advised to complain," says one of the top students in the department. "We've seen cases where lecturers retaliate against you. We don't have the freedom to complain." By comparison, the student says, more established departments provide stronger instruction and greater support. "In computer science, the university doesn't care about us."

Aryetey admits that the computer science department is a poor stepchild to older academic disciplines and explains that the university is frozen in time, with relatively large resources devoted to a department of statistics, because in the 1960s when the university's priorities were set (and largely remain), computer science was in its infancy as an academic field and statistics was central to the social sciences.

Individuals take the lead

The task of reforming technical and scientific education in Ghana is urgent, but the government possesses neither the resources nor the roadmap to lead the effort. Ghana is typical of countries in sub-Saharan Africa. The best Ghanaian students try to land places as undergraduates in U.S. or European universities, hoping to remain abroad after graduation. One who did was Patrick Awuah, who went on to become a code writer at Microsoft. In his mid-30s, Awuah decided to leave Microsoft in order to help Ghana, his native country, better compete in the software world. Showing no shortage of ambition, he founded a new

university 18 months ago.

The university is called Ashesi, which means "beginning" in Twi, the country's dominant traditional language. It is housed in an attractive compound in the central Accra neighborhood of Labone. To ensure that students gain a foundation in the school's core subjects, Ashesi offers a fixed lineup of courses for the first two years. These courses creates a common experience for students, help to maintain quality of instruction, and reduce the cost of running the school. The goal is to blend training in software engineering with liberal arts and business studies. In early 2002, Ashesi began its second year of instruction, with a freshman class twice the size of the previous year.

The very existence of a Patrick Awuah comes as a shock to theorists of underdevelopment and the digital divide. Africa is not supposed to supply code writers to Microsoft, and it certainly is not expected to get them back older, wiser, and more idealistic. Yet Awuah is literally trying to bring the spirit of Silicon Valley to Accra. Awuah is a quiet revolutionary, bent on creating a cadre of successful technology business leaders who are public-spirited and committed to lifting Africa by its bootstraps into the age of cyberspace. "We're not just building a technical workforce," he says. "We're training ethical and entrepreneurial business leaders."

Awuah, now 37 years old, lives in Seattle, shuttling to and from Ghana to administer the university. He plans to move and live full time in Ghana in mid-2003. Launching a university, he admits, is a gamble, both professionally and personally. In addition to raising $2.6 million in charitable donations on behalf of the school—some from other former Microsoft employees—Awuah has invested his own money as well. "We're taking some big risks here," he says. In order to maintain Web access for its faculty and students, Ashesi must spend $1,800 a month for a satellite link. Because of severe shortcomings in Ghana's public telecom system, Awuah's university must create and maintain its own infrastructure. This in itself is a step forward for Ghana. As recently as three years

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ago, private data networks, linked by satellite to the outside world, were unknown (and indeed essentially illegal) in Ghana.

The Ashesi experiment is drawing the attention of government officials and education policymakers, but it alone is not the answer. The annual tuition of more than $1,000 put Ashesi out of reach for all but a fortunate few. In the absence of either a good public university or an affordable private one, enterprising, computer-obsessed Ghanaian youth are crafting their own way forward. They grab whatever training they can: a mish-mash of distance learning over the Web and paid training courses available from private centers in the city. Some of these computer enthusiasts work in Web cafes, others manage computer networks, and a few customize standard software programs.

Dan Odamtten is one of these people who tailors programs, which requires him to learn programming scripts. Odamtten, 29, has only a high-school diploma. His father wanted him to become a nurse, but "I thought computers were the future," he says. To get started, Odamtten took a nine-month course at a computer institute, for which his mother paid the fees without telling her husband. Odamtten learned how to program in BASIC and, as an exercise, wrote a payroll program. Unable to find a computer job when he graduated, he convinced a local software house, which specializes in supplying programs to small banks, to train him without pay.

Odamtten began by installing shrink-wrapped software for the company's banking clients. After six months the company decided to put him on the payroll, but at only $30 a month. After another six months, he was asked to customize a program in MS-DOS. He has since moved to customizing Windows programs. The company now counts him as among its best programmers and pays him a few hundred dollars a month, or about five times the salary of a nurse. Despite his success, Odamtten worries about "falling behind," because it so difficult to acquire new skills.

The pressure to keep up with the pace of change is even greater for the relatively few programmers

in Accra who write original code. These programmers usually have some university training but are largely self-taught. One of the most thoughtful and active programmers in Accra is Guido Sohne. The son of a successful civil engineer, Sohne showed aptitude for computers in secondary school, posted a near-perfect score on his math SATs, and gained admission to Princeton University. But after two years, he flunked out because of poor study habits and failure to attend class. "I was too smart for my own good," he says. "I didn't go to class. I didn't take things seriously." Instead, he surfed the Internet constantly, becoming an accomplished player of multiple-user computer games. "On the Web, I was this superpowerful being, reaching the apex of my power—around exam time," he recalls. In his final quarter at Princeton, Sohne failed three classes.

That was about a decade ago. Sohne returned to Ghana with something to prove and sought help from Nii Narku Qauynor, a pivotal figure in Ghana's computer scene. A native of Ghana with a Ph.D. in computer science from the State University of New York at Stonybrook, Quaynor had in the early 1990s returned to live in Ghana after more than 10 years working for Digital Equipment Corporation. Quaynor was the first significant instance of an accomplished technologist returning to Ghana from abroad, and he would go on to form a networking company in Accra that brought Internet access to a West African country for the first time.

Quaynor helped Sohne found a software services company, which turned over an impressive $30,000 in revenues over two years before Sohne, ever restless, grew bored with the business and closed it. He then worked for a couple of years as the computer network manager of Soft, the pioneer software house in Accra. Today he works independently as a code writer, battling such difficult conditions as an absence of good tools and frequent power outages. Often, he codes in his parents' bedroom on his father's PC. With an electricity supply marked by frequent surges, drops, and interruptions, he says, "We just have to make saving every five minutes a habit."

Sohne is an advocate of open-source code and is an important voice in the emerging debate over protections on intellectual property in Ghana and the potential benefits of choosing public-domain software over proprietary programs such as those sold by Microsoft. Ghana, as a member of the World Trade Organization, is under pressure to revise and update its existing copyright law, which makes no explicit reference to software or digital media. Draft legislation to enact a U.S.-style system of protections for software has been proposed, but no action has been taken for many months as the government conducts a study that is expected to lay the basis for a national IT policy. Sohne opposes tight protections on software. He argues that although the country's small software producers need to benefit from their intellectual property, they also need to draw on the intellectual property of the United States and Europe in order to develop a pool of knowledge out of which African innovations may flow.

For programmers such as Odamtten and Sohne, there is no place to go to improve their skills. The instruction at the commercial computer schools in Accra is too basic, and universities don't offer challenging courses geared to adult students. There is no place in Ghana, for instance, to get a master's degree in any subject related to software or computer engineering. Professional bodies are weak or nonexistent. Ghana has an association of engineers, but the group devotes little time to computing or electrical engineering. There is an association of "Internet professionals," but the emphasis of the group is on marketing and business, not technical issues.

Sohne copes with his situation by foraging on the Web for useful bits, sometimes e-mailing Americans or Europeans whom he has never met for help. In late 2002, he wrote to a programmer in Utah, asking for an algorithm to help with a phone billing system that he was writing for Busyinternet, the Web café where he has kept an office. The American sent him a useful algorithm for free and Sohne responded, in hacker spirit, by sending him his completed billing code.

Forging technical links with foreigners can be difficult, however. Neither of the major U.S. professional bodies for computer engineers or software programmers, the Institute of Electrical and Electronic Engineers (IEEE) or the Association of Computing Machinery (ACM), has tailored memberships to people living in poor, remote countries. In the fall of 2002, Samuel Oduro, an electrical engineer, inquired about membership in IEEE, which has just a handful of members in Ghana, and was disappointed at the high cost of membership. The lowest fee rung, for

engineers earning under $11,000, calls for a membership fee of $70. Even if Oduro can scrape together the money, he has no mechanism to pay. He doesn't have a credit card (the normal way to pay on the Web) and the IEEE won't take a check from his local bank (in Ghana's currency). "Even if I want to pay the $70, how do I do send the money?" he asks.

Brain drain

The steady flow of educated people out of Africa puts great pressure on the university professors and technical professionals who remain behind. Although sub-Saharan Africa has the lowest educational achievement on average of any region in the world, African immigrants to the United States on average have spent more time in school than not only native-born Americans but every other immigrant group. According to the United Nations (UN), as many as 30,000 Africans living outside of the continent hold doctoral degrees. Thus, African migration to the United States, and to a lesser extent to Britain, France, Germany, and Holland, is a migration of elites. The elite migration pattern is especially applicable to Ghanaians (look no further than UN secretary general Kofi Annan, who hasn't lived in his country of origin for decades). One estimate, cited in the World Competitive Yearbook 2001, claims that 26 percent of the professionals educated in Ghana today live in developed countries; that is about eight times the percentage for India and China.

Most of the professionals leaving Ghana are doctors, accountants, and especially nurses. In the late 1990s alone, more than a thousand nurses may have left the country to take jobs in nurse-hungry Britain, South Africa, and northern Europe. Ghana simply doesn't produce a large enough number of electrical engineers and computer scientists to match the numbers of other professionals. But because demand for skilled computer people is already so high in Accra, Ghana's largest labor market, even a small flow of departures hurts.

Some of the best technical talent in Ghana leaves the country after secondary school to attend British or

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U.S. universities. These students are unlikely to ever return to Ghana, because the skills they gain from attending top universities essentially "price them out" of the Accra labor market. The question of brain drain is central to any analysis of the transformative potential of technology in Ghana. Recruitment of new code writers—even at an average starting salary of $500 a month, or 10 times the wages of a policeman or a nurse—is difficult. And retaining those who are hired is a problem. With no university within Ghana offering a master's degree in computer science, people who want advanced training often leave the country. "Keeping skills, stopping the brain drain, is our number one priority," says David Bolton, a British-born Ghanaian who manages programmers at Soft. "As soon as a programmer realizes what he can earn in the United States, how do you keep him?" Bolton, whose task is to find ways to keep code writers at home, points to his own decision to leave Britain a decade ago and move to Ghana, where his mother was born. "We have a good quality of life, but programmers need the latest tools, challenges, and rewards," he says.

The shortage of accomplished technical people raises costs and reduces output. "There are not a lot of good people," says an Australian who until recently served as the engineering chief of a wireless phone company in Accra. "The good ones become consultants, and they are bloody expensive."

There is no quick fix to the brain drain, and government policymakers seem flummoxed by the situation. Some have considered educating fewer people in computers or electrical engineering, because so many emigrate and provide no benefit to Ghana. But the government needs to boost enrollments in order to make Ghana a place where skilled computer workers can thrive and advance.

One intriguing possibility is to mobilize a planned software institute that will initially help the government improve its own use of IT. Initial funds for the institute, likely to open in the second half of 2003, come from India, whose government was privately

importuned by Kofi Annan to assist his country. India, whose prowess in software is well known, agreed to outfit a research and training lab and to tutor the inaugural group of Ghanaian instructors for six months in India. The government chose the group of trainees from its own civil servants, thus missing an opportunity to reward some of the country's talented but undertrained working programmers. But if managed wisely, the institute could transcend its initial mission of modernizing government operations to become a powerful magnet for the country's top programmers, who need a public center for advanced training in software engineering in order to undercut the temptation to exit Ghana.

To be sure, the brain drain won't stop, but perhaps it can be tamed. Quaynor argues that Ghana must produce more IT professionals, even if the domestic economy can't absorb them. If they succeed elsewhere in the world, he believes, "these people can be mobilized from a distance." And he warns against making it too hard for Ghanaians outside of the country to contribute back home. "Let them contribute easily and earn a reward."

Ways to help

U.S. universities are not set up to do charitable work in developing countries, but with support from the government and international organizations they can play an important role in helping African universities and their surrounding technical communities. Providing meaningful help will be challenging, but conditions in Africa are far from hopeless. As Ghana's case illustrates, there is a growing computer community that has the skills and interest to take advantage of stronger links to U.S. computer scientists and electrical engineers. Americans would be building on an existing base—fragile and immature, but dynamic. I recommend beginning with a few inexpensive and flexible efforts that can be done without Americans leaving the comfort of their offices and that will set the stage for integrating the African high-tech sector with the rest of the world.

Form a distance-learning partnership with a computer science department. The Massachusetts Institute of Technology and several other universities are making the materials for a number of courses available online. It would be a short step to identify various universities in sub-Saharan Africa that would encourage 5 or 10 of their best computer science students to audit a U.S. course electronically. There is no better way for an African to learn something of the state of the art in a field—and where his or her own educational deficits are—than to learn what the pacesetters are learning. U.S. professors can also help by exposing professors in Africa to relevant materials on the Web that would freshen course materials and excite students. And all of this would be done electronically.

Nurture a buddy system. Promising technical workers in Ghana face a constant battle against isolation, loneliness, and a shortage of good "inputs." E-mail offers a wonderful antidote to this. Why can't graduate students in top electrical engineering and computer science departments begin "pen-pal" relationships with programmers and computer engineers in Africa? This sounds prosaic, but one-on-one interactions are the basis for forming wider technical networks. Such networks don't include Africans, and they should. And not only the Africans would benefit. Wouldn't American technical talent gain from learning about the needs of less privileged students and professionals?

Enlist Africans in the global project of writing open-source code. Activists in the public-domain software movement can educate African code writers and computer scientists about the importance of open-source software and help them to master the techniques of assembling such code. Open source carries special significance for Africa, where the cost of software can be an insurmountable obstacle to progress. By way of full disclosure, I am involved in the early stages of a small collaboration, of the sort I am suggesting here, between Jerry Feldman, a computer scientist at the University of California at Berkeley, the Finnish philosopher Pekka Himanen (author of *The Hacker Ethic*), and a dozen volunteer programmers and university computer science students in Accra, Ghana. The goal is to create an instance of what Himanen describes as "open community development." Such collaborations could add to the inventory of open-source code and even create code that addresses specific unmet social needs in Africa. Even if no useful programs get created, the exchange between U.S. computer scientists and African university students and young programmers seems worthwhile.

Provide access to information. U.S. associations

of computer scientists and electrical engineers ought to offer more flexible ways for students, faculty, and working professionals in sub-Saharan Africa to benefit from the many journals and other materials produced by these associations. The question is not how to enroll Africans as members but rather to expose them to something of the latest trends in various fields and to remove any gratuitous barriers to African IT professionals who want to join groups such as ACM or IEEE.

Create a business presence. A major U.S. computer or software company could open a small outpost in an African city, dedicated to outreach with local universities and the identification of technical talent. Even a single engineer or programmer could make an enormous contribution to forging links between technically savvy Africans and the global technology mainstream. Corporations have opened such technical outposts in China, India, Russia, and elsewhere. It is easy to say it can't be done in Africa, yet the environment for such an experiment seems right in Ghana.

International organizations such as the World Bank or the United Nations Development Program could increase the relevance of African universities by helping them to improve links to practitioners in the IT community. International donors could support the creation of satellite campuses dedicated to the further education of computer and communications professionals. Individuals also can help. The government of India has funded the creation of a software center of excellence in Accra, and two European aid agencies have provided the bulk of the funding for Ghana's first formal venture capital fund. As the commercial high-tech industry grows in Africa, aid organizations such as USAID could help encourage links between entrepreneurs and African academics that improve the quality of instruction in computing and engineering programs, as well as help commercial companies meet their human resource needs.

Finally, international organizations could help African universities gain efficiencies by developing regional approaches to education. Ghana, for example, could be encouraged to cooperate with its African neighbors so that one country could build a specialty in, say, aviation engineering, while another concentrates on computer networking. Students could then be encouraged to attend the university that best suits their interests, regardless of national boundaries.

The combination of computing and communications is transforming developing countries, especially Africa, where great distances, a harsh climate, and poor infrastructure have long hampered development. But technological innovations do not arise in isolation from the people who create and use these innovations. Social networks shape technological choices, which reflect the values of the members of these human networks. Informal contacts between African and U.S. IT people might seem to be an insignificant contribution to the formidable challenge of raising the technical level in sub-Saharan Africa, but these contacts will create a necessary sense of inclusion among Africans in the global computer community. These transnational exchanges can also help identify and empower future leaders in Africa's fledgling computer scene. In an African country, a small number of capable, motivated, and intellectually nourished people can exert a substantial influence over educational and technological opportunities. If Africa's computer professionals succeed, they will provide an essential building block for wider economic development and an inspiring example to developing-country professionals in other sectors.