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Microcomputer Implementations in the Least-Developed Countries: Some Policy Considerations

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INTRODUCTION

This conference and its predecessors signal the widespread recognition that microcomputers are an important tool for developing countries to use in a wide variety of applications. This is not only a matter of conferences and abstract programs, however, as tens of thousands of microcomputers are already in use throughout the Third World, bought by private businesses and governments alike, independently and with bilateral and multilateral assistance. Microcomputers are now having a major impact on sectoral-management and general planning functions, and there is a growing, if still insufficient, literature on applications and implementation processes specific to the Third World. In this paper, however, we wish to point to one topic that has been relatively neglected—the circumstances facing computer implementations in the least-developed countries of the world. These special circumstances call for special policy considerations.

The suggestions we offer here are based on our experiences as technical advisors to the Government of Sudan on two USAID-funded projects in which computerization played a major role. One project involved the design and implementation of systems for financial accounting, developmental budgeting, project monitoring, commodity-assistance tracking, and donor coordination for the Sudanese Ministry of Finance and Economic Planning. The other project involved support for a program of research, policy formulation, and education for the Sudanese National Population Committee (NPC).

The two projects delivered and installed several microcomputers, developed specialized software (as well as supplying off-the-shelf software), and trained users. The systems installed were used for a range of functions from word processing in both Arabic and English through data-base management to formal simulation modeling.

A SYSTEM-POOR ENVIRONMENT

Even in the world's richest, most technologically advanced countries, computer use is still expanding into new applications and new organizational settings. New users can draw, however, on a rich background of experience, training institutions, support organizations, and technological infrastructure. This is of enormous importance even in small applications, but even more so in larger ones. As Kling and Scacchi (1982a) suggest, computer use involves a whole web of activities, relationships, and technologies. No one application can well be understood in isolation. This is particularly important for those countries of the world where computerization is still very limited—usually among the least-developed countries. In these countries, computerization efforts cannot build on strong foundations from prior computer use, strong support systems, physical infrastructure, technological familiarity, or even, in many cases, a common linguistic basis.

Foreign exchange and spare parts, as well as such basics as electricity, may be in short supply. In addition, in such countries computerization efforts are likely to be part of an unequal relationship between the host government and international donor agencies. Although the initial implementation may be skewed towards the interests of donors, Calhoun, Drummond, and Whittington (1987) have argued that computer use by LDC governments offers a potential aid to administrative efficiency, which in turn is a precondition of maintaining effective national sovereignty and planning autonomy.

In such settings, computing environments are unstable and underdeveloped. Yet computerization makes significant demands on environments. Unfortunately, the planning of many systems assumes a setting like the United States, Western Europe, or Japan, where a high level of environmental support is taken for granted. Failure to think through the special challenges of a "system-poor" environment is an important cause of failure and underutilization. Moreover, it is important that early applications foster the development of a stronger computing (and information-management) environment wherever possible. The following suggestions are guidelines for such implementations. Although they are made with special reference to the least-developed countries, many of them may apply wherever computer applications are relatively new and computing environments are relatively underdeveloped.

EQUIPMENT: KEEP IT SIMPLE

Reliability is more important than "state-of-the-art" in hardware. The number of unanticipated problems is multiplied in a physically hostile environment. For example, repair services in the Sudan were extremely limited, not only in absolute terms but also in the kinds of problems that could be solved. This situation stems from the country's absolute poverty, the low level of previous computer and other technological-system use, and even dependence on foreign aid. Foreign aid often skews equipment choice to those products manufactured in donor countries and may introduce problems (for example, availability of hard currency or stable, direct relationships with vendors) in securing a ready supply of parts.

The issue is not only that technology must be imported from industrial countries—this is a constant problem—but that many donors will give funds only for the purchase of goods manufactured in their own countries. Such restrictions impede any rational and coordinated equipment-purchasing policy in the governments of aid-dependent countries. U.S. government procurement policy systematically undercuts computer vendors in poor, low-technology economies, not only by requiring purchases to be made from U.S. manufacturers, but also by following lowest-bid-price rules that eliminate local vendors. Tying aid to purchases in donor countries is done to ensure that foreign aid boosts the donor's own economy and (in the case of capitalist countries) the private interests of the donor's manufacturers. Lowest-bid-price rules simply represent an attempt to manage costs and combat corruption. Unfortunately, keeping initial prices down in this way does not always keep long-term costs down.

Moreover, undercutting local vendors is both antithetical to the professed goal of development and damaging to the immediate task of computerization because it minimizes the development of support systems. Even where local purchases may be precluded, local maintenance contracts would be helpful; foreign donors characteristically do not provide for later maintenance of the goods they provide. This is also an argument in favor of brand-name purchases because they provide not only prestige but also better chances of service in remote settings. Alternate power supplies are another absolute necessity in a country (such as Sudan) that has an unreliable electricity supply.

An easy-to-maintain, simple system is better than an easy-to-use, more complex system. In the United States, software development has moved towards increasing internal complexity in an effort to achieve "user-friendliness." User-friendliness is a desirable goal anywhere, but an extremely unstable computing environment (like that in the Sudan) makes flexibility more important. Difficulties in training and retaining employees mean that any system will have to be easily learned. Few highly skilled people will be available to "maintain" or modify extremely complex software. Users will not be able to easily buy a new system or hire new technical advisors as applications change. Turnkey systems that work fine at the start of a project will tend to fail because of a lack of software maintenance or a changed organizational environment.

Simple applications are also often overlooked by microcomputer advisors who may have little real familiarity with the institution, its staff capabilities, or its needs. For example, in the NPC project, microcomputers were originally introduced to facilitate population modeling, but their greatest impact on the organization and its work turned out to be in English and Arabic word processing, which allowed for the development of improved record keeping, journal publication, correspondence, and so on. In this case, the advisors had to be familiar with Arabic software in order to select the best system and to provide training.

Observable, interactive, visually-oriented systems stand a better chance of succeeding than "black-box" or batch systems. The interactive friendliness and visual appeal of microcomputers is an important virtue to be maximized—even at the cost of system power. Shared goals and the boss's orders are often insufficient motivations for learning to use a system. We found that seeing the program work was important not only for teaching new users but also for explaining the workings of our systems to the senior decision makers in both Sudanese government and donor bureaucracies. In the Finance Ministry project, no one ever paid much attention to, really understood, or even wished to understand the system based on dBASE III. As a result, the system will probably not be used very much. In contrast, the systems based on Lotus 123 caught the attention of all sorts of people during demonstrations and generated an interest that will probably translate into more effective use.

Systems with modular, decentralized component parts will be more likely to survive. Highly integrated systems have undeniable advantages, but not as first (or early) computer implementations in very unstable, poorly developed, computing environments. Remember that systems will always fail. It is impossible to completely eliminate systems failure—the reasons can be technical, political, or organizational. In a modular system, the failure of one subsystem will not cripple the whole. For example, the Presidential Palace for a time overruled the Sudan Ministry of Finance's authority to enforce development-budget allocations. If work on the budget itself (the ultimate unifying system of our project) had to stop, other information-management functions could still proceed separately. Moreover, implementing one module at a time allows for an iterative feedback process to inform the whole effort (see below).

PEOPLE: TRAINING AND ORGANIZATION ARE KEY

The success of any computer application will be determined largely by its effect on the career paths (and remuneration) of individuals. One serious difficulty both projects faced was providing career tracks for the newly trained computer personnel. USAID and the Sudanese managers were unable to establish a fair method of awarding additional pay to people who could dramatically increase their salaries by leaving the Ministry of Finance as soon as they were trained. One of our better pupils secured a part-time position that paid ten times her government salary. Over time, such problems could become one of the greatest barriers to further introduction of computer technology. However, the answer must still be more, rather than less, training.

Training a few people to very high levels will not be as effective as training many people to lower levels. Highly trained specialists will, in the absence of very expensive inducements, probably leave. It might make more sense for such experts to be trained through the usual educational channels. Only by making training widely available will the organization as a whole become a hospitable environment for computer applications. This approach will make computer training less a scarce "property" to be controlled by individuals (or their supervisors) for personal advantage. It will encourage more employees to feel an investment in the new systems instead of a hostility toward them.

Training must include senior decision makers as well as the junior staff specializing in using a particular system. Senior officials cannot be expected to make good policy decisions about computerization efforts without general knowledge of the equipment and systems. Moreover, senior staff will shy away from discussing crucial questions if they think that it will make them look ignorant in front of junior staff. Special kinds of training are needed for senior officials who need to understand a system but are not expected to use it themselves. Senior staff will very likely consider it "inappropriate" to receive training side by side with the junior staff (even the middle-range managers for whom we designed one course failed to come after the Undersecretary decided that several very junior staff should also attend).

In the case of the National Population Committee, the secretary whose duties were once filing and occasional typing is now an indispensable part of the organization. Despite the importance of the computer in the committee's daily activities, no higher level staff have become familiar enough with the software to carry on in the secretary's absence.

Prior technical training or use of machines is an important predisposition to success in computer training. In the advanced economies nearly everyone deals with a sufficient range, variety, and complexity of mechanical and electromechanical appliances to be superficially familiar with how any specific device, such as a microcomputer, works. However, assumptions that seem obvious to us are not common knowledge in a system-poor environment. In a very poor country, even fairly well educated people may find it difficult to learn the basic orientation to a particular machine. For example, in the Ministry of Finance and Planning, many people were totally unfamiliar with an English keyboard and general typing skills. This unfamiliarity was a major obstacle for some people. The same problem may occur even when not using machines directly. Progress on our project directory was repeatedly delayed as a series of committees redesigned forms for data gathering. We had failed to communicate to the committees both that a data-base structure need not be an exact copy of the visual appearance of data on a form and that changing kinds or definitions of data for various fields would mean restructuring the data base.

As Kaplinsky (1985:435) has noted: "The recognition of the systemic nature of technology is not something that can be left to common sense. It requires a specific recognition in the structure of training programs, right across the skill spectrum."

People with engineering backgrounds tended to do better in our course than those who studied mathematics or economics. That, however, raises another problem: such people often had little interest in economic planning or financial management and only worked in the Ministry of Finance for lack of a more appropriate job.

TECHNIQUE: DEVELOPING THE COMPUTING ENVIRONMENT

Technical efficiency in itself is seldom a sufficient reason for adopting an innovation. The gains from such efficiency (1) may be spread very thinly through the organization as collective goods and not of sufficient benefit for someone to sponsor the innovation, (2) may be offset by a loss in personal power on the part of an important decision maker, or (3) may not be accompanied by a corollary improvement in personal situation in the organization. Generally, every application, no matter how self-evident its benefits may seem, requires an enthusiastic and powerful sponsor within the organization (compare Moris, 1977:127). For example, one subsystem that we proposed in the Ministry of Finance and Planning offered a fairly obvious gain in efficiency. Budget preparation—a task which occupies half-a-dozen staff for several months each year and which involves burdensome and repetitive clerical and arithmetical work that overwhelms policy analysis—was computerized in 50 work hours, including both system design and data.

Revisions that previously meant lengthy and error-ridden human recomputation would have been made routine. However, as best we can determine, the computer system was not fully or enthusiastically implemented because no one saw a direct gain. It would probably have cut the staff of an important section head; at the same time (against our advice), the physical computer (the potential reward) would have been located in the centralized MIS Unit, rather than in the section whose work would be computerized.

Any system that requires a new information flow, however reasonable or efficiently designed, will be more likely to fail than one that does not. Systems should be designed to make maximum use of existing information flows in order to make data collection as simple as possible. It proved much easier to develop software systems than to organize the data collection to make the systems worthwhile. The sheer shortage of reliable data and the difficulty of getting government officials to do research to find data should not be underestimated. Indeed, those who possess new computer skills seem particularly prone to feel that they are above searching for or checking over data. Whereas professionals may see computers as worthy of their attention, dealing with data is usually considered a merely clerical matter (even if, as in our case, clerical assistants able to do this work are not available). Consultants need to build a substantial plan for implementing data collection and management processes into their designs rather than assuming that these will follow easily from good system design.

Applications should be computerized incrementally to allow the implementation experience to influence the design and to increase organizational fit and commitment. Implementing this principle may run counter to the prevailing emphasis on top-down programming, but, as Simon (1969:209) has suggested, "Complex systems will evolve from simple systems much more rapidly if there are stable intermediate forms than if there are not."

Within the Ministry of Finance we found little appreciation of the need for accurate paper records. Ministry personnel did not themselves understand the flow of information from donors and within the Ministry. When the system was first being developed, virtually no one understood what was being computerized. As a result, it was necessary to design a simple system prototype, partially implement it to show how it worked, and then gather comments from Ministry staff as they began to better understand what was going on and what the range of possibilities were.

Verbal explanations are no substitute for seeing the systems at work. Any system that is designed completely in advance will tend to be less well suited to user needs and less accurately understood by users. It is also easier to keep the systems simple when they are developed modularly.

Implementations should be planned to promote rather than subvert development of a country's support-systems for computing. Within both a particular organization and a country as a whole, the biggest gain from early computerization efforts is likely to be the creation of a stable, supportive computing environment that will allow future implementations to be made at higher and higher levels of sophistication and efficacy.

One of the strengths of microcomputer technology as opposed to mainframe computing is the lower level of infrastructural support required. Nonetheless, microcomputer technology requires a fair amount, and much of that support may be lacking in developing countries. At present, applications tend to undercut the growth of better computing environments by (1) failing to buy from local suppliers, (2) failing to use and support local computer specialists and institutions (such as university computer-science departments or computer centers), and (3) failing to provide as much training and infrastructural development as they might. Any turnkey system, for example, designed to be run by very low-skilled locals with high-skilled contributions coming only from foreigners, minimizes its contribution to developing a better computing environment.

SUMMARY AND CONCLUSIONS

During the next few years, microcomputers are likely to become increasingly common in even the poorest Third World countries. In aid-dependent economies, especially, they hold the potential to help meet particularly acute problems of national administration and mediation between donors, planners, and development project workers. These countries, however, are extremely unstable and inhospitable computing environments. The nature of the earliest implementations will play a major role in determining how rapidly overall progress can be made, not only because they will serve as models, but also because they will create either rich or poor environments for later implementations.

Moreover, consultants and others engaged in introducing computers into these distinctive environments need to orient their work differently than they would in a more technologically or economically advanced country.

The issues we have suggested do not arise primarily from differences in individual abilities or motivations, nor even from general education levels. Rather, the key differences stem from the distinctive problems of (1) the introduction of microcomputers into organizations that have not used previous generations of computers (or even paper-based record-keeping and accounting techniques) and (2) the underdevelopment of computing environments because of general infrastructural weaknesses, specific organizational weaknesses, shortage of trained personnel, and more computer-specific issues. It is important to remember that even in the late 1980s computers are new in such settings. Applications, therefore, are unable to benefit from the higher level of general knowledge and support systems that bolster the use of computer systems in industrialized countries.

Despite the problems that will continue to plague computerization efforts, we think that microcomputers are an appropriate technology for even the least-developed countries. With sensible design and implementation, microcomputers will meet an important need. This need, moreover, is increasingly recognized by major international organizations and by various Third World governments. Consultants will be called upon to develop systems, many of greater magnitude and potential importance than those discussed here.

The features of computing environments that determine the outcomes of computerization efforts and the best implementation strategies should be specified. The present paper offers only extrapolations and suggestions from field experience. We hope, however, that it can contribute to the analysis of the effects of differing computing environments by showing some of the implications of a relatively extreme case: computerization in a very poor, very aid-dependent country, which had minimal experience of computers or other formal information-technology and management systems. The case is extreme because it unites two phenomena that are more commonly found apart: (1) a lack of organizational autonomy, signified in part by the predominance of external pressures in the push for computerization and (2) a lack of supporting technical infrastructure and prior experience with information systems. The problems we have cited do not make us think that computerization is intrinsically unfeasible or undesirable in such settings. On the contrary, we think that computerization can play a valuable role in enhancing administrative efficiency. This is useful not only for direct economic gains, but because it gives aid-dependent countries a better chance to gain control of development efforts.

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