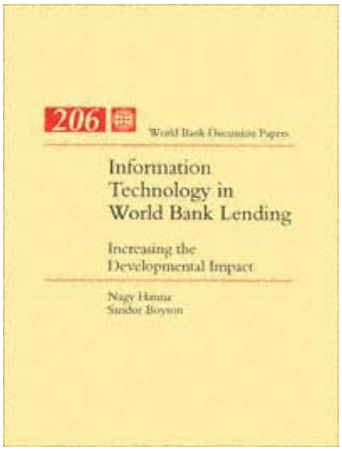


# Information Technology in World Bank Lending

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Increasing the Developmental Impact

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Sandor Boyson

The World Bank
Washington, D.C.


Manufactured in the United States of America}
First printing August 1993

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ISSN: 0259−210X

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**Library of Congress Cataloging−in−Publication Data**

Nagy, Hanna.
Information technology in World Bank lending increasing the
developmental impact / Nagy Hanna and Sandor Boyson.
p. cm.—(World Bank discussion papers; 206)
Includes bibliographical references.
ISBN 0−8213−2515−9
1. Bank loans—Data processing. 2. Loans, Foreign—Developing
countries—Data processing. 3. World Bank. I. Boyson, Sandor.
II. Title. III. Series.
HG1641.N22 1993
>332.1'532—dc20 93−5183
CIP

## Foreword

Information technology is rapidly changing all types of industries and services. It is becoming necessary to be fit for competition. It is inducing new business practices—such as outsourcing, delayering, lean production, Just−in−time procurement, customization and flexible manufacturing. These practices will increasingly influence how countries will participate in global trade in services and manufacturing. Developing countries must keep pace with this fundamental and pervasive technological change.

This study responds to a need to examine the role of information technology applications in the Bank's lending, the economic payoff of such investments, and ways and means to enhance their developmental impact.

A major finding of the study is that information technology lending is now an extremely dynamic business area for the Bank, growing at six times the growth rate of total Bank lending, and present in 90 percent of lending operations. A set of core competencies Is emerging, which blends the Bank's traditional concerns with macroeconomic and project management with the power of specialized applications of information technology. When best practices are adopted, the study demonstrates dramatic productivity increases and major qualitative improvements from modest investments in information technology components.

But the study also indicates that common practice in applying information technology still falls far short of best practice. Spearhead examples were often the product of "skunk work". A more proactive role is suggested, to avoid common pitfalls in applying the new technology, to ensure sustainability of investments in improved information systems, and to capture opportunities to build local capacity and diffuse best practice more widely among developing countries. The study recommends measures to enhance institution−wide management and learning, and to improve borrowers' and task managers' practices in developing information and communication systems.

Study findings and recommendations present a challenge to the Bank, aid agencies and developing countries. We are Just beginning to understand the profound implications of the information technology revolution. In a fast changing world, the Bank—and other aid agencies—must ensure it remains responsive to change and devise ways

to acquire new competencies and accelerate institutional learning. Substantial adjustment and learning will be required in moving to the information age.

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## Acknowledgement

The authors would like to acknowledge the contributions of Melissa Stone in developing a database on the information technology components, Laura Goodin for the graphical display of the analysis, and Bruce Ross−Larson for editing.

The authors are deeply indebted to Dan Ritchie, whose enthusiasm and support has made this research in this new field possible. They would also like to thank the large number of task managers and survey respondents (Table A3.1, Annex 3) whose insights and experience were generously shared. Finally, the study has benefitted from the extensive interactions and comments from Khalid Siraj, Carl Dahlman; Ali Sabeti, James Cowie, Eduardo Talero, Robert Schware, Jeremy Oppenheim, Sverrir Sigurdsson, Claudio Fernandez, Ali Hashim, Tony Moussa, and Ike Ikramulah.

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## Executive Summary

1. The burst of information technology is transforming industries, services, Jobs, products, markets, and organizations1 / . It is also creating a new divide between fast moving information−rich economies and slow moving information−poor economies. Developing countries and aid agencies need to keep pace with the associated technological, organizational, and human resource imperatives. They also need to overcome various barriers—in the adoption and diffusion of new technology and in the investment in new skills, practices, networks, and infrastructure. In this global information technology revolution, the World Bank has emerged as a major institutional investor in information technology applications in developing countries. This study, the first of its kind, examines both the patterns of such lending and the payoffs, drawing lessons for the Bank and for developing countries.

### Patterns of Information Technology Lending

2. A database on Bank lending for information technology components in Bank investment projects was established to analyze key regional and sectoral trends. This database contained almost 1,000 projects from fiscal 1986, 1989, 1990, and 1991, a portfolio representing about $100 billion in total investment lending. A major finding of our review is that *information technology lending is now an extremely dynamic business area for the Bank.* Its lending for information technology (not including telecommunications) rose from $379 million in 1986 to $890 million in 1991, a 235 percent increase—six times the 39 percent growth in total Bank lending over the same period. The dynamism of Bank lending in information technology has been largely the result of escalating demand by borrower countries for computing power that has become increasingly flexible, reliable, and lower in cost.

3. Perhaps more important than the growing level and share of lending for information technology are the presence of information systems components in almost 90 percent of Bank lending operations, and the increasingly critical and strategic functions such systems play in the implementation and management of those operations. This review provides substantial evidence of the versatile and catalytic roles of information technology components in all sectors and regions. It also provides evidence of the high expectations of task managers regarding the economic payoffs. The common use of information systems components in projects may not be fully reflected in aggregate lending levels because applications do not require lumpy investments. The pervasive use does, however, indicate the increasing intensity and importance of information and communication in adaptive planning and implementation of policies and investment programs, in responsive management of large organizations and public services, and in all types of transactions.

1 / Information technology (Informatics or IT) is defined broadly here as the set of technologies for information processing, storage, retrieval and transmission. Cost estimates of ITY components includes hardware, software, systems development, and associated training and technical assistance. As components, the study excludes free−standing telecommunication loans and telecommunication components.

4. Other major findings relate to shifting regional and sectoral patterns in information technology lending. Lending to Eastern Europe and countries of the former Soviet Union shifted dramatically the distribution of information technology lending among the regions. Between 1986 and 1991, the EMENA region went from having the lowest regional share of information technology lending to having the highest. Its share grew from $66 million to $330 million even though the number of projects in the EMENA region was the lowest among all regions. This reflects a major increase in the information technology intensity of Bank lending to economies whose financial and market institutions are being created or transformed. A spearhead project in this regard is the Hungarian Financial Systems Modernization Project. Eighty percent of the investment in this project—or $112 million—is directed at creating a data network linking 240 branches of the 12 largest banks with the National

Bank of Hungary for interbank accounting transactions.

5. The Asia region has had the second largest volume of information technology lending since 1990. Consistent with the region's rapid pace of industrialization and urbanization, information technology applications have focused on natural and urban resource management and on industrial modernization and pollution control in projects in China, India, Indonesia, the Philippines, and Sri Lanka. In Latin America, technology applications have tended to support the recent liberalization of previously inward−oriented middle−income countries, and have been aimed at the modernization of trade and finance, public sector management, and human resource development. Examples include the computerization of customs activities in Mexico, public tax revenue and expenditure tracking activities in Bolivia and Jamaica, and education activities in Brazil and the Dominican Republic. Finally, the Africa region has had the largest number of projects with information technology components of any region since 1986. The main focus there has been on automating data−intensive tasks in public administration, mostly in central ministries. Compared with those in other regions, information technology components of Bank−assisted projects in Africa tend to be small and less complex.

6. Underlying the accelerating pace and diversity of lending in information technology has been the development of a group of staff with generic skills in assisting borrowers in planning, appraising, and implementing information systems in all types of applications, as well as the housing of a Bankwide set of specific and highly leveraged technological and organizational skills—or *core competencies.* Scanning the range of Bank projects and information technology applications, one can readily identify emerging core competencies in macroeconomic and project management, geographic−based policy and planning systems, and sectoral networking.

7. *Macroeconomic and Project Management.* Core competencies blend the Bank's traditional concerns with macroeconomic and project management with the power of specialized applications of information technology. The need to analyze and monitor large amounts of socioeconomic data—and to manage public expenditure more effectively—has given rise to substantial investments in large−scale databases and interdependent information systems for macroeconomic management. In 26 countries in Africa, the Social Dimensions of Adjustment Project is using information technology to quickly gathering and analyzing vast amounts of household data on demographics, housing, education, health, nutrition, income, expenditure, and consumption patterns. As a result of

assistance to a growing number of borrowers, the Bank is also building core competencies in developing and integrating key systems to support fiscal policy, budgetary planning, expenditure control, debt and revenue management, government accounting, and personnel management. In computerized project management, the Bank has developed software packages to address project analysis, monitoring, and implementation (such as the family of software tools Jointly developed and marketed by EDI and Team Technology). Although the use of computerized project management tools is currently very low at the Bank, such tools offer powerful and user−friendly methods to improve project implementation, planning, and supervision. Perhaps more important, they could promote collaboration with clients and more systematic learning from experience in implementation.

8. *Geographic−Based Policy and Planning Systems.* Geographic information systems (GIS) technology merges separate digital databases containing maps and other essential information, such as demographics, to allow "views" for planning and management purposes that were previously impossible. The Bank has cultivated a strong core competence in GIS and adapted this technology across many regions and diverse sectoral applications—ranging from urban infrastructure analysis to natural resource mapping and monitoring. Through these diverse projects, Bank staff are learning to unbundle GIS packages and customize applications for specific development purposes. In the Angola Urban Environmental Rehabilitation Project, Bank staff have even developed novel extensions of the technology. Aerial photos of shanty areas were digitally processed, and shanty parcels were assigned "electronic pushpins" in a virtual addressing system that was a rapid and low−cost alternative to full parcel mapping for planning and taxation purposes. In the Philippines, GIS technology is being

used to map public health and sanitation data, and to Better target health services to poor, vulnerable, and remote communities.

9. *Sectoral Networking.* The demand to share information across distances has given rise to major Bank investments in networking projects across sectors and institutions in many countries. The Indonesian Higher Education Network is linking 16 universities in an on−line science database. The Hungary Agriculture Export Project includes a commodity exchange component that is creating an electronic network for trading food and related products nationwide. In Thailand, the Bank is sponsoring the largest integrated computer network ever attempted in that country—to computerize the tax system. These projects have all contributed to the Buildup of skills in network design, procurement, and installation support among a cadre of Bank staff and in−country technical staff.

## Payoffs of Information Technology Lending

10. To map and measure the payoffs of Bank lending in information technology, techniques from the total quality management field were employed. Quantitative process improvement measures and qualitative perceptions of "process owners"—or Bank task managers—were gleaned from appraisal and evaluation reviews and structured surveys.

11. Quantitative data were gathered from project appraisal reports, from Operations Evaluation Department project completion and audit reports, and from additional documentation provided by experts within and without the Bank.

In particular, three major areas of impact were targeted for examination: transforming trade and tax administration, modernizing public institutions, and poverty alleviation and social support. This review generated many concrete measures of process and product improvements tied to information technology lending.

12. *Transforming Trade and Tax Administration.* In support of structural adjustment programs, Bank−financed information systems are coming on−stream in Argentina, Brazil, Mexico, Morocco, the Philippines, Thailand, and elsewhere to modernize tax administration and trading systems, mobilize resources, and streamline bureaucracy. A review of spearhead projects presents a picture of radically transformed institutional capacities. In Mexico, the trading and customs system was changed through computerization and process redesign. Traders now make tariff payments not to customs but to commercial banks, which transfer computerized records of the transactions to the national treasury. Customs brokers, too, must present weekly electronic data on their clients' trades. In addition, a computer−based selection process was initiated to inspect trade transactions. This has streamlined the customs process from 12 steps to four. Finally, an electronic data communication network now links 13 customs sites. At Nuevo Laredo, the main trucking entry point to and from the United States, the number of operations handled daily went from 800 to 1,200, and the normal processing time per transaction was sliced from three days to 20 minutes as a result of the new computer system. Based on the results at Nuevo Laredo, it is estimated that reduced customs processing time attributed to automation will save Mexico $2 billion a year in quicker transactions, reduced transport and storage costs, and reduced undocumented expenses. These savings are about 5 percent of the value of merchandise trade—and almost 1 percent of Mexico's GDP.

13. *Modernizing Public Institutions.* The modernization of public sector institutions has been another common objective of information technology lending, with a range of projects in Brazil, Korea, India, and elsewhere. A spearhead example has been the China Railway Investment Project's computerized railway investment analysis system, a GIS tool developed by Bank staff to help transform the planning capacity of the Ministry of Railways. This tool simulates present and future traffic flows in the railway network, pinpoints traffic bottlenecks, analyzes the costs and benefits of potential investments, and allows for a comprehensive modeling of network impacts. It has enabled the Ministry to produce an optimization plan—a plan that optimizes the location, scale, and timing of

railway investments to yield gains of 10 percent in systemwide rail traffic throughput, representing some $4−5 billion of savings in new railway construction costs through the year 2000.

14. *Poverty Alleviation and Social Support.* Bank assistance has helped develop network computer systems that reduce central bureaucracies and allow services to move closer to clients. Projects in China, Ethiopia, Mexico, and elsewhere have begun to demonstrate the efficacy of information technology in this regard. An important Bank−sponsored automation project coming on−stream in Poland will link 350 local labor offices and 2,500 social welfare offices in a massive computer network. The network will help the nation cope with the rising unemployment and labor displacement emanating from its rapid shift to a market economy. Rapid client registrations, calculations, and payments of benefits; exchanges of client information between labor offices to accommodate migratory workers; labor market information exchange—these will

be functions of the system. In Lodz, a model automated labor office can register and calculate benefits for a client in about five minutes. The same process in unautomated labor offices can take two to three weeks.

15. These spearhead examples show the quantifiable process improvements that Bank lending in information technology have produced. As a check against these findings, a validated survey instrument was sent to 62 task managers to measure their perceptions of the value of information technology in projects. Most of the managers had information technology components of $1 million or more in their projects, which in many cases represented minor components of much larger projects. The managers were extremely positive in their perceptions of the impact of information technology. Among survey findings, 78 per cent of respondents perceived that—to a great or very great extent—information technology was critical to achieving project objectives. About 85 percent of the respondents expected major or transformational improvements from information technology applications in their projects. The most frequently cited improvements: better financial management and reporting, improved coordination between organizational activities, and improved organizational response to beneficiary or market needs.

16. Although recent Bank lending for information technology has evolved rather quickly in response to broad changes in development assistance programs and priorities, there is a relatively large gap in exploiting information technology in support of some new development priorities. The study provides examples of a new variety of Bank−financed information technology applications in support of environmental management, beneficiary participation and private sector development.

17. While highlighting the potentially high payoffs from "successful" information technology investments in developing countries, the study points to common pitfalls and constraints to effective adoption and broad diffusion of this new technology. Many of these pitfalls are universal, not unique to Bank projects or developing countries. But the severity of institutional weaknesses and information gaps in developing countries puts a high premium on setting the enabling policy environment, diffusing best practices, investing in complementary inputs, training local staff, and developing the infrastructure and support services to realize and sustain such payoffs.

## Implications for the Bank and Developing Countries

18. *Towards a Proactive Role.* So far, the Bank's response to the exploding demand for assistance in this new field has been reactive, with little strategic direction. The Bank has excessively relied on outside consultants to appraise and supervise information technology components. As a result, common practice appears to fall far short of best practice, and core competencies have built slowly in isolated pockets across the Bank, with little institutional direction or support. Moreover, the Bank has yet to exploit its strengths in strategy and policy formulation to address the policy, infrastructural and institutional constraints to the wide diffusion and effective use of information technology for economic modernization and borrower countries. More systematic Bank effort would help internalize the many valuable lessons in adapting information system to the needs of developing

countries and bring operational experience to bear in policy

dialogue and sector lending. Developing the Bank's competence in information technology assistance is critical to its future relevance and responsiveness. The developmental impact of the spearhead examples identified in this study suggests that it is both feasible and desirable for the Bank to take a proactive role, and thus move from "an industrial age mindset to an information age focus".

19. Two sets of recommendations flow from the study's findings:

(i) institutional measures that senior management of the Bank—and other aid agencies—may consider to promote institutional adjustment and learning, by (a) supporting experimentation, networks and research; (b) developing and harnessing core competencies; (c) deploying information technology for new development priorities; and (d) making project design more flexible and improving information sharing; and

(ii) practices and measures that task managers and their counterparts in developing countries may use to improve the payoff and sustainability of investments in information systems, by: (a) addressing the human and organizational factors; (b) using information to transform cost public management and business processes; and (c) adopting a strategic approach to address the policy and capability constraints to the wide diffusion and effective use of information technology.

20. *Experimenting, Networking and Researching.* Recent Bank lending suggests a growing appreciation of information technology's potential and versatility. Yet, information technology is far from mature and still at an early stage of diffusion. The information and communication needs of developing countries are extremely diverse, as are the capabilities and infrastructural conditions for deploying the new technology. Developing countries, the Bank, and other aid agencies must experiment and learn to exploit the new tools in different contexts and for different functions. To facilitate and accelerate such learning, the Bank should further develop its in−house information technology expertise, build networks with outside sources of expertise, intensify interactions between suppliers and potential users of expertise, and tailor expertise to the needs of different regions. The Bank may also need to develop "hybrid" staff with substantive knowledge of both a particular sector such as education, and of the information and communication needs and best practices in applying specialized information technology tools to the sector.

21. In addition to learning by using, the Bank—and other aid agencies and developing countries—must begin to invest in developing a set of analytical frameworks and tools to assess policies and investments in informatics. What policy and institutional frameworks are necessary for effective investment and diffusion of information technology? What frameworks should guide the development of public sector information management and public data networks? What evaluation techniques maybe appropriate to capture the benefits from the strategic application of information technology? This review suggests that .there is a long and pressing research agenda that is increasingly critical in view of the growing investments in information and communication systems.

22. *Developing and Harnessing Core Competencies.* Core competencies in key generic information technologies—and in fields ,of application of special relevance to the development agenda—should be strategically identified, developed, and managed. Examples include computerized project management and geographic information systems. Focusing on such core competencies would promote effective investment in key generic technologies among borrowers—and would provide common frameworks and information tools to facilitate dialogue, joint assessment of options, and partnership in project implementation. A strategy is being developed to accelerate the diffusion of computerized project management tools within the Bank and among borrowers and implementing agencies. The Asia Information Technology Laboratory may take the lead in implementing this strategy, in collaboration with other units with potential expertise. Best practices in the use of

information technology in major sectors and key management functions may also be monitored, and codified and disseminated as guidelines and frameworks for task managers and development practitioners. One example is a recent staff paper on information systems strategies to simplify, integrate, and speed up the processes involved in public financial management.

23. *Deploying Information Technology for New Development Priorities.* Information technology promises novel solutions to long−standing challenges and new development priorities: environment, governance, and private sector development. It offers a fundamental shift from the energy−intensive to the information−intensive economy. Consider these examples: Microprocessor control and computerized manufacturing resource planning can optimize industrial processes and reduce waste. Several countries are developing an electronic trading environment aimed at creating opportunities to benefit from the increasing globalization of trade. And geographic information systems combined with remote sensing can improve information on natural resources for planning, policy analysis, and monitoring. Information technology also offers new media and channels for participation, social learning, and governance. Applications in agricultural extension can lead to fast communication of more relevant information to more farmers and in interactive, demand−driven ways. The recent Venezuela Judicial Infrastructure Project supports improved governance by streamlining courtroom administrative procedures and improving the information systems of the judicial council. And the potential is unlimited for using information and communication technology to promote trade, develop competitive markets, reduce transaction costs for the private sector, and facilitate access to technological information.

24. *Making Project Design Flexible and Improving Information Sharing.* Modern information and communication systems offer opportunities to intensify communication and share tools and frameworks between the Bank and its borrowers. If appropriately built into lending operations, these information components can facilitate a shift from rigid blueprint project design to flexible design, continuous planning, and real−time implementation assistance. The Bank can also accelerate the process of retooling itself to become a truly knowledge−based learning organization, as it plays as an information broker and systematically captures and disseminates the learning arising from its engagement with its clients. Such retooling is particularly important for building new competencies and for sharing best practices in such fields as informatics.

25. *Addressing the Human and Organizational Factors.* Since the payoffs from information technology investments depend on institutional and human resource factors, it is disturbing that this review revealed that project funds for training and technical support make up a small share of total investment in information technology applications, significantly below the norm in industrial countries. Designers of information systems in development projects must understand the overall information infrastructure within institutions, and how this infrastructure reflects the power relationships and information needs of stakeholders. They should adopt approaches and processes to system design and implementation that identify the stakeholders and their interests, take account of current communication and decision making practices, and engender local ownership and sustainability.

26. *Transforming Core Public Management and Business Processes.* Apart from straightforward automation and operations support, information technology has the potential to transform organizational structures and business processes. In industrial countries, it is increasingly used to support new forms of organization, business practices, and service delivery. More recently, in public administration, there has been a shift in information systems use—from control to support for empowerment, service enhancement, and responsive governance. For development practitioners, the challenge is to use the power of the new technology to fashion new patterns of information and communication systems, support improved managerial practices, and induce change toward adaptive learning organizations.

27. Realizing this potential is unlikely to be easy, particularly in developing countries. It will require in−depth understanding of the institution's core business processes and leveraging those activities with highest value−added

to clients. It will also require substantial and cumulative organizational learning. It will depend on harnessing the support of stakeholders of the institution who would benefit from change and on mobilizing public or client pressures for responsive services. However, best practices are emerging to guide organizations in these advanced stages of learning to exploit modern information and communication systems. Development practitioners should identify such best practices, facilitate their international transfer, and mobilize resources and intermediaries to help in local adaptation and diffusion.

28. *Developing a Strategic Approach to Information Technology Lending.* With the growing volume of information technology components in lending operations and the vast potential for applications in public and private sectors, it is important to adopt strategic and comprehensive approaches to Bank assistance in this field. Currently, information technology applications are typically incorporated as a component of an investment operation in response to specific needs of the project, with little appreciation of information needs within and across sectors. As a result, information systems are often disparate and isolated, within little capacity for sharing data, and they sometimes provide overlapping or conflicting functionality and incomplete coverage, even when concerned with a common function within the public sector, such as financial management. Lending to isolated and specific information technology applications may not also address the policy, skill, and infrastructural factors that are often critical to the sustainability of these components and to the effective assimilation and diffusion of the new technology.

29. A strategic approach to developing and diffusing information technology in developing countries would aim at creating the policy and institutional environment for effective diffusion of the technology and, where applicable, at developing key segments of the information technology industry, such as software services. Within the public sector, a comprehensive approach is likely to identify and support those sectors or functions where information technology would contribute the most to a country's development. It could also induce standardization and competition in public procurement of information systems and the diffusion of best practices in technology and information management. Private sector users would be supported through the development of specialized technological infrastructure and consultancy services that would extend best practices in redesigning management and business processes with the help of information technology. The software industry has unique needs, typically requiring specialized intermediaries and programs for finance, marketing, quality improvement, and other common services. An example of a strategic approach is the proposed Information Technology Development and Diffusion Project for India. Such approaches recognize the emergence of information technology as a strategic industry, as a core technological competency, and as an enabling infrastructure—indispensable to all developing countries.

## 1.— Introduction

1.1 This study maps the roles of World Bank information technology lending in development and measures its impact. The study responds to a widely felt need in the Bank and outside to begin to formally evaluate the effectiveness of this lending, which reached $890 million in 1991.2 /

1.2 The study involved a series of exploratory activities:

Establishing a database on Bank lending for information technology components in investment projects

Reviewing feasibility reports, appraisal studies, and evaluations of ongoing and completed Bank projects with large information technology components

Administering structured surveys to a sample of task managers

Interviewing other key Bank staff, consultants, and outside experts.

1.3 This process was intended to give development practitioners a more multidimensional view of the impact of information technology lending and a more realistic picture of the ways in which institutions in developing countries can rethink and rebuild themselves with the help of information technology.

## Global Trends

1.4 The past decade has seen the emergence of the information economy. The share of information activities in national economies has increased steadily. Witness the fast growth of such services as finance, advertising, research, training, communication, electronic publishing, and on−line databases. Information workers now make up close to 50 percent of the working population in industrial countries.

1.5 This burst of information technology is creating a new divide: fast moving information−rich economies versus slow moving information−poor economies.3 / In a Schumpeterian "gale of creative destruction," information−technology−based innovations are transforming industries and services, undermining existing skills and occupations, creating new user−supplier relations, and challenging hierarchical organizational structures.4 / New

2 / Earlier studies have focused on describing some information technology landing patterns, but without attempting to measure the benefits—for example, Mousse and Schware (1992); and Hanna and Schware, (1990). The figure on the World Bank's information technology lending underestimates the total as it does not cover (1) financial intermediation lending, where subloans are used by information technology users and suppliers for investments in information systems; (2) structural adjustment and trade loans and credits; and (3) telecommunications lending (free−standing and components). When landing for free−standing telecommunications projects is added, information technology landing in 1991 would be $1.2 billion.

3 / OECD 1986; Machlup 1962; Porat 1977; Heisbitt 1983; Boll 1989; and Toffler 1990.

4 / Soete 1987; Freeman and Perez 1988; Miles 1992.

infrastructural systems, including telecommunications, integrated logistics, and value−added networks, are radically changing the cost of information processing in production and control activities, making new economies possible in the use of materials, labor, energy, and capital.

1.6 There has also been a fundamental shift from an industrial system based on mass production and mass consumption to one based on flexible production and customized consumption.5 / Industrial users and consumers are demanding more varied products and faster response. In response, firms are decentralizing and networking. They are using flexible manufacturing systems, which can be rapidly reprogrammed, allowing economies of scope and rapid customization. The capacity for faster transactions and Just−in−time delivery is emerging as a prerequisite of competing in the global business environment.

1.7 Such changes in production methods are driving associated changes in management practices and organizational models: total quality management, Just−in−time techniques, computer−assisted design, lean organization, and lean production.6 / Networks of suppliers and subcontractors are replacing vertically integrated structures, and large organizations are transforming themselves into small, decentralized, networked units.

1.8 Changes in corporate strategies (outsourcing and flexible specialization) and structures (networked organizations) are adaptive responses to a fast−changing environment for technologies, markets, and skill requirements. Faced with intensified competition on an increasingly global scale, corporations are adopting new forms of organization and resource management to capture and coordinate inputs across national boundaries and to achieve advantages in scale and scope.

1.9 All this is inducing new spatial forms for the organization of economic activities, new patterns of location, and new kinds of relationships between cities, regions, and nations.7 / The likely result: increased regional diversification and inequality—a division between territories that are plugged or switched into the network and those left behind.

### Opportunities—and Threats—for Developing Countries

1.10 The growing information base provides a major opportunity for developing countries that can access and use it effectively—and a threat to those that cannot. Information technology can be used to capture and mobilize local knowledge, to disseminate it among institutions and economic agents, and to blend it with global knowledge. It is an enabling technology, indispensable for competing in an increasing number of global industries and services. To exploit the potential of information technology, developing countries need to overcome various barriers to diffusion. They also need to develop new infrastructure and networks. And they need to invest in new skills and learning. Developing the systems, infrastructure, and capabilities

5 / Piore and Sabel 1984; Hirst and Zeitlin 1989; Hurray 1991; and Schmitz 1989.

6 / Womack and others 1990; Antonelli 1988; Peters 1989; Drucker 1988; OECD 1989.

7 / Hirst and Zeitlin 1989; Robins and Gillespie 1992; and Harvey 1989.

requires a strategy and no small amount of coordination among public, private, local, and foreign actors.

1.11 Developing countries also need to keep pace with new technological and organizational imperatives. This implies an increasing share of investments in intangibles: R and D, process rationalization, market exploration, total quality and just−in−time inventory management methods, flexible and lean organization, new documentation and transaction procedures, technical assistance, shared systems with suppliers, worker involvement, and labor force with multiple skills.8 / All this needs to be complemented by incentives and support systems to facilitate information flows, liberalize trade and foreign investment in services, institutionalize learning and experimentation, promote experience sharing and user groups, and mobilize local consultancy and industrial extension services.

1.12 Governments can improve the use and diffusion of information technology as users, investors, strategists, and regulators. Public agencies remain the largest user of and investor in information technology, and they have been influential in determining standards, developing the local market, and establishing best practices in systems development. In the East Asian newly industrializing countries (NICs), governments have proved crucial in coordinating investments and programs in telecommunications, education and training, and the diffusion of specific information services and software applications. They have also created clusters of institutions to improve the absorption capabilities of their small and medium−size enterprises. Demonstration projects are used as mechanisms to build cooperative infrastructure (networks and research consortia) and to speed the learning process (TradeNet and civil service computerization in Singapore).

1.13 The public sector is the biggest collector of data on all types of economic and social activities and on natural and demographic resources. The dissemination of such information is one key to competitiveness. Industrial

country governments have policies to expand private access to public data, to improve and harmonize data standards, and to promote a competitive market in information services. These policies are also essential for developing countries—to provide access to global knowledge and international databases and to create new options for mobilizing and using their own local knowledge and information resources.

1.14 Perhaps the biggest opportunity information technology holds for the public sector is to inform policy analysis and strategic management, to improve monitoring and accountability, to facilitate participation and lateral communication, and to enhance learning and feedback. Particularly in developing countries, improved information and communication systems could enable public institutions to respond to rising demands for diversified public

8 / Physical investment is being outstripped by high rates of intangible investments in most OECD countries. Factors that are changing the balance between physical and intangible investments include (1) increasing realization that R&D, skills, and organization determine competitiveness; (2) process rationalization investments; (3) high rates of investment in information systems; and (4) shifts to service and high−technology industries that are skill−innovation−, and information−intensive (OECD 1992).

services, new modes of delivery, faster transactions, and more transparent processes.9 /

## Study Design

1.15 Given the global trends and their implications, and the high investments in information technology by the Bank and by its country borrowers, three questions arise' What role do such investments play in overall Bank lending? What have been the payoffs? And what lessons can be learned?

1.16 Even though information and communication systems have become integral components of most investment and technical assistance projects, few attempts have been made to track information technology investments in multilateral lending and other official aid flows.10 / there are many opinions about the payoffs to information technology investments, but there is little in the way of hard data. Some raise doubts about the payoffs in the context of developing countries, given their absorptive capacity and institutional constraints. Discontent with approaches and methodologies for mapping the payoffs (if any) of information technology seems pervasive and it extends well beyond the bank staff or their developing country counterparts.

1.17 The total quality management movement has given rise to techniques for measuring the impact of information technology that capture and analyze both quantitative and qualitative data. Concrete "before and after" measures that describe process improvements and end−product performance improvements are matched with surveys of attitudes and satisfactions levels of process "owners" (customers and shareholders) in unified information technology impact assessments. (The variety of such techniques now available is summarized in table A1.1 in annex 1.)

1.18 These techniques share two related assumptions about the effective use of information technology:

It Is Linked To Effective Organizational Structures And Management.

It entails organizational redesign, taking a broad look across an organization to introduce changes in strategy, management, operations, cost structures, and external transactions.

1.19 In short, these techniques recognize that information technology payoffs are about' "Massive, multidimensional business change—instead of work fragmentation and task specialization, we have task compression and integration. Instead of linear and sequential process structures, we have

9 / Given the information−intensive and transaction−driven nature of public administration, a major role of information technology is to modernize and automate large transaction systems, such as in payment systems, tax administration, customs, social security, and financial and personnel management. These systems have become essential to public administration and the running of government—and to timely and effective transactions with the private sector. Zuboff (1985 and 1988) and Strassmann (1985) make the distinction between the "efficiency" and "effectiveness" payoff or the "automating" and "informating" roles of information technology. Efficiency is accelerating existing work; effectiveness is changing the nature of work. Realizing the payoff from informating rewires new levels of training and motivation. See, for example, Peterson (1991).

10 / Hanna and Schware, (1990).

parallel process structures."11 / Thus, measuring the payoffs of information technology is not about the technology itself, but about the major changes that organizations can bring about to "rethink and rebuild" themselves.

1.20 Case studies and a growing literature show that the productivity gains from information technology can indeed be enormous, when it is applied effectively (see Annex 2). Because of the low degree of automation in information handling in most developing countries, the application of information technology can lead to even greater gains for developing countries than those now being realized (in later rounds of application) in industrial countries.

1.21 This study addresses these issues by analyzing a database on information technology components in Bank−financed projects and examining their roles in the Bank's overall lending program. It also draws on three other sources: a formal survey of task managers in the Bank; a review of project appraisal and Operations Evaluation Department reports; and a set of interviews with staff and consultants.

1.22 The purpose of this study is to identify the broad roles of information technology in Bank lending and to map and measure the impact of information technology lending using both quantitative and qualitative data from a wide range of sources. Thus, quantitative data gleaned from project files were checked against qualitative data from task managers, staff, consultants, and outside experts. So that the findings could be shared relatively quickly, the study has placed a premium on intermeshing small data samples from a wide variety of sources. In that sense, we have used methods similar to rapid appraisal techniques, rather than a more formal research methodology. The study should be viewed as an exploratory research or progress report in a fast−evolving field. Our interest was in assessing the degree of convergence or divergence between several data sources to gain a more coherent picture of the nature and pattern of the effects of information technology lending. The coverage of Bank projects and task managers in this study has obviously been limited; larger−scale, more detailed data analyses and more extensive surveying, including end−users in developing countries, will be a necessary next step to convincingly replicate and validate the study's preliminary conclusions.

1.23 Our initial review of data on active and completed projects uncovered many examples of quantifiable improvements in processes and end−products that have resulted from information technology lending. The consistency of our findings is encouraging, and appears to indicate a growing competence in the Bank in designing and executing technology−based development initiatives.

1.24 We believe, however, that the assessment methods developed in this research represent—in and of themselves—an advance in knowledge that Justified the endeavor.

1.25 The magnitude of Bank investment in informatics has thrust the institution into a global leadership role in applying information technology in support of broad and diverse development objectives, and that role requires

11 / Hammer 1992, p. 14.

continuous reflection and self−improvement. This study has fashioned a few tools to assist in this process.

## 2.—
## Bank Lending for Information Systems

2.1 The study suggests that Bank lending in information technology is a dynamic and increasingly significant element in the growth of the Bank's investment portfolio (Figure 1). Almost 90 percent of all investment lending operations contained information technology components. Growth rates for information technology investment far outpace growth rates for overall Bank portfolio investment. Between 1986 and 1991, total Bank lending rose 39 percent, from $16.3 billion to $22.7 billion, while investments in information technology projects rose 235 percent, from $379 million to $890 million—*six times the growth rate of total Bank lending.* Information technology is a dynamic business area that can lead to new lines of products and services if the demand pull is effectively exploited. In development terms, this growth reflects a major change in the mix of the investment and technology needs of borrowers.

2.2 The share of information technology in Bank lending has increased from 2.3 percent in 1986 to 3.9 percent in 1991, for a total increase of almost 70 percent over five years. These percentages probably underestimate the share of information systems in Bank lending. For a group of Latin American countries, an in−depth review of documents and interviews with task managers suggests that information technology components amounted to almost $90 million of the $900 million lending program for fiscal 1990, or about 10 percent.12 /

2.3 The flexibility, reliability, and low cost of information technology systems have fueled demand by borrower countries. At a time when investment is stagnating in borrower countries, borrowers' contributions to information technology investments under Bank−assisted projects have grown from $272.4 million in 1986 to $433.4 million in 1991, a 60 percent rise.

2.4 Several forces will lead to a continuing expansion of Bank and borrower information technology investment throughout the 1990s. On the Bank side, the promotion of leaner, decentralized bureaucracies and market reforms will help shift the computing and communication model in developing countries from an emphasis on mainframe and minicomputer−based, ministerial−level information processing to cheaper, microcomputer−based networks that provide real−time information processing support to field units. On the borrower side, the growth of technology−aware managerial cadres in the government and private sectors will no doubt sustain demand for information technology applications. This awareness was recently highlighted in a 1990 world leadership survey of 12,000 managers, which found that: "Managers in developing countries are more likely to attribute economic success to technology than are the developed world's executives. Brazilian managers—followed closely by Venezuelan, Indian, Mexican, and South Korean managers—put it first on their list of critical success factors.13 /

12 / Carlos Barandiaran, LAC. This sample is for the country group covering Argentina, Chile, Ecuador, Paraguay, and Uruguay (Country Department 4).

13 / Harvard Business Review, July−August 1991, p. 136.

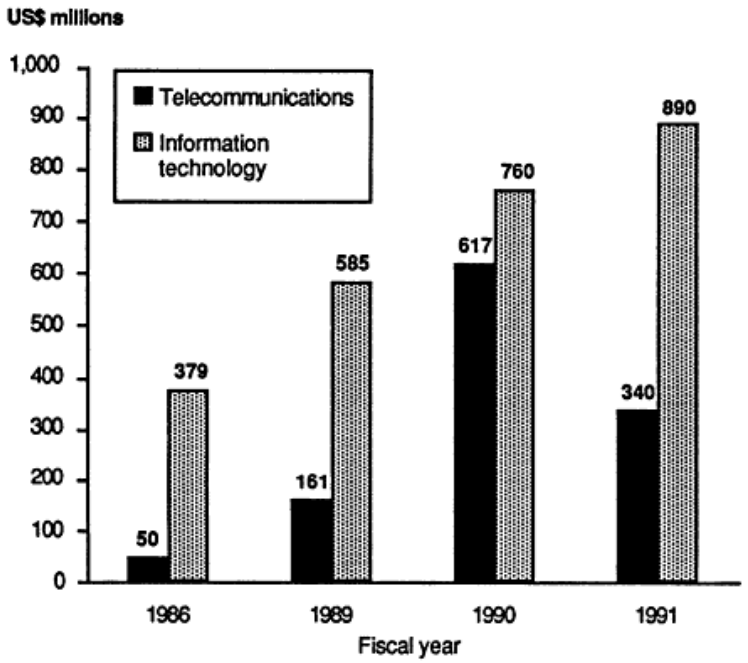



Figure 1
Trends in World Bank Information Technology Lending, Selected Years, Fiscal 1986−91

2.5 *Telecommunications* lending is another key aspect of Bank involvement in the informatics sector. When free−standing telecom projects are added to information systems lending, total informatics lending would amount to $1.2 billion in fiscal 1991 and $1.4 billion in fiscal 1990, or about 5 percent to 7 percent of total lending. Lending to telecommunications components (in sectors other than telecom) is not included in these figures. An earlier study of these components estimated the total amounts of telecom components for fiscal 1986 at $36 million (in 24 projects), for fiscal 1989 at $35 million (in 34 projects), and for fiscal 1990 at $70 million (in 31 projects). Telecommunications policy and investment aspects are also covered under structural adjustment loans; when such operations are covered, the lending operations that include telecom assistance (free−standing, components, or adjustment) amount to 18 percent of total operations for fiscal 1986, 23 percent for fiscal 1989, and 13 percent for fiscal 1990.

2.6 Bank assistance to the informatics sector is even broader and more diverse than suggested by the focus of this review on information technology applications. The following highlights four other forms of Bank assistance to the sector: (1) information services; (2) statistical services; (3) microelectronics and computer production (industrial development); and (4) informatics human resources development.14 /

2.7 *Information services* components range from training information personnel and gathering research data to supplying libraries and documentation centers—in schools, colleges, research institutions, health and population agencies. In a few lending operations, those components involved the development of nationwide information infrastructure, such as a national library network for Indonesia, and scientific and technical information infrastructure for Brazil. The trend in this area is toward increased demand for access to such information services as international databases, and increased applications of information technology to electronically capture, store, and share information, such as in optical storage disks, computerized cataloging and bibliographic systems, and electronic networking for interlibrary loans.

2.8 Bank advice for lending for *statistical services* development has increased, and its focus has shifted toward new areas of concerns, such as environment and poverty (social adjustment) indicators. The Bank has relied on

the United Nations system to set statistical standards and provide borrowers with the necessary technical assistance. While there has been some Bank lending to build national statistical capacity, support has declined in recent years. At the same time, demand from developing countries is rising, generated by the Bank's requirements for data on progress and the effects of structural adjustment; the need for improved national statistics for macroeconomic management under conditions of rapid change and increasing uncertainty; domestic requests for statistical services to address such new issues as environmental management and the social costs of adjustment; a decline in U.N. funding; and advances in software and hardware that increase the value of statistical data by providing tailored analysis and quick feedback to monitor current policies.

14 / For a qualitative discussion of the Bank's role in these areas, see Hanna and others (1990).

2.9 The Bank's response to the low statistical capacity in developing countries has been limited to narrow and short−term improvements. Lending operations and country economic work concentrate on meeting the Bank's internal needs for policy analysis and are not usually linked to building the capabilities of national statistical systems to support local decisionmakers in managing their own policies and development strategies. This is due in part to the internal focus of the Bank's statistical expertise and the use of the limited resources to develop statistical systems in support of the Bank's own policy and macroeconomic work.

2.10 *Local production of microelectronics, computer hardware and software, and telecommunications equipment* presents new opportunities for some developing countries. The Bank is beginning to recognize the importance of information technology industries to these developing countries through projects to promote these industries. Examples are India's Electronics Industry Development and China's Shanghai Industrial Development projects; the second includes restructuring of the electronics components subsector. More recently, two projects are under preparation for India and Turkey; they will address the broad development of the information technology sector and the software and support services in particular. These new types of assistance are critical to developing local capabilities within developing countries to become effective users of information technology throughout their economies and, for some, to become competitive suppliers and partners in the global and fast−growing software and support services industry.

2.11 Bank assistance to help borrowers develop their informatics manpower includes project−related training, science and technology education, and manpower development for the informatics industries. Project−related training, the most common, is usually limited to the specific application required by the project. Lending for education in science and technology—and in electronics, information, and computer disciplines—is indirect (through lending for university education and vocational training). It is unclear, however, how much has gone to support education in the new disciplines as distinct from the well−entrenched ones.

2.12 Training for manpower development tends to focus on the use of specific hardware and software tools but neglects skills needed by users for information analysis and technology management. Like other project−related training, information technology training tends to be ad hoc rather than directed to current and future needs. Information technology project−related training faces other difficulties: short−term orientation, the high turnover of trained staff in the borrower's public sector, a common inattention to training in noneducation lending, a poor link to local training infrastructure, and the unfamiliarity of task managers with the special demands and skills required to master the new technology.

2.13 The Bank's traditional lending to academic institutions in science and technology typically led to training that was not based on an understanding of what employers want, not responsive to fast−changing and application−oriented fields, and not tailored to the special requirements of the relatively new disciplines. One promising example is the Electronics Industry Development Project for India (1989), which addressed manpower development needs from the perspective of user industries.

2.14 A recent and encouraging trend in education lending is the emphasis on strengthening the relevance of higher education and research to economic development, among others, by channeling Bank funds through higher education councils with representation from a wide spectrum of economic, education, and research interest groups, both public and private. During project implementation, this approach has typically meant giving a high priority to informatics−based subprojects, but because of the flexibility of these projects, this may not have been identified in any detail during project preparation and appraisal.

2.15 The above discussion highlights the different dimensions of Bank technical assistance and lending for information technology development and application in support of various sectors and macroeconomic management. It suggests that there is no single measure that can capture the information technology intensity of Bank lending. The large presence of information technology components in Bank operations (about 90 percent of projects) and the rising share of information technology in the total volume of lending (from 2.3 percent in 1986 to 3.9 percent in 1991, not counting telecommunications and other missing information technology costs) are useful aggregate indicators. But they do not measure the growing complexity, multi−functionality, and criticality of such applications.

2.16 The function of an increasing number of information systems components in Bank operations may resemble that of microelectronics−based controls in machine tools. They may constitute a small fraction of the investment or production cost of the machines but are crucial to the quality and utilization of such equipment and to management's ability to incorporate them into a flexible or integrated manufacturing system. Similarly, it is our contention that information technology components often play a crucial role in the management, coordination, and continuous adjustment of—and learning from—complex projects and programs. In many ways, they also provide catalytic effects and high payoffs.

### Regional and Sectoral Patterns

2.17 Bank lending for information technology applications over 1986−91 indicates interesting sectoral and regional shifts. Lending to Eastern European countries has shifted dramatically the distribution of information technology lending (in volume or dollar value) among regions; this is reflected in the dramatic rise of information technology lending to the EMENA region from the lowest to the highest regional share (Figure 2).15 / This occurred even though EMENA continues to have the lowest number of projects (including those with information technology components) among the regions (Figure 3). This reflects a major increase in the information technology−intensity of Bank lending to these economies, where financial and market institutions are being created or transformed in fundamental ways.

2.18 Human resources, finance and industrial restructuring, and public sector management and technical assistance are the primary sectors with recent substantial gains in information technology lending (Figures 4 and 5). Such

15 / EMENA refers to Europe, Middle East, and North Africa (1986−89) and, more recently (1991), to We Europe and Central Asia (ECA) and Middle East and North Africa (MENA) regional groupings of the World Bank.

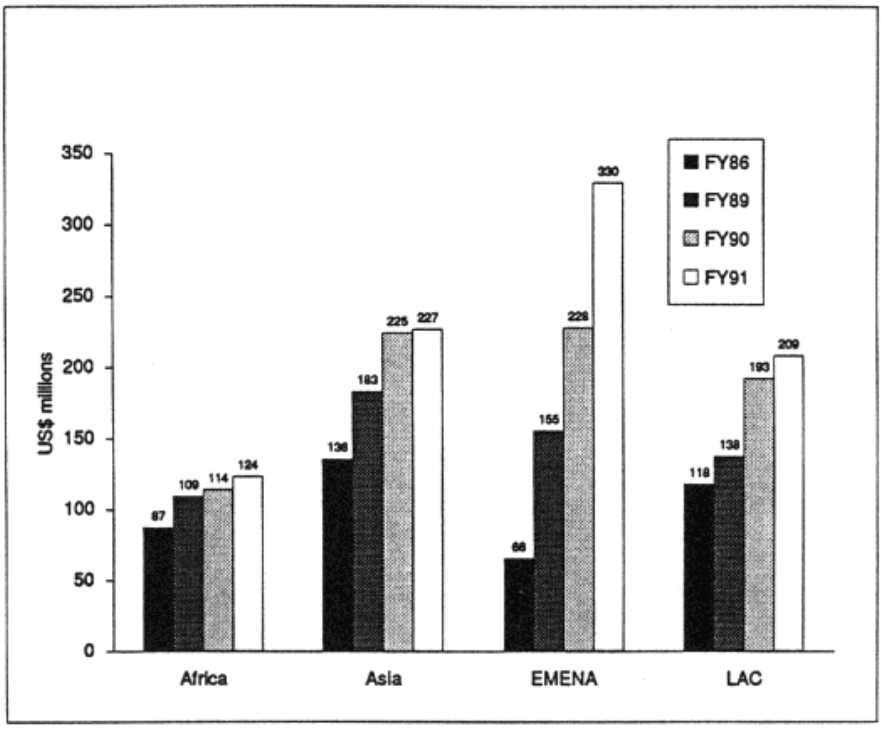



Figure 2
World Bank Lending for Information Technology,
by Region, Selected Years, Fiscal 1986−91 (US$ millions)

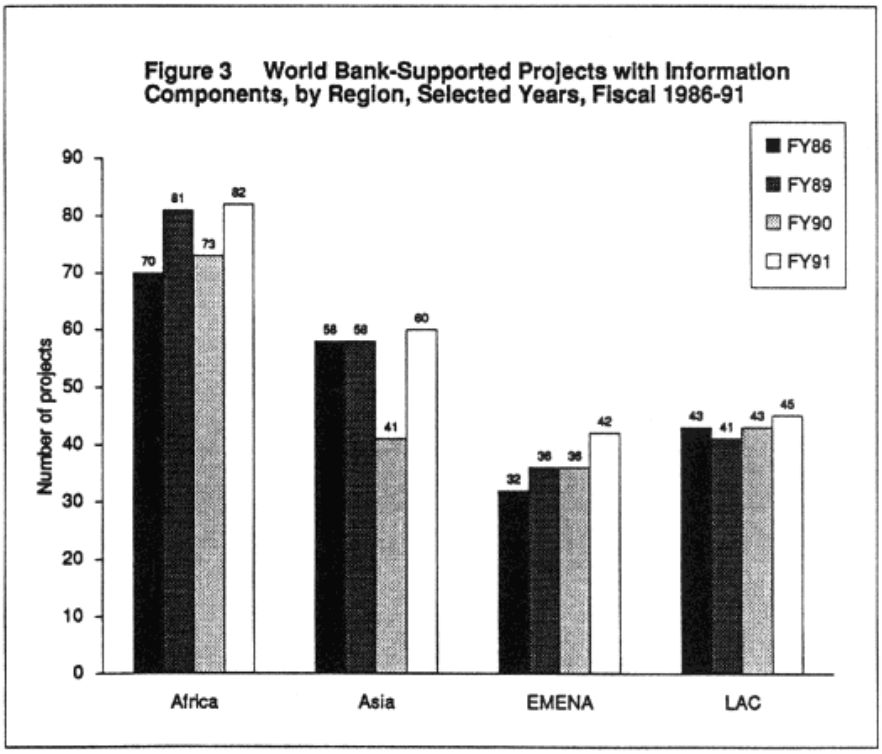



Figure 3
World Bank−Supported Projects with Information

Components, by Region, Selected Years, Fiscal 1986−91

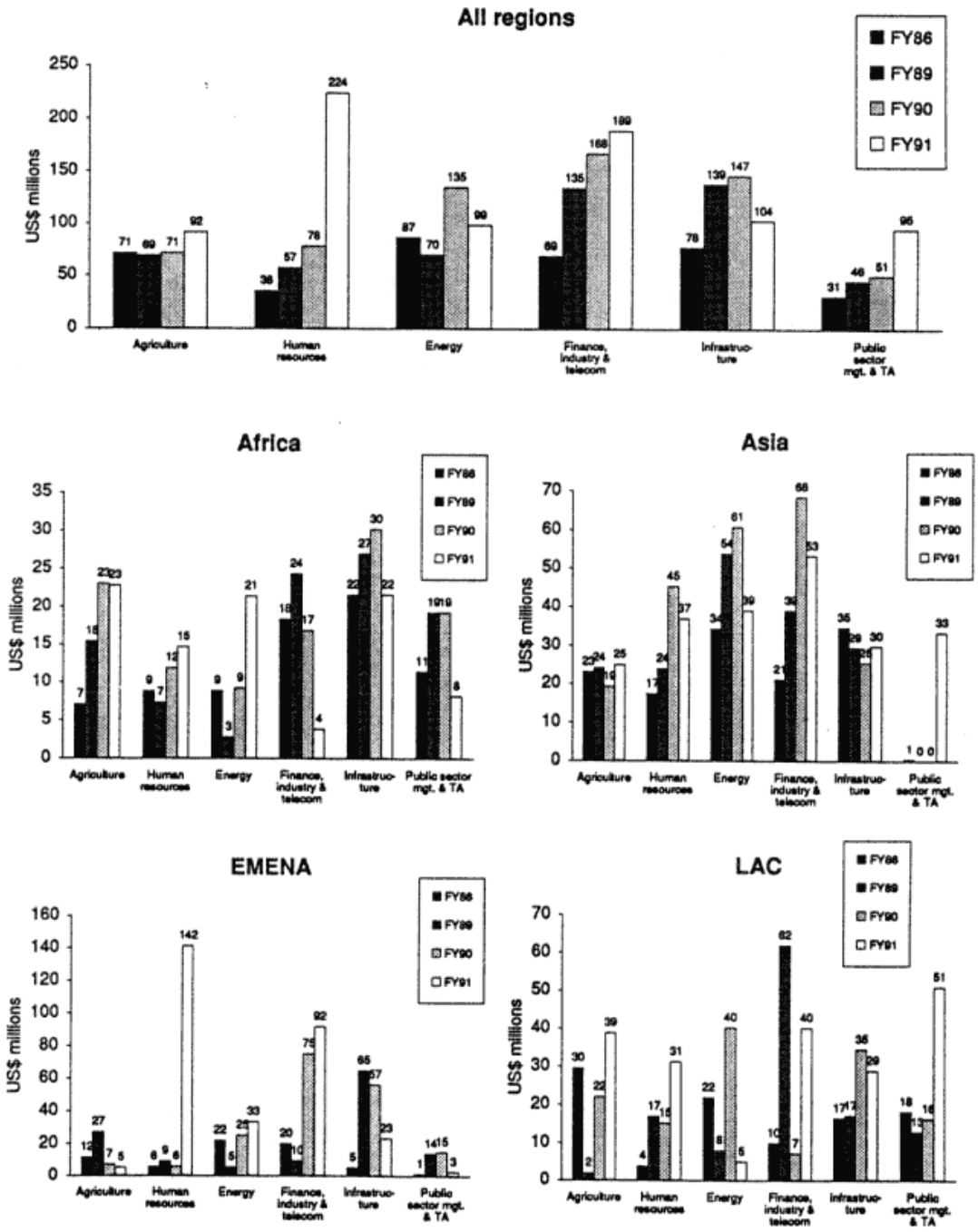



Figure 4
World Bank Lending for Information Technology, by Sector and Region, Selected Yean Fiscal 1986−91 (US$ millions)

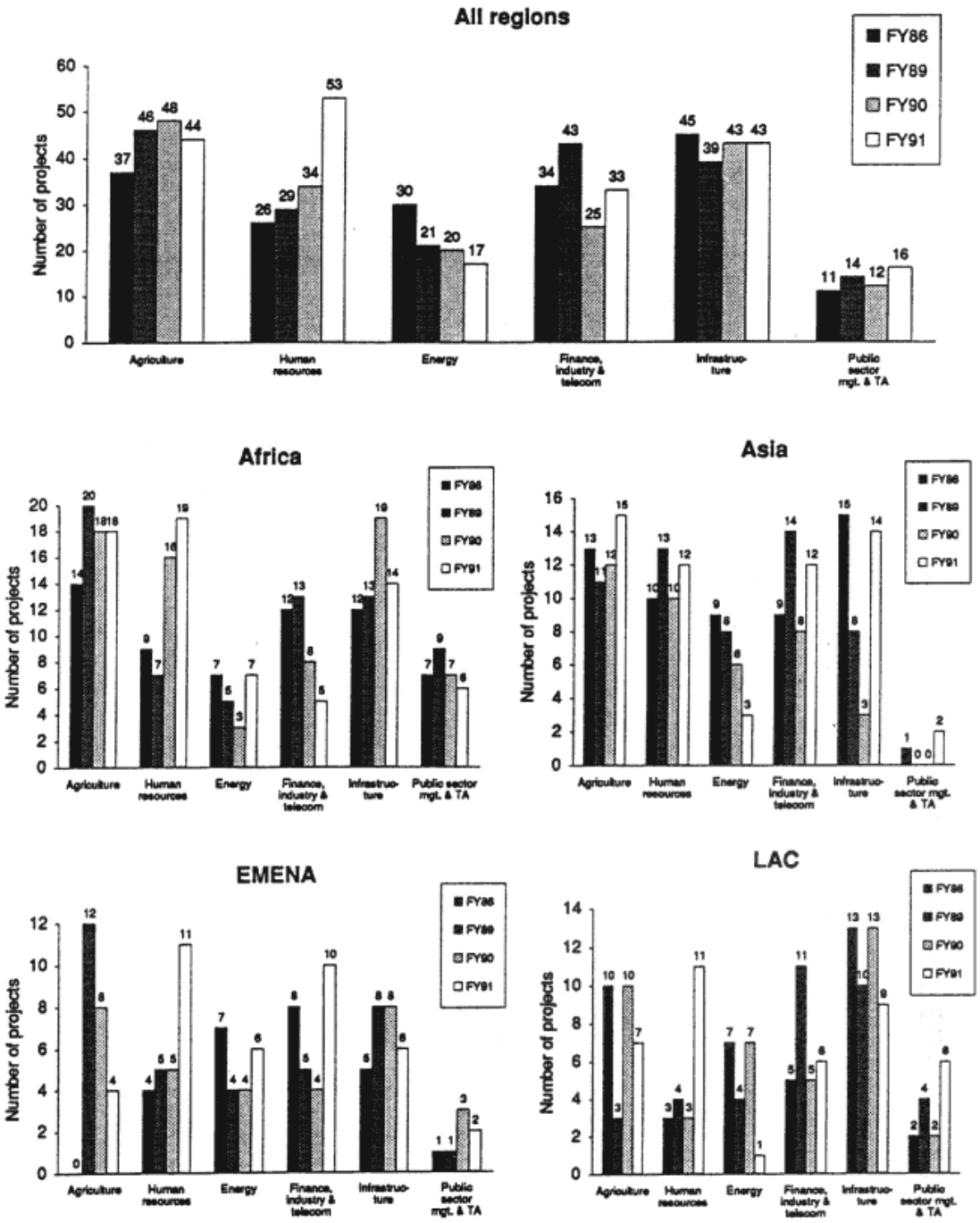



Figure 5
World Bank−Supported Projects with Information Technology
Components, by Sector and Region, Selected Years, Fiscal 1988−91

sectoral shifts also reflect the increased demand for information systems in support of financial, industrial, and public sector reforms as well as social funds and social sector adjustment.

2.19 *Africa.* The combined regional and sectoral distributions of information technology components in the

Bank's lending (Figures 4 and 5) suggest that the versatile roles that information technology can play in Bank assistance are broadly deployed in line with the level and priorities of development of the regions. The Africa region (Sub−Saharan Africa) suffers from information scarcity at all levels of management. Information technology investment is driven primarily by foreign aid, foreign investment, and expatriates. A primary focus of information technology applications in Africa is on automating data−intensive tasks in public administration and the central ministries, such as finance. Another focus is on implementation of the isolated tasks of a project, or on the financial management of a single project. With few exceptions, information technology components in Bank−assisted projects in the Africa region are smaller and less complex than those in other regions. Despite increasing decentralization and resource mobilization efforts, few information technology applications rely on electronic data communication because of the lack of standards, reliable networks, and implementation capacity. Yet, information systems components in Bank lending to Africa represent the largest share of the Bank's information technology portfolio (in number of projects), and they are key ingredients and indispensable tools for management and accountability in an information−poor and institutionally weak environment.

2.20 Sectoral and functional patterns of information technology applications in Africa reflect the region's development priorities. Information systems are most frequently used in macroeconomic management (adjustment or technical assistance, and public sector management), agriculture (including environmental management), human resources, and infrastructure. Adjustment and Public Sector Management operations typically include databases on macroeconomic and sectoral statistics, investment planning and monitoring of systems, management and control of public expenditure, monitoring the Social dimensions of adjustment, improved accounting systems for public enterprises, automation of tax administration and customs, and integrated payroll and personnel management systems. These operations have become common as many African countries undertake structural adjustment and public sector reform; in fiscal 1991 countries with such operations included Angola, Benin, Burkina Faso, Central African Republic, Comoros, Cote Ivoire, Ghana, Mall, Rwanda, Uganda, and Zambia.

2.21 Information technology support in agriculture is focused on agricultural research, extension and support systems, and environmental management, in such countries as Congo, Ghana, Guinea, Kenya, Mauritius, Mozambique, and Nigeria. Infrastructure planning and management includes such information technology applications as databases and information systems on road networks, traffic, and safety statistics; public works employment programs; billing and accounting systems for water supply enterprises; transport investment planning; urban management systems; and financial and operational management systems for railways. Human resource sectors employ diverse information technology applications ranging from support to outreach programs on women in development (Cote Ivoire) and health extension and population programs (Ghana, Madagascar, Malawi, Malt, Nigeria), to university

development and education sector management (Mozambique, Nigeria, Rwanda) and labor market information (Togo).

2.22 *Asia.* The Asia region, particularly East Asia, has been a steady and growing user of information technology in Bank−assisted projects. By volume of lending, it was the highest user of information technology in fiscal 1986 and 1989, and second only to EMENA since 1990. It is second to Africa in number of projects with information technology components (Figure 3). Consistent with its advanced stage of industrialization, the region's information technology investment is highest in finance, industry, and telecommunications (Figure 4). Examples of such information technology applications can be found in China's Shanghai Industrial Development and Rural Industrial Technology projects, India's Petrochemicals, the Philippines' and Sri Lanka's industrial restructuring projects, and Indonesia's Private Sector Development and Small Credit projects. Applications cover modernization of process industries and emission warning systems, improvements to information systems of public enterprises and financial institutions, corporate planning and financial management systems, databases on technology and portfolio management, and the streamlining of foreign investment administration and information.

The fast pace of industrialization and urbanization in Asia is also reflected in information technology applications in such projects as India's industrial pollution control projects, and Indonesia's urban development projects, and in the extensive use of geographical information systems (GIS) in urban planning and management (Korea, Indonesia). Also associated with the Region's industrialization is the energy sector, a capital−intensive sector in which information technology applications are typically large and often used to optimize investment and maximize capacity utilization, as in Indonesia's Power Transmission Project.

2.23 Asia's information technology applications in human resources development vary among the low−income South Asian and the middle−income East Asian Nits. In South Asia, information technology is used to support, for example, program management and policy analysis. And it is being used to support the implementation of large national programs for population and health in Bangladesh, India, and Pakistan, such innovative programs as Sri Lanka's Poverty Alleviation Project. In Korea, information and communication systems are being developed in several projects to support research centers, vocational and technical education, and health technology. The heavy use of information technology in the social sectors reflects the data− and communication−intensive nature of people−oriented projects.

2.24 The use of information technology in public sector management and technical assistance is on the increase in Asia. This reflects in part the ongoing decentralization of public programs and administration, and the need to improve management and decisionmaking at the local level, as in Indonesia's urban development and family planning programs. In other cases, it is part of public sector modernization and institution building, as in Papua New Guinea's Public Sector Training projects. An important recent application is Thailand's Tax Computerization Project, which is dedicated to designing and implementing a computer−based, nationwide tax collection system. A similar project is under preparation for the Philippines.

2.25 *Europe, Central Asia, Middle East and North Africa (EMENA).* The EMENA region's information technology lending has risen dramatically, fueled

by the need to support major reforms and create new trade and financial infrastructure in Eastern Europe (and the former Soviet Union) and to facilitate social adjustment throughout the region (Figure 2). This is most clearly illustrated by the rise of information technology lending in the human resource sectors (Figure 4). A science and technology university development project for Algeria introduces databases and information systems and library computing facilities. A similar project for Hungary adds a major R and D computer network and employment information services, among others. A significant part (about 40 percent of the Bank loan) of an employment promotion and services project in Poland is for the automation of social welfare and employment services and the improvement of labor market information systems. An Emergency Social Fund for Egypt includes a management information system for public mobilization and statistics.

2.26 Information technology applications in finance, industry, and telecommunications represent a large share of the total cost of many projects in the region, particularly in Eastern Europe. Information technology is playing a central role in moving these economies toward open market−based structures. The role of information technology investment in Bank lending in the financial sector is significantly underestimated since most lending to the sector is in the form of adjustment loans, with substantial emphasis on improved information systems, but with no specified Bank−financed information technology investments. Where specified, information technology constitutes a major share of total investment, as in Hungary's Financial Sector Modernization Project ($112 million, or 80 percent of $140 million project cost) and Poland's Financial Institutions Development Loan ($42 million of the total loan of $200 million). Similarly, a rise in investment in telecommunications infrastructure is evident in Bank lending to Eastern Europe, such as Hungary and Poland. Such infrastructure includes information systems to modernize operational management and services.

2.27 Another feature of information technology lending in this region is the use of information systems in support of economic and public sector reform programs. For example, Bulgaria's technical assistance for economic reform includes computerization of the central statistical office and the payments clearing system. A structural adjustment loan for Poland requires modern payment systems and new accounting and auditing systems. Although directed at the public sector, these applications are designed to facilitate essential public and financial transactions within and outside the country, and are thus critical to the development of markets and private enterprises.

2.28 *Latin America.* The Latin American region is characterized by the recent liberalization of previously inward−oriented middle−income countries; information technology applications tend to support this process. This is reflected in information technology components in public sector management and technical assistance, trade and finance, and human resource development (Figures 4 and 5). The modernization of information and communication systems has become a key instrument in the strengthening of core processes and institutions. Examples include new customs and financial systems under the Public Sector Reform Technical Assistance loan for Argentina, the computerization of tax revenue tracking and government accounting and auditing under the Public Financial Management Operation for Bolivia, and major systems development under the Financial and Program Management Improvement Project for Jamaica. All adjustment and public sector reform operations also include

conditions for improving information and processes in support of such areas as policy analysis and monitoring, public expenditure planning and control, and debt management, even though no information technology investment component is specified in the loan amount.

2.29 Examples of the use of information technology in support of trade, finance, and industry are Jamaica's Trade and Financial Sector Adjustment loans, and Mexico's Export Sector Loan and Labor Market Modernization and Mining Sector Restructuring projects. The export sector loan includes requirements for commercial banks to computerize all transactions, for brokers to present electronic data on a weekly basis, and for customs to decentralize and computerize.

2.30 Lending to the human resource sectors in Latin America includes significant information technology components, in support of the management and delivery of services and the development of information technology manpower and local capability. Brazil's Science and Training Project is one example of the development of an information infrastructure, including national databases and electronic networks. Mexico's Technical Training Project includes measures to strengthen computer science education and the use of computers for training and administrative purposes. Countries in which information technology is being used in support of the management and delivery of education and health service programs include the Dominican Republic (Primary Education Development), E1 Salvador (Social Sector Rehabilitation) and Mexico (Basic Health Care). And in Haiti, Honduras, and Venezuela, policy, planning, budgeting, and monitoring systems are being developed for social development funds in support of the adjustment process.

### Application Functions

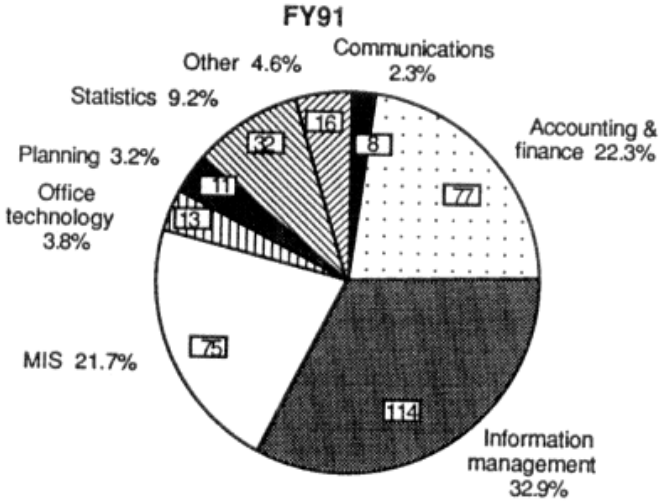
2.31 This study also classified the main functions of information technology applications for each project in the database to capture the patterns of functional areas most commonly addressed by information systems components in Bank lending (Figures 6 and 7). The main functions are:

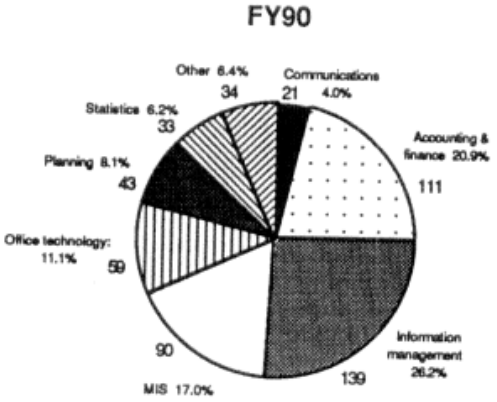
Management information systems (MIS) to support executive and operational management;

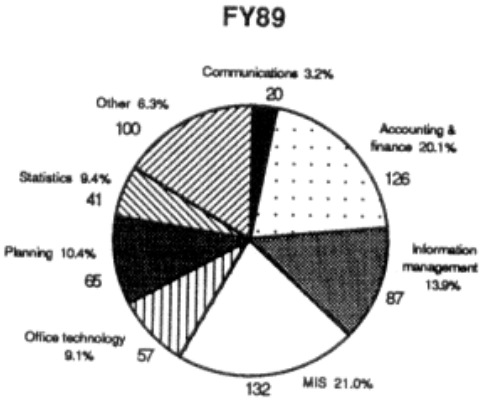
Finance and accounting functions for project program, or enterprise financial management, accounting and auditing, payroll administration, and billing and collection;

Information (or data) management for substantive databases used in professional analysis in such areas as demographics, health information, environmental and geographical information (GIS), labor market information, agricultural research and marketing, mining databanks, and road maintenance databases;

Statistical applications, such as for national accounting, socioeconomic monitoring, household surveys, and other major data surveys and statistical systems, often in support of macroeconomic management, structural adjustment, and socio−economic research;



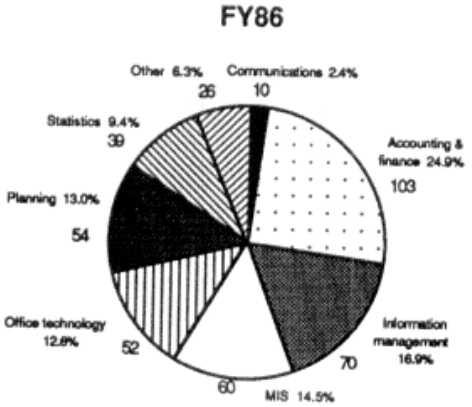



Figure 6
World Bank Information Technology Lending, by Application Function, Selected Years, Fiscal 1986−91

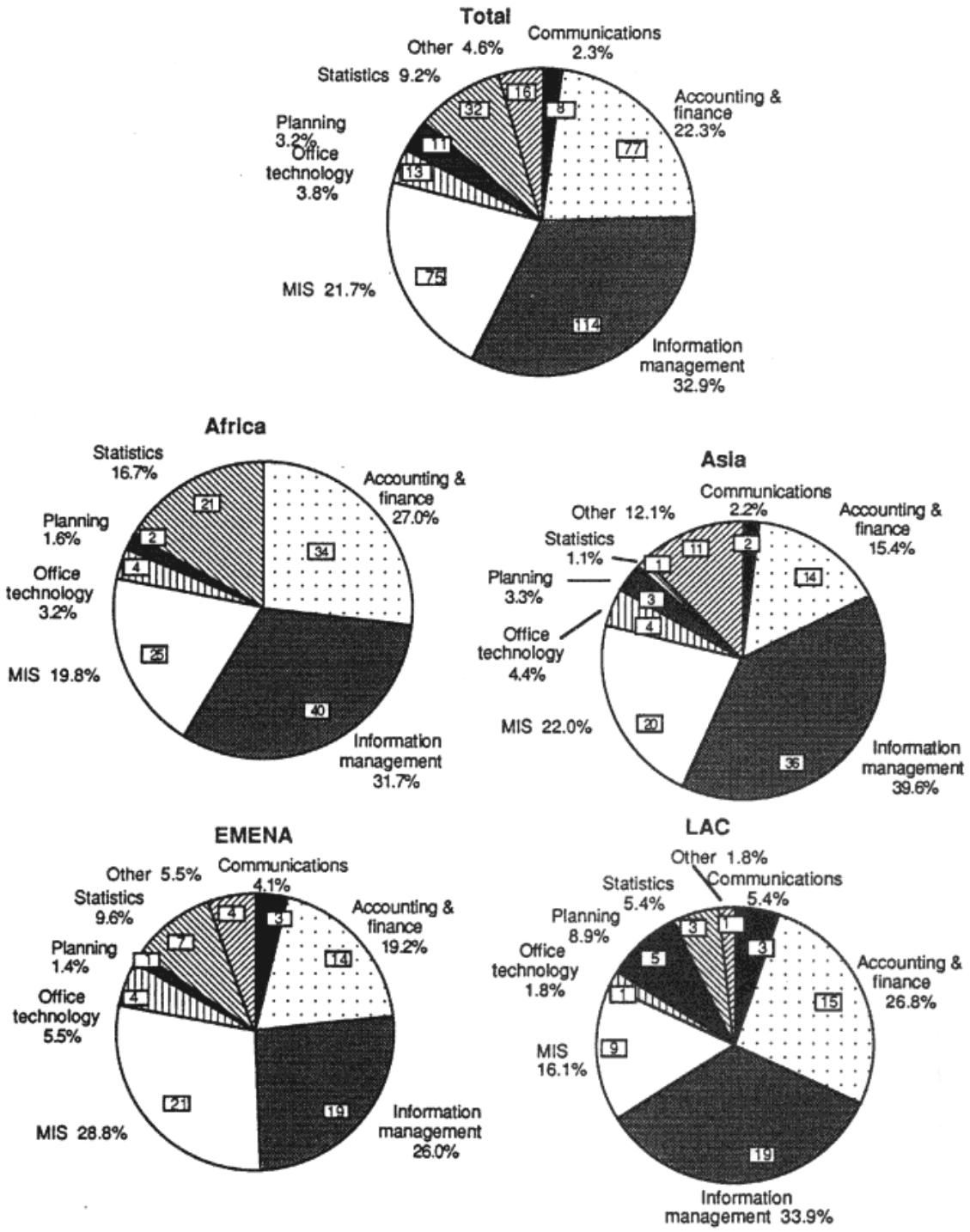



Figure 7
World Bank Information Technology Lending, by Application Function and Region, Fiscal 1991

Office technology, communications, and other related applications for such functions as word processing and general clerical and office automation, document and information retrieval, data communication networks, and desk−top publishing.

2.32 Due to the multi−function nature of information technology, individual applications are difficult to isolate. Although these categories are general, and inevitably overlap in most applications, they reveal some interesting patterns about the priorities of IT users. For one, overall lending patterns across regions suggest the dominance of management and financial and accounting information as well as substantive information management functions, perhaps in response to aid agencies' concern about financial resources management and project implementation. In Africa, where basic macroeconomic statistics are often lacking, statistical applications are more common than in other regions. Communication applications are relatively absent, however, perhaps due to limited capabilities for network−based and complex applications and for on−line data sharing. The highest share of management information systems is in EMENA and that may reflect the current preoccupation with establishing modern managerial systems and project implementation units among the Bank's new member countries of Eastern Europe. For Asian and Latin American countries, the largest shares go to information management, perhaps reflecting advanced capabilities to implement complex databases and information sharing systems.

2.33 Over the years 1986−91, the trend has been toward information technology applications that serve two or more of the above categories of functions. Other functions not easily captured by our classification have also emerged, such as automating large transaction systems, and computer−aided design applications.

2.34 Analyses of regional, sectoral, and functional patterns of Bank lending are likely to yield better insights as cost estimates and functional categories are refined and, more important, when they are supplemented with in−depth surveys of task managers and end− users. For example, the survey and interviews of task managers for this study suggest that information technology lending patterns are influenced as much by the task manager's (and regional management's) familiarity with and initiative in applying information technology as by country conditions and sectoral needs. This may explain in part explain the recent and sudden rise of information technology lending in EMENA, in the financial and human resource sectors in particular, and of environmental and geographic information systems applications in lending to Asia.

## Core Competencies of the World Bank in Information Technology

2.35 Gary Hamel and C. K. Prahalad, in their classic 1990 Harvard Business Review article, "The Core Competence of the Corporation," argued that a combination of individual technologies and specific organizational skills underlie a company's diverse businesses or products. Thus, Sony's core competence in miniaturization enabled the company to produce products ranging from video cameras to notebook computers; and Canon's core competencies in optics, imaging, and microprocessors allowed it to produce copiers, laser printers, cameras, and image scanners. Core competencies are like the

invisible roots of a tree that nourish the diverse fruits of the bough. The concept of core competencies has now become an accepted part of corporate strategy theory.

2.36 This concept can speak equally well for large enterprises that provide a myriad of services, and we believe that the concept can help provide a richer perspective on the technical and organizational learning that has been built up in the World Bank through information technology lending. Even a cursory review of the information technology underpinnings of Bank projects reveals a set of core competencies in *management information systems,* with a strong emerging specialty in *geographic information systems;* in ne*tworking technology,* with an emerging emphasis on *sectoral networks* ; in macro management systems; and in computerized project management systems.

*2.37 Macro Management Systems.* There are several examples of Bank competence in designing and implementing large−scale computer databases. The Socioeconomic Data Division has established an Economic and Social Database that contains some 2,000 core macroeconomic indicators for each client country. This database has brought together UNSEEN, UNDO, and IF databases, as well as data from the Bank's regional offices and country teams, under an integrated information architecture readily accessible to planners and task managers. Through advanced data compression techniques, this database has recently been made available for use on personal computers, allowing for easier use and broader relevance in the field. Finally, a more interactive version of this database is under development for use as a system architecture in national planning initiatives in Eastern Europe.

2.38 An example of a large−scale database built "from the ground up" to assist social policymaking has been the Bank's Living Standards Measurement Study (LSMS), and the expanded, follow−on version of the LSMS called the Social Dimensions of Adjustment (SDA) Project. The LSMS was designed to support structural adjustment initiatives in Africa in the 1980s by quickly gathering and analyzing vast amounts of high−quality household data on demographics, housing conditions, educational attainment, health and nutrition status, and income, expenditure, and consumption patterns. Personal computers were used in the field to enter, verify, and process data from household surveys, which made it possible to aggregate and tabulate the data within six to eight months. The data were then fed as analytic inputs into social policymaking at the national level.

2.39 The successful experience of the LSMS in two pilot countries—Côte Ivoire and Ghana—led to the expanded SDA Project in 26 countries in Sub−Saharan Africa. A partnership of host governments, six bilateral donors, the UNDP, and the African Development Bank are now collaborating with the Bank in building a regional information architecture for social policymaking based on the LSMS model (Chander 1990).

2.40 An emerging core competency is the development of computerized information systems to support improvements in public expenditure management. Increasing attention has been given to reforms of public expenditure management in response to debt and fiscal constraints, and the need to sharpen budget priorities, to monitor and control expenditures, to evaluate policy and budget implementation, and to improve revenue administration and accounting systems. An important element of the reform process has been the development and implementation of computerized information systems to support the associated business processes. Bank staff have assisted a variety of client governments, such as Argentina, Bolivia, Jamaica, Kenya, Mexico, and Papua New Guinea, in establishing strategic databases to support fiscal policy, budgetary planning, revenue and expenditure control, accounting, and human resource management.

2.41 Bank experience (best practices) in this area of assistance suggests the need to take a coherent view of all the key systems that may support a modern public expenditure management. Typically, a wide variety of computer−based systems support public expenditure management. But these systems are usually implemented as components of separate projects responding to specific needs, with little appreciation of requirements in other areas, and little thought given to critical interrelationships. As a result, public expenditure management information systems are often disparate and segmented, with little or no capacity for sharing data. They have overlapping and sometimes conflicting functionality, and provide incomplete coverage, particularly for managerial information requirements that normally span several functional areas. Developing a framework that provides an overview of the entire systems network required to support public expenditure management, and that can serve as a road map for implementation purposes, is therefore of value in the planning and implementing projects with public expenditure management systems components. An example of such a framework (information architecture) is shown in Figure 8.

2.42 Bank experience suggests that a purely computer systems−based response to the problems encountered in public expenditure management would be inappropriate. Implementing and streamlining computer−based

information systems should be undertaken as part of developing or re−engineering the broader business processes and institutions. First, the business processes, procedures, the legal regulatory framework associated with the management of public expenditure, and the institutional capacities of the relevant government agencies would be analyzed, inadequacies highlighted, and appropriate corrective measures identified. Then computer systems would be introduced to assist in the implementation of the corrective measures. The benefits from implementing computer systems depend on the degree of success achieved in strengthening the basic processes and organizational arrangements related to public expenditure management.

2.43 Bank involvement in Latin America suggests the emergence of a new paradigm in public financial systems, the Integrated Financial Management System model characterized by "open architecture equipment, Unix−based operating systems, highly portable database management systems, and decentralized computing (Mejia 1992).

2.44 *Geographic−Based Policy and Planning Systems.* A geographic information system involves the merger of two separate digital databases, one containing maps and the other essential information, such as demographics, to create "views" for planning and management purposes that were previously impossible. Geographic s information technology is making possible levels of analysts—in environmental and natural resource management, in urban development and infrastructure planning, in health and social service targeting, and in business and market forecasting—that were unimaginable a

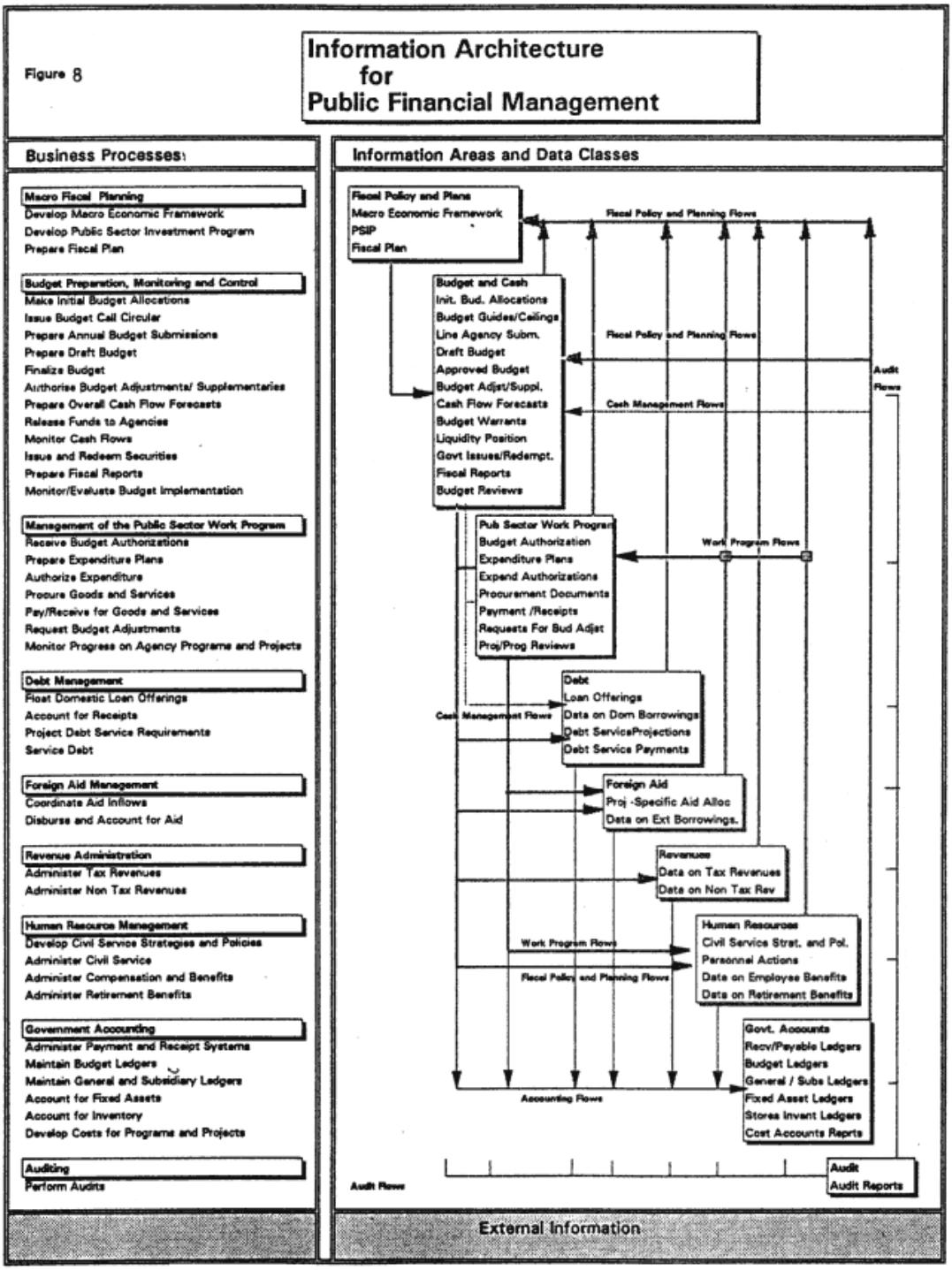



Figure 8
Information Architechture for Public Financial Management

Source: Davies, Hashim, Talero 1993

**Table 1:**
**Examples of World Bank Geographic Information System Applications**

| Urban development | Health | Env. and natural resources | Transportation and infrastructure |
|---|---|---|---|
| **China Medium−size Cities Development Project** —Municipal information centers in Changzhoys Luoyand and Shashi use GIS for planning and management of land use patterns.<br><br>**Angola Lobito Bequela Urban Environmental Rehab Project** − Land Registration GIS to identify all taxable property is tested in a pilot study. Digital processing of aerial photos is being tested in a pilot study for "virtual addressing," with electronic pushpins assigned to shanty parcels as an alternative to full parcel mapping. | **Tianjin Health Planning Project** (China)—Environmental health maps by subdistricts are being created for city with population of 8.5 million.<br><br>**Philippines Health Development Project** −Five village areas in Manila have been targeted for a GIS aimed at capturing health, water, soil, air, and sanitation data to assess environmental health and epidemiological patterns. | **Brazil National Environment and Land Management Projects** —Regional GIS centers are set up in Manaus, Sao Paulo, and Cuiaba for environmental mapping; and to complete a digitized soil survey of 96 priority micro−catchment areas.<br><br>**Arun Project (Nepal)** —A GIS is in use as part of river basin resource management initiative.<br><br>**Central African Republic Natural Resource Management Project** —GIS is being used to inventory national forests. | **Pakistan Second Karachi Water Supply and Sanitation Project** —Geo graphic information systems are being used to inventory the water network and establish an inventory of sewerage lines—critical in Pakistan, where 30% of illness and 40% of deaths are attributable to waterborne diseases.<br><br>**China Jiangsu Provincial Transpons Project** —GIS is in use for paved road management covering 2,000 km of highway, and featuring road inventorying, traffic density, and maintenance equipment, workshops, and parts stores. |

decade ago. World sales of geographic information hardware and software have quadrupled, increasing from $58 million in 1988 to $222 million in 1992.

2.45 In recent years, geographic information technology has diffused to developing and newly industrializing countries, and has applied in urban and land management systems and property tax systems. Thailand, for example, raised $283 million in 1989 from real property transfer taxes as a result of its land registration and valuation GIS system. Indonesia's Semarang City Land Geographic Information System has raised property tax revenues by 50 percent in a pilot area of 30 square kilometers (Holstein 1992).

2.46 The Bank has cultivated a strong core competence in GIS, and has adapted this single technology system across many sectors and country applications (Table 1), investing about $100 million in urban land information systems between 1973 and 1988, and about $1 billion in rural land information systems as of 1987 (Holstein

1992).16 /

2.47 Through these diverse projects, Bank staff are learning to unbundle GIS system packages and customize applications for specific development purposes and even, as in the Angola "virtual addressing" case, create novel extensions of the technology. Thus, as an institution, the Bank is going through a learning curve leading to mastery. Yet, we discovered in our explorations that this learning curve has been slowed by the relative isolation of Bank practitioners. We were surprised at the degree to which practitioners were unaware of each other's work. Perhaps this speaks to a larger need inside the Bank to more effectively cross−fertilize its knowledge bases and skills—in other words, to map and mobilize its technology assets more effectively.17 /

2.48 Organizations in the United States are currently making a large effort to capture intellectual capital through on−line databases. For example, Carnegie Group, U.S. West, Digital Equipment, Ford and Texas Instruments have formed a consortium called the Initiative for Managing Knowledge Assets to create software to share know−how across enterprises. The Texas Innovation Information Network System, a state program, has created a database containing detailed technology and research skills profiles of over 2,000 high−tech companies and research profiles, based on a common keyword dictionary, of more than 5,000 university faculty members.

2.49 These examples highlight the lengths to which organizations are going to better exploit their own intellectual assets. The relative isolation of GIS practitioners across the Bank is probably typical of other areas of technology as well, and the installation of a simple, on−line profiling system for staff members' technology skills might contribute to greater cross−fertilization and help facilitate more rapid movement through the technology learning curve.

16 / Data collection represents We largest share of such costs.

17 / As Forutme magazine noted in a recent article on "Brainpower," "The challenge is to capture, capitalize and leverage free floating brainpower. One way is to automate it. Till now, the time and energy invested in computers has gone into automating systems that relate to tangible assets — like payroll and inventory — not knowledge assets. Knowledge has been too hard to get to; it's in peoples' heads. It's unstructured" (Fortune, June 3, 1991, p. 50).

2.50 *Sectoral Networking.* The demand for computers to share information across distances has generated a sectoral (wide−area) networking industry employing such technologies as packet−switching and T−I multiplexing. Packet−switching is a method of formatting data from one computer system into standard "packets" to be sent to another location for reception by a different computer system. T−I multiplexing refers to high−speed digital transmission technology that can provide simultaneous voice and data transmission in a single cost−effective network. In recent years, the Bank has heavily financed major networking projects in diverse sectors and countries (Table 2).

2.51 Considerable technical assistance skills have been built up in the Bank in project design, in procurement, and in installation of large−scale networks. Also considerable have been the effects on member countries of massive network creation activities. The upgrading of work forces' technological skills, and the diversity of challenges and opportunities facing information workers having to master complex systems of hardware and software all contribute to the expansion of national intellectual capital at a time when the global economy is becoming information−intensive.

2.52 Consider the impact on national intellectual capital formation of Just one Bank− sponsored system: the Thailand Tax Computerization System. The network includes two large mainframes in Bangkok, nine medium−size mainframes at the regional level, 48 smaller computers at the provincial level, and 1,300 intelligent terminals at the district level. *This is the largest integrated computer system ever attempted in Thailand.* An

estimated 250 Revenue Department staff will be trained in high−level systems operation and network management skills; 12,000 staff will be trained and given computer literacy skills over five years; and the relationships and the structures of authority and responsibility among the central, regional, area, and district offices will be re−engineered. There will be more real−time, interactive, simultaneous processes—and a widely decentralized decision making pattern. This will likely place much more of a premium on employees' critical thinking and problem−solving skills, as has been the experience in similar re−engineering initiatives around the world. New compensation, incentive, and Job−enrichment packages will be required to retain highly skilled employees. In fact, these incentive packages are already being planned by project managers. From a broader perspective, this project will prepare a cadre of information workers. This cadre may remain largely intact within the Revenue Department organization, or it may partially migrate into other enterprises and institutions, transferring and diffusing know how throughout the wider economy.

2.53 The Thailand tax system illustrates the type of direct and indirect developmental effects of the Bank's buildup of a core competence in wide−area networking technology, a competence that draws on accumulated skills and experience in telecommunications, information systems, and financial and human resource planning.

**Table 2:**
**Examples of World Bank−sponsored Networks**

| Education | Private sector development | Infrastructure |
|---|---|---|
| **Indonesia Second Higher Education Development Project** —National Information System and Network (SINAS) will link up 16 universities nationwide in an on−line access and retrieval system for scientific information. | **Hungary Financial System Modernization** —Computerized data communication (GIRO) network will link 240 branches of the 12 largest banks in Hungary and the National Bank of Hungary for inter−bank accounting transactions. | **Punjab Irrigation Drainage Project** —A wide− area network is connecting the Central Water Authority office with state and district offices for voice and data transmission. |
| **China National Computer and Network Facility** —Under the Key Studies Development Project, a network will link Beijing and Qinqhua universities and the Chinese Academy of Sciences for enhanced computational problem−solving in science technology at a level not possible before. | **Hungary Integrated Agriculture Export Project** —Agriculture Commodity Exchange Wide− Area Network collects, processes, and distributes electronically information about food and agricultural products across the country and transfers funds for payments. | **Brazil Municipal Development Project** —In state of Rio Grande do Sul, a computerized network "telecontrols" 15,000 new sewerage connections in Porto Allegre and Sanep. |
| **Yemen Education Ministry** —A network of computers is linking several hubs of the | **Chile Financial Markets Loan Project** − Wide−area network links the | **Yemen Third Power Project** —Adan System Network has a computerized control center that remotely controls 26 stations. |

| | | |
|---|---|---|
| education system to allow sharing of data on teachers, students, and facilities. | superintendent of banks, a national network of reporting banks, credit card businesses, and money desk operations. | |

2.54 There is ample reason to expect that the Bank will continue to build its knowledge in sectoral networking, knowledge that will likely result in the "capture" of successive generations of new networking technology. The next important generation of such technology might well be "wireless" sectoral networks that employ innovations such as those now being installed in Kazan, Tartarstan, by the Hughes Network Systems Corporation. Rooftop "multi−subscriber units" are being placed throughout the urban area. These will receive wireless signals from telephones, fax machines, and computers; the signals will then be transmitted to central reception towers and relayed through digital switching systems to telecommunications satellites for instant transmission around the globe. This system—the first of its kind—completely bypasses Kazan's antiquated phone system. 18 /

2.55 Another such innovation is the "wireless" networks driven by low−orbiting satellites. Motorola is investing $3 billion to put up 70 of these small, "closer−to−earth" satellites and create a global network capable of picking up and relaying the signals from cellular phones, pagers, and both desktop and portable computers. Applications will include global messaging, emergency communication, and point−to−point data transmission. At the 1992 International Telecommunication Union Conference, 124 countries endorsed this global network, and it is expected to be operational by 1997.

2.56 Volunteers in Technical Assistance (VITA), which put up its first low−orbiting satellite in 1982 and recently won its own global frequency from the U.S. Federal Communications Commission (FCC), has already demonstrated the power of this networking technology in rural areas of developing countries. In Nigerian, Sudanese, and Tanzanian demonstration projects, VITA has shown that laptop computers connected to solar−battery−powered ham radios can transmit and receive data using low−orbiting satellites for global relay.

2.57 These innovations can bring the benefits of wide−area networks to backward regions that have deficient telephone infrastructure—or none at all. And they could represent yet another generation of technology that will add to the Bank's accumulated competence.

2.58 Increasing Bank assistance to public data networks and specialized cooperative networks raises the issue of coordination between different segments of the informatics field—for example, between sectoral networking issues and telecommunications network policies. The financial sector is a particularly interesting case because the Bank is helping to establish new arrangements for banking at the same time that it is promoting new approaches in telecommunications. There is general recognition that a reliable and cost−effective public data network available to all customers is an increasingly important resource for modern business. Industrial countries have in the past promoted such a capability by inhibiting to some degree sector−specific network solutions for a group of customers, such as banks, which could develop their own individual private network arrangements and had special dispensation to share in a cooperative network system (SWIFT) designed to meet worldwide interbank requirements. The restrictions have been reduced recently in some cases as part of liberalization trends, but where public data networks are well established, deciding who is allowed to utilize shared network facilities within sectors can be a controversial issue. For the Bank,

18 / Wall Street Journal , "Kazan Calling," August 21, 1992, p. 1.

this would imply that decisions about networking for important sectors—finance and banking in particular—should not be made independent of telecommunications policy decisions, particularly for data.

2.59 *Project Management Systems.* The Bank is accumulating significant experience both in creating new software packages and in customizing off−the−shelf packages related to project planning, managing, monitoring, and reporting. The proliferation of computerized project management information Systems within the Bank has followed the larger industry trend, and can be tied to the rise of microcomputer−based systems.

2.60 There are now some 200 project management information systems packages on the market for microcomputers. These span the stages of the project cycle, *including planning resource management* (resource analysis, cost estimating, and financial modeling); *tracking and monitoring* (critical path analysis, baseline and actual resource and schedule displays); *report generation* (status summaries, task and resource details); and *decisionmaking* (multiproject tracking with cross analysis, expert system capability) (Meredith 1989).

2.61 The major software packages created in the Bank to address its own project requirements have been COSTAB and FARMOD. FARMOD was designed to generate crop area, farm−family household, and project planning data; COSTAB was designed to generate project costing data.

2.62 Prior to the development of the COSTAB mainframe program in 1980, project financial analysis and capital costing were done by task managers with pencil and paper. COSTAB was a significant advance. Yet, although it provided an efficient costing tool to headquarters staff, the mainframe version could not be used in the field. By 1984, sufficient Bank−wide demand existed to launch a development effort aimed at perfecting a personal computer version. The latest, "COSTAB for Windows," is a fully functional tool for use in the field. It appears to be user−friendly and easy to learn, which can facilitate its use for project preparation by local staff in developing countries and save time in reentering data. Its flexibility and power should result in rapid diffusion among the Bank's project planning staff, expanding the userbase well beyond the thousand staff who have already been trained in COSTAB.19 /

2.63 Recently, the Bank's Economic Development Institute entered into a unique commercial Joint venture with Team Technologies, Inc. to create and field−test four software packages that can complement COSTAB and "close the loop" in automating the entire development project life cycle. Several modules or tools for project design and management have already been commercialized by the Joint venture. One module, PC/LogFRAME, is a computer−assisted project design tool, used at the very beginning of a project cycle, that provides a guide for the systematic analysis of interrelated project elements. One innovative application of this tool is to use it to enhance participation by stakeholders and beneficiaries in project preparation (Box 1).

19 / Interviews with Gordon Temple, CODIS, memorandum from Naureen Moore, CODIA, September 22, 1992.

| **Box 1:**<br>**Project Management Tools for Stakeholders and Beneficiary Participation** |
|---|
| The Bank is currently experimenting, with different participatory methodologies and software applications, to enhance the role of line agencies in the process of project formulation and design and to elicit greater participation from stakeholders and beneficiaries. In the Philippines, the Bank is collaborating with the Department of Environment and Natural Resources in using a computer−assisted tool for project preparation; the tool is used to initiate a dialogue between relevant sector agencies, industrial firms, associations and non−governmental organizations active in the area of industrial efficiency and pollution control. |
| Computer−assisted software has been developed by the Economic Development Institute and Team Technologies Inc. to more clearly define sector goals and |

| |
|---|
| operationalize objectives on which consensus is reached. This software has been used internally by the Bank project team to sharpen its own approach to problem and project analysis. It has also been used in the field to bring together, through two one−day workshops, the various stakeholders to define the core problems of industrial pollution control and explore through an "objectives tree" analysis, the relationships between the various factors identified. Information generated through these workshops is used for discussions between more specialized sub−groups of stakeholders and government agencies to draw the outlines of alternative project designs. These will constitute the basis of discussions with the Bank on future possible projects. |
| In Chad, the Bank has used the same tool to initiate a series of stakeholder conferences to ensure local ownership and to outline an implementation manual for a primary education project. |
| These experiences have already shown the value of microcomputers and software applications in establishing and documenting the various iterations of a "project" during its early preparation phases. As a common descriptive framework and the basis for later phases of design, implementation and performance monitoring, these and other software applications in project design and management can provide an effective mechanism for dialogue between the Bank and the borrowers, as well as a useful way for them to monitor and supervise project performance. Experience also suggests that the payoff of this tool is a function of taking the time necessary to organize the counterpart terms and to actively elicit their contribution. |

Another module is for designing research and development projects and modeling different implementation strategies. A third module provides collaborative

management tools to help project teams analyze assignments and integrate activities. Finally, the PC/PIP (Planning For Improved Performance) module is designed to make operational improvements in projects through the use of measurement and team process tools, such as cause−and−effect diagramming, force−field analysis, brainstorming, and nominal group technique.20 /

2.64 It is too early to tell whether the EDI/Team Technology Inc. software and the COSTAB software will integrate into a powerful project management standard within the Bank. In the absence of such standards, however, the initiative of individual task managers in customizing off−the−shelf software for their own development projects will remain a decisive factor in the spread of Project Management systems in Bank operations. There are numerous examples of this type of initiative.

2.65 The task manager for the Tamil Nadu Urban Development Project in India has pioneered a Lotus−based strategic management model for the Pallavan Bus Company in Madras that integrated ridership, fuel prices, manning ratios, and fare revision information into a standard accounting framework. This integration resulted in a quicker turnaround time and greater precision in forecasting. With the old forecasting mechanism, three people needed two days to perform one simulation to examine the effects of changes in Just three variables. Now, a run examining eight variables can be completed in one day. Moreover, the model has been used to optimize investment and cash management. Under the terms of its covenant with the Bank, the Bus Company must generate cash equal to 20 percent of the total investment program before it can procure 2,000 new buses. This computerized planning model has enabled management to track actual versus projected performance, to pinpoint areas for improvement, and to meet its cash targets. It has empowered the borrowers to fulfill project covenants.21 /

2.66 Other examples of successful customized applications by Bank task managers include the standard package developed to value the assets and receivables of 40 government−owned water companies in Korea, and the financial planning model installed in 14 public companies in the Philippines, including the power, port, and water corporations. The financial planning model enhanced the government's ability to conduct sectoral planning, to evaluate performance, and to target incentives (bonuses) at high− productivity corporations. 22 /

2.67 Thus, on many levels, the Bank is clearly building significant core competencies in creating and adapting computerized project management tools.

20 / Salem 1992; and interviews with Moses Thompson and Ed Silensky, Team Technology, Inc.

21 / Interview with Evan Rotner, task manager, Tamil Nadu Urban Development Project.

22 / Interview with Claudia Fernandez, task manager, Philippine Reform Program for Government Corporations

# 3.— Payoffs from Lending for Information Technology

### Selected Areas of Impact

3.1 This section is concerned with mapping and measuring the specific impacts of Bank information technology lending in development projects. It focuses on defining quantifiable improvements generated by information technology applications across a diverse group of sectors and projects and assessing task managers' perceptions of the value of information technology. It also reviews computerization and re−engineering projects in three areas of impact areas: transforming trade and tax administration, modernizing public sector institutions, and alleviating poverty. All are crucial fields of operation for the World Bank.

3.2 Structural adjustment lending by the Bank has often been accompanied by transformations in the administration of taxes, customs, trade, and other key national transaction systems. In modernizing public sector institutions, the Bank seeks to assist governments in confronting the paradox of containing the costs of governance while simultaneously responding to escalating demands for infrastructure, human resources, and social welfare investments. Poverty alleviation—meeting such basic needs as employment, health care, education—is the Bank's primary mission recently described by the President of the Bank "as the preeminent focus of our work in the 1990s." Thus, a review of the impact of Bank information technology lending in these three areas offers a good starting point for our analyses.

3.3 *Transforming Trade and Tax Administration.* Bank−supported computerization and re−engineering projects have played and are playing critical roles in national policy reform. In support of structural adjustment programs, large−scale information systems are coming on−stream to revitalize tax and trading systems, increase revenues, and streamline bureaucracy—and thus unburden the private sector.

3.4 A review of spearhead projects in this arena, highlighted by a case study of Mexico, presents a picture of sustainable and often radically transformed capacities of key institutions. The Bank's role has been a far−ranging one: advising on systems design and procurement; assisting in monitoring and implementation; and evaluating end−products and planning next stages planning. The long−term, focused involvement of the Bank has been a critical success factor in Mexico's computerization and re−engineering of its customs system.

3.5 Mexico is an important test case of how Bank information technology assistance can affect macroeconomic reforms. With $11.03 billion in investment in Mexico by the end of 1990—or 11.33 percent of its total

international exposure—the World Bank has a high stake in the outcome of the massive government computerization and re−engineering process underway. About 10 percent of recent Bank lending in Mexico has been in the trade arena, and the effects of information technology investments in this area are now starting to emerge.

3.6 As part of a major transformation of the tax system, the trading and customs system was radically changed through re−engineering and computerization. Prior to reforms, the system was highly centralized under the Directorate General of Customs, and traders faced long delays in the processing and clearing of merchandise.

3.7 Several critical changes have been made. The special registry of exporters and importers was abolished, and traders are now required to use their Standard Federal Tax Registry Numbers—that is, for each taxpayer there is one national account for all taxes. Traders now make tariff payments to commercial banks, not to Customs, and the banks keep and transfer computerized records of payments to the national treasury. Customs brokers, too, must present electronic data on a weekly basis on their clients' trading activities.

3.8 Since inspecting each trade transaction was impossible, customs shifted to a computer−generated random selection process, which determines which trade transactions are inspected. These refined sampling techniques reduced the steps in the custom process from twelve (nine of which involved paperwork) to four. This has resulted in substantial process time reductions and cost savings.

3.9 Finally, an electronic data communication network has been implemented which links 13 decentralized customs sites. This system was initially installed at five key customs facilities, which account for 75 percent of all imports and exports; in 1990 the remaining customs sites were computerized. This national system will eventually allow electronic data transfers between the Mexican, U.S., and Canadian customs systems as part of the North America Free Trade Agreement.

3.10 The initial results of this computerization effort at customs sites have been encouraging. For example, at Nuevo Laredo, the main trucking entry point from the United States, the number of operations handled daily went from 800 to 1,200, and the normal processing time per transaction was sliced from three days to 20 minutes. The daily collections increased by 12 percent in the first six months of the new system's being on−line. In Mexico City Airport, collections have increased even more, to 15 percent above the levels prior to automation.

3.11 Based on the results at Nuevo Laredo, it is estimated that the reduced customs processing time attributed to automation will represent an annualized national "savings" of more than $2 billion. The savings will be from interest "earned" because of quicker trade transactions; reduced transport and storage costs; and reduced undocumented expenses. These savings' represent 5 percent of the total value of merchandise trade, or almost 1 percent of Mexican GDP23 / .

3.12 The Mexico case is representative of a whole family of new information systems for macroeconomic policy and resource management developed with Bank support (Table 3).

23 / World Bank 1991d.

**Table 3:**
**Benefits of World Bank−Sponsored Tax and Customs Information Systems**

| Project | Benefits |
|---|---|
| Morocco's on−line Tax Database of Large Businesses | Tax collections have increased by 30% per year because of the better analysis and follow−up capabilities (1992).1 |
| Argentina's Automated Tax Collection System is on−line in five agencies; it will now extend to 36 agencies and allow real−time data entry and integration of records of large taxpayers. A MIS system is also being installed in the legal section (tax court). | These reforms are expected to increase revenues by over 1% of GDP per year. An additional $175 million per year in tax revenues collected is anticipated from the modernization effort.2 The MIS in the tax court is expected to reduce cases lost due to faunal errors by 75%.2 |
| Thailand's New ($67.9 million) Computerized Tax System will automate most tax activities, provide better assessment, audit, and cross−referencing of taxpayer records, establish a network of central, regional, provincial, and district computerized databases. Currently only about 38% of the 6.5 million tax returns are computer−processed; the new system will allow more than 20 million documents a year to be processed. Massive computerization was launched after a study showed that high income provinces that had the most computerized processing of tax returns paid more taxes than other similar provinces. | An extremely high financial rate of return of 541% is projected, with 8.94 billion baht in incremental annual revenues attributed to the better auditing and collections capabilities engendered by the new computer system.3 |
| The Philippines' Tax and Customs Information System is a large−scale, decentralized network for computerized tax and customs collections. | Currently taxpayers pay only 35% of the taxes they're supposed to pay; the computer system will double annual revenues.4 |
| Brazil's Siscomex System (Integrated Foreign Trade System), links the Central Bank, the government−owned Banco de Brasil, the federal treasury, end SERPRO, a government data processing service in a 1,500− terminal network with privets banks and businesses. | To reform an overly complex trade system, one electronic document will replace 32 paper−based import documents and 16 paper−based export documents. This should help break up the monopoly on trade, in 75% of which is controlled by 100 companies, and help smaller firms.5 |

Source

1. Interview with Mr. Tony Moussa, task manager for Morocco Project;

2. World Bank 1992, pp. 23 and 52;

3. World Bank 1991e, p. 4; p. 2, Annex 7; p. 52;

4. Interview with Mr. Claudio Fernandez, task manager;

5. Miami Herald , "Computerized Trade System Coming to International Edition Brazil Oct. 4," August 12, 1992, p. 16A.

3.13 *Modernizing Public Sector Institutions.* The modernization of public sector institutions has been a key objective of information technology lending. The impact of this lending is illustrated by a case involving China's

railway. This case points to the Bank's increasing capabilities as a bridge between the advanced software industries of the OECD countries and the user communities in developing countries, transferring to local agencies state−of−the−art database planning tools that can lead to transformational changes in capability.

3.14 The Chinese railway system is the main mode of intercity transport in the country, handling more passengers and freight than any other railway except those of the United States and the Commonwealth of Independent States. Yet, since the mid−1980s, bottlenecks have become widespread in the system due to a sharp rise in traffic as national economic reforms took hold (8 percent growth per year for freight and 12 percent per year for passengers during 1979−89); past under−investment in the system (1 to 4 percent of GDP compared with 2 to 4 percent for India, Japan, and Korea); and the general inefficiency of the economy (to generate $1 of economic output, China must transport 10 times as much freight as India or Brazil).

3.15 Since 1983, the Bank has provided more than $1.36 billion in loans and credits to the Chinese Ministry of Railways. The first four operations financed construction and expanded traffic capacity; the fifth operation represents a major departure, focusing on computerization and re−engineering of the planning and management functions to accompany a policy of decentralized decision−making.

3.16 Two key elements of the fifth operation are a computerized transportation management information system (TMIS) to keep track of equipment and traffic on a real− time basis; and a railway investment study (RIS) computerized analysis system. The RIS analysis system is a geographic information system−based tool that uses databases and graphical interfaces (digital maps) to help evaluate strategies for capacity expansion and to prioritize projects on a systemwide basis in accordance with economic criteria and budget constraints. The RIS system simulates present and future traffic flows in the railway network, pinpoints bottlenecks that emerge from these traffic flows, analyzes the costs and benefits of potential investments, and makes possible a quantitative, comprehensive modeling of the effects of the investments on the network.

3.17 The system first develops a "scenario definition": detailed specifications of the base transport network; the capacity expansion projects to be analyzed; the transport demand forecast data; the railway operating policy; and economic prices (investment and operating cost, and shadow price conversion factors). Then, the system carries out a complete round of analysis by activating four modules in sequence: traffic forecasting; facility performance; traffic assignment; and benefit cost analysis modules.

3.18 This computerized analysis system has already generated two important and rather dramatic conclusions. First, it has determined that, left alone, the railway network will experience bottlenecks that will slow the growth of traffic in ton−kilometers from the 1980−90 rate of 6.4 percent to 2.5 percent in 1990−2000. Second, it has produced an optimization plan—a plan that optimizes the location, scale, and timing of railway investments to yield gains of 10 percent in systemwide rail traffic throughput, representing some $4−5 billion of savings in railway construction costs through the year 2000.

3.19 The effects of the computer−generated optimization plan—the RIS Preferred Package—are compared with those of the initial RIS package in Table 4.

3.20 The RIS computerized analysis system is revolutionizing the planning function of the Chinese Ministry of Railways, making possible for greater targeting and control of resource allocation in an era of investment constraints.

**Table 4:**
**Expected Performance of China's Railway System and Investment**

| | INITIAL RIS PACKAGE | RIS "PREFERRED PACKAGE" | DIFFERENCE Amount | % |
|---|---|---|---|---|
| Improvements Due to Package Optimization (1995) | | | | |
| Total system[b] / tonnage carried (min tons) (Interzonal only) | 1,376 | 1,486 | 110 | 8.0 |
| Railway ton−km (billion) (Interzonal only) | 1,193 | 1,317 | 124 | 10.4 |
| Improvements due to Package Optimization Plus Additional Investment (2000) | | | | |
| Total system[b] / tonnage carried (min tons) (Interzonal only) | 1,601 | 1,846 | 245 | 15.3 |
| Railway ton−km (billion) (Interzonal only) | 1,375 | 1,818 | 443 | 32.1 |
| − due to optimization (Y billion) | 1,375 | 1,519 | 144 | 10.4 |
| − due to added investment (Y billion) | 1,375 | 1,675 | 300 | 21.7 |

This is a combination of the best performing investment packages presented in the RIS Yellow Cover Report: Package 3 for 1995 and Package 5 for the year 2000.

Including railway and waterway shipments.

Adjusted for changes in the base network, which increased the base ton−km by 4.3 percent in the RIS Phase II analysis.

Optimization is assumed to yield the same percentage increase as in 1995.

The additional investment of Y 60 billion accounts for the remaining difference in ton−km (21.7 percent between the RIS "Preferred Package" and the initial RIS package. In other words, the Y 60 billion additional investment has been determined with RIS optimization. Without RIS optimization, the additional investment would be Y 60 x (21.7 − 10.4)/21.7 billion or Y 89 billion.

Sources : World Bank 1992b, Annex 7, p. 7.

3.21 Other Bank−supported projects have also had quantifiable effects on public sector performance (Table 5). Computerization under the Pusan Urban Management Project in Korea increased taxes collected from city−owned corporations by 6 percent annually (1986−91) and reduced the city's outstanding debt by half. Morocco's debt management system enabled its government to carry out rapid debt restructuring and take advantage of declining interest rates. And Brazil's treasury management system eliminated the need for a float of at least $150 million which earned no interest.

**Table 5:**
**Benefits of World Bank−Sponsored Information Systems for Public Sector Institutions**

| Project | Benefits |
|---|---|
| Pusan city government (Korea ) installed a computerized budget and financial model and a computer−based investment tool used in the preparation of annual plans—these systems were "crucial" in restoring the city's financial health. | Total taxes and fees collected from city−owned public corporations increased 6% per annum in the 1986−89, reflecting improved cost recovery; outstanding debt was reduced to less than half the level of 1986 (from W1.4 trillion to W0.6 trillion).1 |
| Morocco's Ministry of Finance Debt Management Information System automated data on the national debt; enabled the government to drastically cut the time needed to pull together data on the debt from the original 40 days, and identify where it was paying high interest on loans, and reschedule debt. | Rapid debt rescheduling enabled the government to lower the interest rates paid on some loans from 22% to 8 to 9%.2 |
| Brazil's National Treasury Secretariat (STN) Financial Management System, created in 1986, resulted in the training of 3,900 public servants in database management, and establishment of an on−line network of 1,300 computers nationwide to improve federal budget expenditure control and financial management. | This system brought the entire network of 400 decentralized federal−level public entities and their subsidiaries—totaling 2,600 budget management units (BMUs)—under a real−time public expenditure system that enabled the government to manage all categories of sectoral expenditure much more efficiently; and merged the 3,700 accounts that the BMUs draw against in the Bank of Brazil into a unified Treasury Account, eliminating the need to maintain a float of at least $150 million which earned no interest. |

Source: (1) World Bank 1991a, pp iii−iv; (2) interview with Mr. Tony Moussa, Bank task manager; (3) World Bank 1986, p. 11 and 56; World Bank 1987; and interview with Mr. Carlos Fereira, project consultant.

3.22 *Poverty Alleviation and Social Support.* Bank assistance for poverty alleviation has developed computerization and re−engineering strategies to reduce central bureaucracies, decentralize services, and transform agencies into effective agents of social change. At an early stage, the Bank emphasized large−scale transaction processing and management information systems housed in central ministries. But it has moved toward into a more sophisticated approach, supporting wide−area networks that link central offices with field offices in interactive systems designed to support client−centered services.

3.23 *An important* site for Bank assistance aimed at achieving this kind of paradigm shift in social welfare systems has been Poland. The Bank is sponsoring two vanguard automation projects in Poland that have the potential to significantly strengthen the social welfare and health systems of this economy in transition.

3.24 The Employment and Services Project represents a $100 million Bank loan to assist Poland's Ministry of Labor and Social Policy in dealing more effectively with consequences of restructuring the labor force. In the first

year of the Economic Transformation Program (ETP), registered unemployment rose from 55,800 to 1.125 million (1990). As unemployment rises, the burden for Poland's local labor offices will continue to multiply, straining the already overloaded staff. With a ratio of staff to registered unemployed of 1:225 (compared with 1:64 for selected OECD countries), the obvious deficiencies in the labor offices processing capacity will become even more serious. As they seek to expand the services they provide beyond simple registration and benefit payments to include career counseling and job placement, they will be hampered not only by shortages of appropriately skilled staff, but also by the lack of national databases on labor markets and employment opportunities.

3.25 To address these difficulties, a comprehensive automation program is being executed with $28.7 million in Bank support. A massive distributed computer network architecture is under development, utilizing microcomputers, local area networks, and communication links via small aperture satellites and network connections. This network will link the 350 local labor offices and the 2,500 independent social welfare offices in virtually every city and town in Poland with a central information clearing house. The automation program will make possible rapid client registration and calculation and payment of unemployment benefits; the operation of a labor exchange and the collection and analysis of labor market information; networking between offices to accommodate the increasing numbers of clients who move among employment offices and social welfare programs; and the creation of a management information database for the entire network. While an automated network will not solve the problems of unemployment in Poland, it will help to alleviate the pressure of growing caseloads. The positive impact of automation can already be seen in Lodz, where a model local labor office has computerized registration, job matching, and the calculation of benefits. This office can register clients and calculate benefits in approximately five minutes. By contrast, in unautomated labor offices in Cadz the registration process alone takes fifteen minutes and benefit calculation takes two to three weeks. In addition, the automated office can handle a total client load 33 percent larger than those of the manual offices. These limited results suggest that

wider automation can improve the capacity of the system to handle escalating growth in demand.24 /

3.26 Another Bank−supported automation component is Poland's Health Services Development Project, which is aimed at restructuring a health sector characterized by underfinancing and neglect of maintenance, repair, and replacement of equipment; chronic shortages in drugs and supplies; long queues for patients; inappropriate structure and specialization of services; and a lack of management systems. A first step in the reorganization of the sector will be the establishment of health consortia in three regions that will link hospitals together to reduce costs and to share services, including materials, technology, and equipment management.

3.27 In the three pilot regions, extensive automation of 100 hospitals (out of 700 hospitals nationally) will cover the following key functions: patient admission and discharge, cost accounting, drug monitoring and dispensing, and general management. The computerization of patient admission and discharge data will assist the regional consortia in monitoring and, hopefully, modifying treatment patterns (which are thought to involve excessive hospital stays and overuse of drugs). The computerization of drug monitoring is designed to reduce the use of expensive, foreign−made drugs, which can now be freely ordered by independent physicians. To support this monitoring effort, standard software will be given to all hospital pharmacy operations, and a private group representing 4,500 independent pharmacies is to encourage the installation of similar automated systems in the affected communities.

3.28 An innovative feature of this initiative is its adoption of a software tool for microcomputers that allows hospitals to track data on admissions, discharges and the cost and quality of care. Currently in use only in the United States, the Pandora software package, an interactive graphics and database tool developed by Codman Research Group, will be used to monitor medical practice epidemiology—the pattern of medical services and their relationship to the rates and distribution of illness in defined service areas. Large variations in the per capita

rates of consumption of health care services between demographically similar populations can often be pinpointed, and the root causes of these variations (such as physician practice style—a prime determinant of utilization patterns, according to most research) can be addressed.25 / This surveillance of medical care systems and user−population demographics in small areas can also help in altering the mix of services to better reflect real demand.26 /

24 / The discussion of Poland's Employment and Services Project is drawn from World Bank 1991c, pp. 1−15 and 60; an interview with Mr. Kurt Moses, Bank consultant and Vice President of the Academy for Educational Development, Washington, D.C.; supervision report, January 29, 1992; and an interview with Mr. Sverrir Sigurdsson, EMENA Division. This project is currently facing major political difficulties, but these are hopefully temporary and should not detract from its innovative application of information technology.

25 / For example, in Waltham, Massachusetts, admissions for pediatric pneumonia were consistently between three and four times the statewide average; about 90 percent of these admissions and charges in Waltham were traced to a single physician.

26 / For example, the Ohio Medicaid program is now able to track the birth weights of newborns on a statewide basis, and target aggressive prevention activities to areas with high rates of premature and problem newborns.

3.29 As a result of advances in computer technology over the past five years, the hundred hospitals in the Polish consortia will be able to perform epidemiologic analyses on microcomputers that previously could only be done by mainframes processing large−scale data sets.

3.30 The combined effect of computerization and re−engineering on the health systems in these three regions is projected to be great: a 10 percent savings in operating budgets with efficient materials management, and a 5 percent savings in both investment and operating budgets with efficient equipment management. The total savings from measures that address pharmaceutical consumption and overall service efficiency in hospitals are expected to be as high as 3 trillion zloty, or 8 percent of the total health care budget. These internal savings could be redirected toward such priorities as prevention, health promotion, and primary care.27 /

3.31 Thus, in a period of major transformation in Poland, the Bank is assisting the government in implementing entirely new ways of managing its employment, welfare, and health care systems. The networked organizational structures and information systems that are being created can respond more flexibly and effectively to Poland's shifting social needs.

3.32 The Philippines Health Development Project (1989) represents perhaps the most imaginative and comprehensive combination of information technology applications in support of social programs and poverty alleviation. The project applies a variety of information and communication systems in support of policy analysis, planning, management, communication, and evaluation, systems that will lead to more effective targeting and timely and efficient delivery of health services to high−risk households and poor and remote areas (Box 2).

27 / The discussion of Poland's Health Services Development Project is based on World Bank, Staff Appraisal Report, "Poland Employment Promotion and Services Project," March 27, 1992, pp. 1−8, 18, 24, and 39; an interview with Dr. Mary E. Young, task manager, EMENA Department; an interview with Dr. Philip Caper, President, Codman Research Group, Inc., New Hampshire; Caper 1990, p. 41, and 52; and American Journal of Public Health , "The Epidemiologic Surveillance of Medical Care," June 1987, Vol. 77, No. 6, pp. 669−70.

3.33 Examples of other automation projects aimed at poverty alleviation are highlighted in Table 6.

**Table 6:**
**Benefits of World Bank−Sponsored Information Systems for Poverty Alleviation and Social Support**

| Project | Benefits |
|---|---|
| The Tianjin Health Planning Project (China) created a geographic information system that mapped and digitized housing, health, and morbidity data sets down to the district level of this city with a population of 8 million, city. | GIS analyses demonstrated that where the density of housing was greatest, health, water, and sanitation were poorest. As a result of these analyses, $6.5 million in funds originally designated for construction of a beltway around the city was redirected by the mayor to improvements in a slum area of a million people.1 |
| As part of the First and Second Addis Ababa Urban Development Project (Ethiopia), the Housing Savings Bank implemented an extensive computerization initiative to improve its capabilities in processing loan applications from self−help housing cooperatives. | Between 1983 and 1989, the value of the Housing Savings Bank's Housing Savings advances to borrowers per employee increased 28% and the number of loan approvals processed rose 300% while staffing experienced a mild growth of only 50% in the same period,2 |
| As part of Mexico's Decentralization and Regional Development Project for the Disadvantaged States, aimed at Guerrero, Hidalgo, Oaxaca, and Chiapas states, where one−third of Mexico's poor live, a database of poverty alleviation investment projects has been computerized. | Municipal councils representing the beneficiary population proposed urgent investment projects; in Hidalgo alone, 90,000 project proposals were computerized. An artificial intelligence package is developed to screen projects electronically and select for approval those meeting pre−defined impact criteria. Currently, 90% of the information analysis work is conducted manually, and the goal is to drastically decrease the time allocated to smaller projects (below $US18,000) and to shift staff to medium−size and large project analyses.3 |

Source : (1) Young and Bertaud 1990 pp. 139−149; World Bank 1990; and (3) World Bank 1991b, pp. 1, 5; and 91.

3.34 Each of the vanguard projects described in this section involves both substantial computerization and restructuring of management support structures and organizational practices. Again, it is the right alignment between computerization and re−engineering strategies that seems to matter most—and that leads to the transformation of institutional capabilities in meeting the challenges of macroeconomic management, public sector modernization, and poverty alleviation.

3.35 *Emerging Development Priorities.* Bank information technology lending has also made significant contributions to such emerging development priorities as the environment, popular participation, and private sector support.

3.36 In particular, there has been a growing variety of Bank−sponsored information technology applications in environmental management. Here are several recent examples:

SIGERCO, the information system for coastal management in Brazil, collects, analyzes, and distributes data about the coastal zones of six states, and geo−codifies data for mapping purposes. (Brazil National Environmental Project)

National environmental information systems in Burkina Faso, Guinea−Bissau, and Nigeria are being set up to better meet the demands for renewable resource management. (Program on Environmental Information Systems in Sub−Saharan Africa)

Computerized process management tools and advance control software have been installed at the Baroda Petrochemical Complexes in India to reduce pollution. At the Vadodara Complex, a Hazardous Emissions Warning System database uses real−time meteorological information to model and predict the dispersal pattern, concentrations, and evacuation requirements for releases of toxic material into the atmosphere. (India Second Petrochemicals Development Project)

Automated Flood Forecasting Networks in the Chambal, Krishna, and Mahanadi river basins in India use microprocessor−based data acquisition systems and telecommunications to monitor real−time water inflows and forecast floods. (India Dam Safety Project)

Environmental information centers have been established in a number of developing countries.

3.37 Geographic information systems and remote sensing have become essential tools for environmental monitoring and assessment and for

| Box 2<br>Philippines Health Development Project |
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| To assist the Department of Health (DOH) in modernizing its operational and management systems and enhancing its responsiveness to its priority programs and clients, the project would strengthen the department's capabilities at the various administrative levels and in a number of specific functions. This would include improving its overall communication system, its capacity to carry out information, education, and communication programs, and its project management, coordination, and evaluation capabilities. |
| To improve the transfer of information within DOH and facilitate effective management of operations, the project would support the establishment of a national information communication and management network for DOH, comprising some 120 central, regional, and provincial sites utilizing packet radio. Packet radio combines two−way radios and computers, allowing the error−free exchange of printed data while permitting the computer and radio to be used separately for other day−to−day activities. Where electricity and telephones are inadequate, the DOH's packet radio−computer network would be fueled by solar power. This low−cost network permits rapid, countrywide aggregation and analysis of management information data. Existing management and educational functions of the DOH requiring frequent and timely communication of information at all levels of the DOH would be supported by this on−line network. This support would include the communication of field epidemiological |

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| surveillance data, health information system data, MIS data, and financial management information, including budget, procurement, and expenditure data. |
| The newly developed health information system is expected to simplify existing DOH reporting systems for health statistical data and facilitate the production of useful analyses for planning, budgeting, monitoring, and evaluation. The project would also support the establishment of a central geographic information system for use in mapping public health problems (malaria, for example) and micro−variations in community risk or health status requiring spatial reporting and trend analysis. A system of health mapping and area classification would be established, building on the existing activities of the malaria and schistosomiasis programs. A desktop publishing system would also be provided to facilitate the production of DOH manuals and IEC materials. |
| The project would support development of an MIS to expand and upgrade the current small, separate systems being used in various parts of the DOH. Routine information now being generated would be assessed for computerization, and appropriate software developed to facilitate and speed up routine operations that affect management decisions. Technical assistance to evaluate the computer−readiness of key DOH operations at the central and field levels would be provided in the initial years of implementation. Specific units targeted for assessment include the financial subsystems, logistics, personnel management, and management (with special priority on impact programs) and community health services. |

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| Box 3<br>Environmental Management and Information |
| The increasing power and declining cost of information technology gives new hoye for managing and containing the pressures on the environment in Sub−Saharan Africa. Through the deliberate, appropriate implementation of management Information systems, geographic and environmental data gathering and processing, demographic analysis, computer modeling, and telecommunications, the region's policymakers can collect, scrutinize, manage, and share the immense volume of information they need to begin restoring the ecological balance. |
| The scope and complexity of social and economic pressures in Sub−Saharan Africa, and their implications for the environment, demand thoughtful, coordinated, informed management—management that bridges local and national boundaries. Such management must be Based on: |
| Timely, dependable access to accurate information on land use and tenure, demographic trends, geographic and geological characteristics, the availability and use of renewable and nonrenewable resources, weather patterns, and such natural calamities an flooding. |
| The ability to analyze this information and bring it together for use in environmental planning and management. |
| The ability to share the Information, as well as strategies, among policymakers at all levels and across the entire Sahel. |
| Remote sensing and the recent development of geographic information systems |

provide powerful tools for Integrating and analysing spatial information in urban and regional planning, land use and water resource planning, natural resource assessment, mineral resource exploration, and environmental protection. The challenge is to build local capability to exploit these new tools and to organize and analyze the vast amount of data involved in environmental and natural resources management.

The Republic of Guinea, for instance, has placed a high priority on efforts toward soil protection and conservation of an appropriate balance of the natural ecosystem. As a part of these efforts, the government has identified the need for strengthening national scientific and technical capacity to provide the required knowledge for rational use of natural resources, and for preparing maps and cartographic images of these resources. The Bank has funded a project to assist the government in establishing systems for managing forestry fishery resources. This project involves informatics−intensive components to manage hundreds of thousands of hectares of forest, rigister land rights, and plan and research offshore fishery management.

As part of a major research effort in Chad on developing an ecologically and institutionally sustainable base for the livestock sector, the Bank is funding research to define techniques for rangeland conservation and crop−Livestock integration that are both: technically and socially acceptable. The project includes the use of microcomputers and satellite data and the training of local scientists to collect and analyze information.

Various forestry and energy projects also rely on information technology applications to improve resource conservation and management. For example, a forestry development project in Tunisia includes communication equipment, forest inventory based on satellite imagery, and information systems for research, monitoring, and planning. An oil refinery rehabilitation project in Ghana uses the refinery's information resources to improve efficiency and increase productivity—and thus reduce water and air pollution and deforestation.

Box 4
Grassroots Participation and Informatics

Information is power, and information technology is generating new tools and novel ways to reach, mobilize, and empower the poor. Information is scarce in developing countries, and the poor suffer the most from the dearth of information, both as producers as consumers.

With informatics' continuing affordability, miniaturization, portability and user−friendliness, it becomes more difficult to withhold, hoard, or ration information—and easier to depressionalize production of media messages and decentralize access and control. Radio and television are still the most important electronic media for the poor, and their potential remains under−used for health and family planning messages, literacy, agricultural extension, vocational training, and social marketing.

Video is proving to be a highly powerful tool for mobilizing and educating people, and changing attitudes. Grassroots groups and NGOs developing countries are just beginning to share experience with video and are developing decentralized, low−cost, interconnected video systems.

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| New technologies—such as facsimile, video−teleconferencing, and electronic networks—are facilitating the pooling and dissemination of information among thousands of NGOs in support of the poor. They are linking scientists and technical experts within countries and regions to grassroots organizations and local institutions. |
| NGOs across Latin America are creating their own databases on the impact of various national policies and programs on target groups and using this information to improve the accountability and responsiveness of public and private agencies to the beneficiaries. Similarly, in Mexico, campesino federations are creating their own databases on the national bank's rural credit programs, and thus are in a position to negotiate the fairness and performance of such programs. |
| Pilot projects to develop district−level information centers in Africa are under way to tailor information in support of local decisionmaking and to provide reliable information for national rural development programs. These centers are linked electronically to pool information resources and provide a bottom−up approach to rural development planning and resource management. |
| So far the Bank has not explicitly or systematically used informatics as a powerful and effective tool to empower the poor to help themselves. But, the Bank has used informatics to improve national information for planning, monitoring, and evaluating programs for poverty alleviation. A pro−poor information agenda for the Bank would: |
| Exploit informatics more fully to support basic education, and out−of−school education. |
| Target information and communication facilities toward the poor and their organizations, Just as the Bank now targets education or agricultural programs. |
| Improve the poor's access to information where information in private markets is highly inequitable; as social services become increasingly privatized in many countries, the states, perhaps through the NGOs, can of assist poor consumers in knowing their rights and options and the merits various choices. |
| Integrate the information and communication dimensions in the design of poverty reduction projects so as to ensure effective participation, motivation, and education of the beneficiaries and maximize the informational spillover, social learning, and linkages to NGOs. |
| Continue to improve information on the social coats of adjustment and build local monitoring capabilities. |
| Improve national information and communication policies to support access to and dissemination of information collected by public sector agencies and to counter any further isolation of the rural population and the poor. |

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| Box 5<br>Informatics For Private Sector Development |
| A relatively new area of investment technology application is in private sector development−−through direct support to the information technology sector and indirect support to private businesses. The Second Urban Project (1990) of the Republic of Guinea creates commercial and technical databases to assist small |

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| construction companies. Poland's Industrial Export Development project (1990) promotes the diffusion of computer numerical control tools. Korea's Electronics Technology Project (1979) strengthens the Korea Institute of Electronics Technology (KIET) to lead industry in acquiring semiconductor technology. Korea's Third Technology Advancement Project (1991) will build a national data network linking Korea's science and education libraries. And Morocco's Industrial Finance Project (1990) builds an electronic network for streamlining and simplifying trade procedures. |
| Many applications of information technology for the modernization of public infrastructure and services are crucial to private sector development. Among these are several financial modernization loans to Eastern Europe, a trade information database for Brazil and trade logistics and customs modernization loans to several Africa and Latin American countries. Similarly, tax automation projects are designed to reduce transaction costs (as well as increase resource mobilization) for businesses, as in Argentina, the Philippines, and Thailand. |
| Two recent projects (fiscal 1992) may illustrate the novel directions information technology applications might take in support of private sector development. The Republic of Cape Verde's Privatization Technical Assistance Project involves the design of a legal and regulatory framework for attracting local and offshore information processing firms, including telecom and teleport activities. The Russian Federation Privatization Implementation Assistance Project involves databases and networks to assist planners in gathering and managing data on firms, assets, and valuation, and thus support the privatization program of more than 20,000 large and medium−size firms. |

integrating environmental and economic information so that natural resource management considerations are taken into account in economic policy analysis and planning. Box 3 provides more examples from Africa where environmental management problems are severe and information on the natural resources is scarce.

3.38 Similarly, emerging experience with information technology applications in the social and agricultural sectors indicates that informatics

is opening new and more effective ways to support social learning and beneficiary participation. The poor (and their organizations—NGOs) have the least access to information that is essential to them as producers, consumers and participants in their own development. Box 4 gives examples of how information technology can be used to support grassroots participation and suggests a pro−poor information agenda for the Bank.

3.39 Finally, information technology lending in support of private sector development is also growing. It has focused primarily on the modernization of transaction systems and infrastructure critical to the effective functioning of markets and businesses, such as customs, financial services, and logistics management. Box 5 provides some examples of recent innovative lending operations that point to unexploited possibilities.

### Task Managers' Survey

3.40 World Bank task managers are involved in a wide range of project−specific activities, and have oversight responsibilities for the preparation, execution, and monitoring of frontline operations. They usually have training in a particular discipline and there are no obvious and intrinsic reasons for them to have either a positive or negative bias about information technology. Task managers are uniquely situated to observe the design, the deployment, and the impact of information technology components of projects under their supervision. So their

perceptions about the value of information technology to current or anticipated project performance are important sources of data for assessing it. For this reason, a survey questionnaire was distributed to a sample of 62 task managers, all of whom were involved in projects in fiscal 1989 and 1990 identified by our database as having information technology components (see Annex 3).

3.41 *Structure of Information Technology Investment.* Respondents were asked to estimate the dollar value of the information technology components of their projects (Figure 9). In addition, we asked respondents to disaggregate the investment and tell us what percentage of costs was for training and technical support. Respondents reported that, on average, 24 percent of the total cost of an information technology component was for training and technical support. In comparison with industry benchmarks, this is quite a low percentage. For example, Strassman (1990) estimates that more than 50 percent of total information technology costs in industry can be attributed to "formal training, time devoted to learning and information support from others." (p. 17) The Gartner Group gave an even higher figure, claiming that hardware and software costs accounted for only 32 percent of total information technology expenditures (Gray 1991, p.3). The remaining 68 percent goes for training and support.

3.42 The low percentage of project resources going to information technology training and technical support in Bank lending might have worrisome implications for the future. As information system installations increase exponentially in scope and complexity, training and support (particularly after installation to assist in institutional re−engineering) will also have to increase in order to continue promoting effective technology transfer to borrower countries.

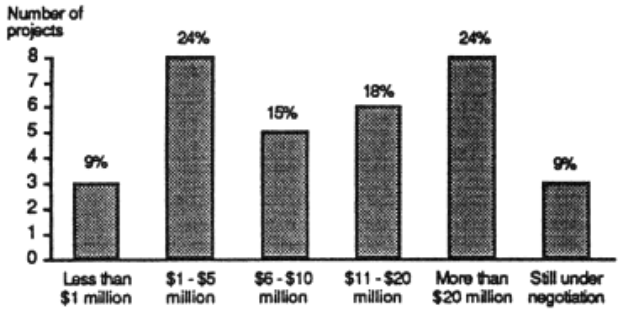



Figure 9:
Dollar Amounts of Information Technology Components in Projects

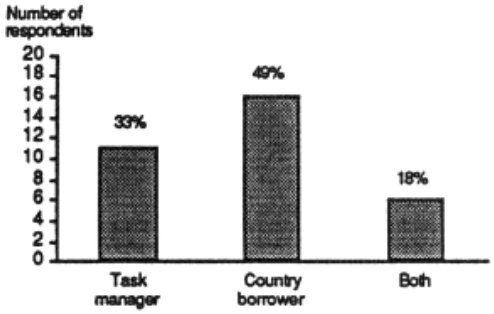



Figure 10:
Source of Concept for Information Technology Component

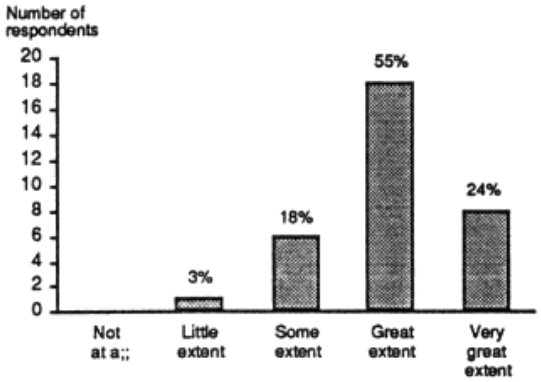



Figure 11:
Information Technology as Critical to Achieving Project Objectives

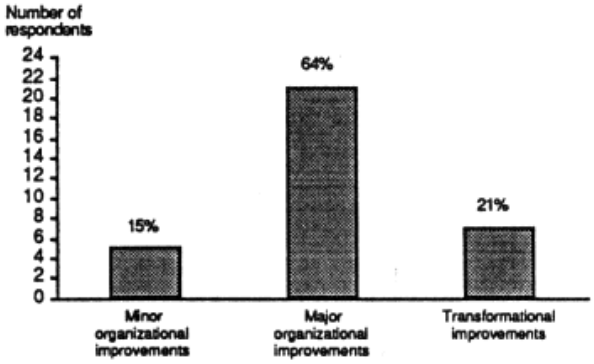



Figure 12:
Information Technology Applications In
Projects as Fostering Organizational Improvements

3.43 *Source of Information Technology Components in Projects.* To determine the initial source of inspiration and demand for the information technology components in projects, task managers were asked who first generated the concept for the information technology component (Figure 10).

3.44 Task managers reported that the borrower country was the source of the information technology concept in 48 percent of the projects, and that they themselves suggested information technology components in only about 33 percent of the projects. This is an interesting finding. It either reflects the deference task managers give to client governments or, more likely, it indicates a real demand for information technology on the part of those governments and an awareness of information technology's potential for contributing to development that is somewhat keener than that of their World Bank (task manager) counterparts. The escalating amounts of matching investments in information technology components by host governments between 1986 and 1991 suggest that the second is more likely.

3.45 *Importance of Information Technology in Projects.* To assess the task managers' perceptions of how important information technology was in meeting project objectives, we used a five point rating scale (Figure 11).

3.46 Almost all respondents (32 of 33) perceived that information technology was critical to achieving project objectives. Twenty−six respondents (78 percent) perceived that—to a great, or very great extent—information technology was critical to achieving project objectives.

3.47 *Outcomes of Information Technology Investments.* A relatively open−ended question was framed to evoke and assess the expectations of task managers regarding overall outcomes and effects on their projects of information technology investments (Figure 12). Eighty−five percent of the respondents expected major or transformational improvements—a clear indication that task managers have a positive perception of current or anticipated outcomes of information technology applications.

3.48 *Specific Benefits of Information Technology.* To gauge the perception of the specific benefits of information technology in projects, we framed a question using a list of strategic organizational variables (developed and tested for reliability by Mahmood and Soon) to ask how managers thought information technology was contributing to the accomplishment of project objectives Figures 13, 14, and 15.

3.49 On contributions to improved efficiency, the largest number of respondents believed that information technology leads to better financial management or reporting (70 percent); better coordination among functions (53 percent); improved process and content of decisionmaking (60 percent); shorter organizational response times (50 percent); and improved productivity of labor through automation (53 percent). Fewer respondents believed that information technology reduced the costs of services delivered (34 percent); or increased flexibility and range of services delivered (27 percent). These responses confirm the dominance of "first−order" Bank−sponsored information technology applications in developing country organizations. These applications effect fundamental improvements in core functions and a basic upgrading of systems of management and decision making. Increased flexibility and range of services—

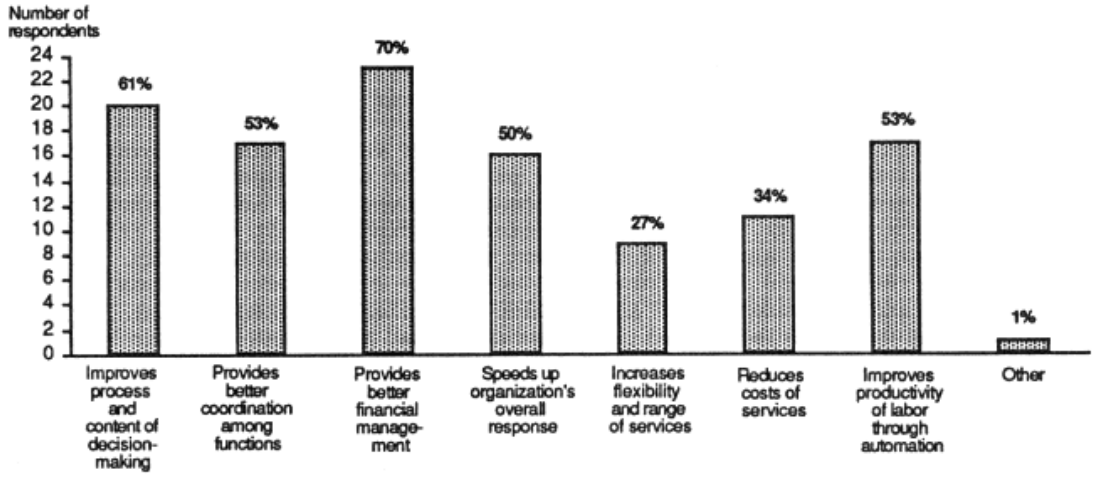



Figure 13:
Information Technology's Contributions to Internal Efficiency in Client Organizations

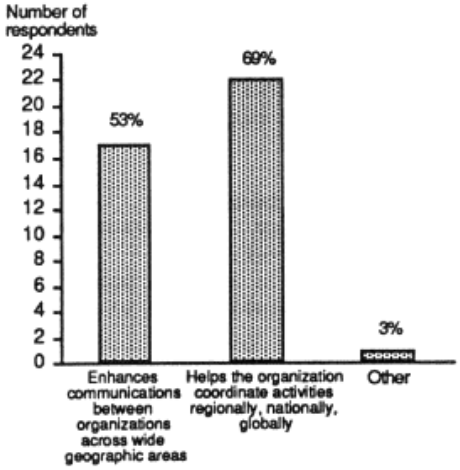



Figure 14:
Information Technology's Contributions
to Communications among Organizations

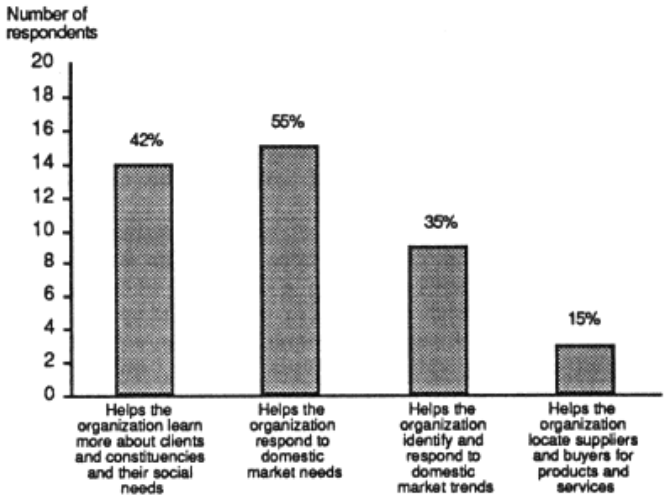



Figure 15:
Information Technology's Contributions to
Responsiveness to Markets or Social Needs

diversification—and reduced costs of services—are second−order, more quality− oriented applications that are still beyond the reach of most developing country institutions.

3.50 On contributions to inter−organizational communications, 53 percent of respondents believed that information technology enhances communication between organizations across wide geographic areas, and 70 percent believed that it helps an organization coordinate activities regionally, nationally, and globally. In large measure, these responses reflect the growing involvement of task managers involvement in decentralization efforts, and an increasing awareness of the impact of wide−area networks, which electronically link central management units of institutions with their operational units for enhanced information sharing and coordination.

3.51 On contributions to enabling a better response to markets or social needs, only 45 percent of respondents

believed that information technology helped organizations respond to domestic market needs. Similarly, less than half the respondents (42 percent) believed that information technology helped organizations to learn more about clients and constituencies and their social needs; to identify and respond to domestic market trends (28 percent); or to locate suppliers and buyers for products and services (9 percent). These responses seem to illustrate the "fee" among task managers that governments are still relatively closed systems that seldom use information technology to interact effectively with social constituencies; to use information creatively and "strategically"; or to electronically scan national and international markets for competitive procurement or direct sales.

3.52 By and large, task managers seem to perceive that the strongest effects of investment in information technology on strategic organizational variables occur inside organizations, in improving the efficiency of operations and the effectiveness of internal communications between operational units. Positive effects on externally oriented variables—such as the social marketing function or wider information−gathering efforts outside the boundaries of the institution for improved forecasting and more rapid buyer− seller interactions—are less broadly perceived by these task managers.

3.53 This focus on information technology's effect on internal efficiency is further revealed by task managers' responses to the open−ended question on "other current or anticipated benefits." The comments offered all concerned internal effects. For example, "efficient automation of key economic and financial data will help ensure accuracy of data," and information technology provides "accuracy of reporting and early warning signals for potential problems." Task managers clearly have a tactical, operational orientation toward information technology.

3.54 Task managers do not yet seem to have a good understanding of the great potential value of information technology for intelligent inter−organizational networking and for facilitating the competitive integration of countries into the global information economy. This points to a need for further educational initiatives within the Bank about the strategic use of information technology systems in developing countries. Such initiatives could build on the already strong base of understanding of information technology's value in development.

3.55 Obviously, this survey's findings must be treated with caution because of the small sample size and the non−random method of choosing the task managers. To fully validate the findings for broader acceptance, a larger sampling of task managers needs to be conducted. A next phase of research would expand the sample and test the replicability of our results.

### OED Impact Assessments

3.56 To capture the conclusions of Bank evaluation specialists on the effects of information technology, a review was conducted of World Bank Operations Evaluation Department (OED) completion and audit reports for projects with significant information technology components. Evaluations completed in 1990 and 1991 were chosen for review, for a total of 27 projects. Most of these projects (25) had been approved in or before 1985, indicating how long it takes in the Bank to evaluate technology investment, execution, and performance. Of these 27 projects, 11 (41 percent) were in Africa, 7 (26 percent) in Asia, five (18 percent) in EMENA, and four (1.5 percent) in Latin America. The projects represented a heterogeneous sample of sectoral activities, ranging from telecommunications to rural development (Annex 4, Table A4.2).

3.57 Of the 27 information technology components in the sample, 20 (74 percent) were rated satisfactory and favorably described by reviewers as contributing to project objectives. In four of these 20 cases, the information technology component was favorably described even though the project as a whole received an official "unsatisfactory" rating by the auditor/reviewer. The highly favorable Judgments by auditors and reviewers of the impact of information technology across a diverse group of completed projects contrast with previous analyses within the Bank. Those analyses did not include (to our knowledge) a systematic review of OED completion and

audit reports, but were based on anecdotal information or inspection of bid and procurement documents relating to the information system during the project's design and start−up phase.

3.58 The positive effects of information technology activities described by Bank auditors and reviewers included the following:

Streamlined and strengthened administrative efficiency in public institutions

Enhanced government decentralization

Promoted effectiveness of planning

Diffused best practices to the business sector.

3.59 Of the seven information technology components (26 percent of the sample) rated "unsatisfactory," EMENA, Asia, and Africa each had two, and Latin America had one. Given the disproportionately high number of information technology components in Africa in the sample, it is somewhat surprising that the region did not have a higher number of unsatisfactory ratings. But these ratings do not capture sustainability problems (which arise after project completion), which are likely to be more common in Africa.

3.60 The findings of this selective review are clear: in completed projects with large information technology components, OED evaluations have consistently pointed out the positive role of those components in achieving overall project objectives. This positive perception by Bank evaluation specialists reinforces the conclusions reached from the survey of task managers.

### Gap Between Common and Best Practices

3.61 The focus of this study was on identifying spearhead applications and the high economic payoff of adopting best practices in the application of information technology in developing countries. But these payoffs are based mainly on evidence from feasibility studies, task managers' perceptions and OED findings which do not cover post−implementation or sustainability considerations, where other factors become critical. And there are other complementary evidence, from the reviews of in−house Bank experts (Moussa and Schware, 1993) and the extensive literature on the implementation of information technology in industrial and developing countries (Annex 4, Table A4.1) which suggests that significant problems and common pitfalls occur in many projects. Understanding these common pitfalls is essential to ensure a high likelihood of success in the Bank's implementation efforts and those of its partners.

3.62 Common practice suggests that information technology application components are often added on at a later stage of project preparation, and then left to outside consultants to appraise and supervise. Task managers are faced with increasing demand for assistance in this area, bilaterals are often interested in financing computing hardware, and developing country officials are often bedazzled by high−technology. These conditions are not conducive for the Bank's task managers, and their counterparts in developing countries, to learn about and secure the necessary environment for the successful introduction of new information systems. Under these circumstances, it is also unlikely that issues of sustainability of such investments and diffusion of best practices could be addressed effectively.28 /

3.63 Bank lending for information technology components therefore has some common problems and pitfalls:

inadequate attention to the enabling environment, including informatics policies, information and communication infrastructure, support services, and local consultants and vendor capabilities.

insufficient planning to clarify objectives and priorities of components and align them to sector or institutional strategies, analyze and redesign business processes, ensure appropriate choice of hardware and software, phase and sequence systems investment in line with the institution's absorptive capacity and learning stage,

28 / An extensive literature has documented such common practices of aid agencies and developing countries, including, among others, Hanna and others (1990), Moussa and Schware (1992), Peterson (1991), Robey (1989), Symons and Walsham (1990), and issues of Information Technology for Development Journal (Oxford Press, 1985−1990).

and build flexibility to meet changes in technology and information needs.

lack of management commitment and user participation, to define their information needs and priorities, clarify responsibility for project management and training, ensure know−how transfer to counterpart technical staff, and institutionalize the process of adaptation and learning.

human resource constraints, including scarcity of local technical skills, high turnover of technical and managerial staff, lack of participation of counterpart staff, poor incentives and career ladders for IT professionals (in the civil service), and lack of training for IT professionals and users.

underestimating project cost, particularly for software development, and neglecting recurrent expenditures, particularly for training and systems maintenance.

missed opportunities to contribute to local capability development and the diffusion of best practices in information technology adoption and use, beyond the specific components under Bank−financed projects.

3.64 These problems are not unique to Bank−financed projects or developing countries. As MacFarland (1992; Annex 4, Table A4.1) indicates, these problems appear wherever information systems are implemented. But these problems are particularly severe for developing countries, whose financial and human resources constraint mean that learning costs must be minimized. Industrial countries are ahead on the learning curve and advanced users have institutionalized such learning and are already reaping increasing returns on their information technology investments. Also all indicators point to an increasing use of information in economic activity worldwide. Hence, the Bank and its partners cannot afford to ignore such problems. Rather, they should seek ways to accelerate their learning and to help diffuse best practices in IT adoption, as these practices emerge from both advanced and newly industrializing countries.29 /

29 / A companion study is forthcoming on the experience of OECD and NIC countries regarding policies and programs to diffuse best practices in using information technology.

## 4.— Lessons for the Bank and for Developing Countries

4.1 Is Bank lending for information technology applications responsive to the changing global context and the emerging needs in developing countries? Can borrowers and the Bank improve the levels of payoffs from such investments? How should developing countries and aid agencies adjust to the information technology revolution? This last section outlines the broad conclusions and lessons from our study.

## Conclusions

4.2 The Bank has emerged as a major investor in information technology applications in developing countries. Information technology lending has increased six times the rate of growth of total Bank lending. Information technology components are pervasive, covering all sectors and regions, and currently present in about 90 percent of lending operations. Core competencies are emerging in applying specific information technologies to key areas of Bank lending. There have been dramatic returns on investment in best practices IT applications, most visibly in the case of large automation projects. Small investments in information systems often had high leverage by supporting the planning and management of large projects or major public expenditure programs. Most task managers surveyed were also very positive about the contributions of information technology applications to projects under implementation.

4.3 Notwithstanding these significant achievements, and the demonstrated high payoff of best practice, the Bank's common practice still falls far short of the potential in this emerging and fast evolving field of development assistance. Spearhead examples are often the product of the entrepreneurship and commitment of individual task managers. Core competencies have been built from the bottom up, and, with few exceptions, with little institutional support, nurturing or direction. Core competencies are therefore limited to few pockets of expertise, often single individuals within the Bank, and gaps are evident in other priority areas for IT applications.

4.4 So far, the Bank's response to the information technology revolution has been reactive. As a result, information systems components are often improvised, narrowly drawn and isolated from one another. Such components frequently get short shrift. Because information systems components are diffused over many projects, few realize how involved the Bank is in this business. And because informatics is a new field and highly technical, the work often falls to consultants who may be technically competent but unfamiliar with the requirements of developing countries. Lacking professional assistance, these components are poorly planned and budgeted for, and inappropriate technology choices are often made. And, given the focus on the short−run needs of the lending operation, there is too little attention to sustainability and diffusion. Moreover, because institutional inadequacies and necessary adaptations are not addressed, the new information resources and capabilities are poorly used.

4.5 Equally important, the Bank—and the borrower—are missing opportunities to improve informatics policies to promote the effective management and diffusion of information resources and technology. They are also missing opportunities to focus the management and use of information technology on a country's development priorities—and to develop a comprehensive approach to build country−wide information infrastructure and support services, and where appropriate, to promote the export of promising segments of the fast growing information technology industry, such as software services. Lacking a Bank−wide strategy that anticipates and coordinates the Bank's response, the synergy among multiple interventions—in education, industry, telecommunications, information systems, and statistical and information services—is often lost.

4.6 The Bank has a potential comparative advantage in assisting countries in meeting these needs because of six strengths:

First, the Bank's involvement with its borrowers in all major economic sectors and in macroeconomic management enables it to deal with the cross−cutting dimensions of information and communication.

Second, the Bank's global sweep allows it to transfer the lessons of experience in using this new technology.

Third, the Bank's access to policymakers for high−level dialogue is critical for the formulation of informatics policy and for the removal of basic constraints to the diffusion of information and its technology throughout the economy.

Fourth, the Bank has at its disposal a variety of means for influencing and supporting information technology diffusion in coherent and mutually reinforcing ways.

Fifth, the Bank is free of many of the limits imposed on bilateral and tied aid—freedom that can enable borrowers to avoid proliferating standards and technological discord.

Sixth, the Bank's operations are large enough to allow it to mobilize the substantial resources needed for the development of national information infrastructures and the broad replication of promising applications.

4.7 Concerns about the Bank's gaps in information technology skills are legitimate, but to conclude that business−as−usual is preferable or inevitable is inappropriate for several reasons. As this study demonstrates, the Bank is already involved in lending to increasingly complex and diverse information technology applications. Such lending is spread across the whole spectrum of the Bank's portfolio and has become an integral dimension of lending operations. The Bank already has pockets of expertise in various segments of the informatics field. It now needs to mobilize and consolidate this talent and augment it with the necessary resources and outside experts familiar with the conditions in developing countries. Organizational learning−by−doing could be accelerated by a deliberate strategy and systematic reviews of Bank and country experiences. Keeping up−to−date, always a challenge, is important because borrowers already are investing heavily in information technology, and

the cost of postponing a response will increase over time. In the midst of a fast changing environment, the Bank—and other aid agencies—cannot afford to maintain a "static" view of the comparative advantage.

4.8 A proactive role for the Bank in information technology would support and reinforce the Bank's current priorities and its future−oriented strategic agenda. Information systems have become key instruments in debt and adjustment management, capacity building for policy analysis, and public sector management. Information and communication systems are transforming financial institutions and access to markets and resources for private sector development. Informatics is providing essential tools for environmental planning, monitoring, and management. Its application to education, health, and family planning is supporting the vast needs for information and communication in people−oriented development programs. And new information and communication technologies are capable of generating effective ways to reach, mobilize, and empower the poor (and NGOs) with relevant and timely information. Developing the Bank's competence in information technology assistance is thus critical to the Bank's future relevance and responsiveness in the information ages30 / .

### Lessons and Recommendations

4.9 Two broad sets of recommendations flow from the study's findings (Table 7):

(i) institutional measures for Bank management to promote strategic adjustment and institutional learning within the Bank, and to respond to the growing demand for information technology more effectively and proactively (parse 4.10−4.36); and

(ii) practices and instruments that task managers and borrowers may use to improve the sustainability and economic payoff of investments in information systems components and exploit information technology throughout the economy (paras. 4.37−4.52).

### Institutional Management and Learning

4.10 Management of the Bank—and other aid agencies—may help direct and facilitate the adjustment and learning necessary for their institutions to respond to the demands of the information age. Measures may include:

30 / "The World Bank's lending program is still oriented to an industrial age mindset and requires adjustment to an information age focus", Peter McPherson, Deputy Secretary of the U.S. Treasury, in a speech on Third World Development in Information Age delivered on September 19, 1988. Another U.S. senior policymaker, Clarence Brown, a former deputy secretary of commerce, stated that "changes brought about by the information age are determining significantly nations' economic competitiveness. Most important, these information technologies will drive the development and structure of global markets, as the national markets of the past cease to exist. He concluded that "...communications and information services markets are international in scope, therefore that long term efficiencies for all nations can be attained only through the establishment of a truly international information infrastructure.... International cooperation in adjusting domestic regulatory policies will be essential to fully develop information technology." See "The Globalization of Information Technology", The Washington Quarterly Winter 1988, pp.89−101.

(1) support for experimentation, networking and research in information technology application;

(2) systematic development and harnessing of core competencies;

(3) targeting information technology applications to new development priorities; and

(4) investing in the Bank's and borrower's information infrastructure to support flexible projects and enhance aid management.

**Table 7:**
**Recommendations**

| | |
|---|---|
| **I. Institutional Management and Learning** | |
| *Experimenting, Networking and Researching* | encourage experimentation and learning<br>adapt IT competencies to regional differences<br>build networks to disseminate best practices<br>link central unit to sectoral users<br>develop hybrid staff<br>invest in research |
| *Developing and harnessing core competencies* | systematically develop areas of highest payoff<br>monitor technology trends to target new competencies for systematic development<br>to create an on−line IT skill data−base that captures the dynamic learning of Bank practitioners |
| *Deploying IT for new development priorities* | exploit IT for environment, private sector development, beneficiary participation, and improved governance. |
| *Making Project Design flexible and improving information sharing* | use IT to promote flexibility in project design<br>use IT to enhance information sharing within the Bank and with clients. |
| **II. Improving Practice for Task Managers and Borrowers** | |
| *Addressing the human and Organizational* | improve understanding of managerial and institutional factors for successful use |

| | |
|---|---|
| *Factors* | reconcile the information needs of stakeholders<br>adopt a long−term, adaptive view of improving the information infrastructure of institutions. |
| *Transforming Core Public Management and Business Processes* | build organizational learning processes to move from automation to transformation<br>develop methods to use IT for redesigning business processes and organizations. |
| *Developing a Strategic Approach to IT Diffusion* | initiate country−focused IT strategies and sectorwide reviews<br>design lending operations that develop informatics policies and institutions, software industry, IT manpower, IT diffusion in the private sector, and in government. |

## Experimenting, Networking and Researching

4.11 Developing countries and the Bank are learning to apply information technology in support of diverse functions, sectors, and regions—learning that should be encouraged and sustained. Recent Bank lending suggests a growing appreciation of information technology's potential and diverse uses. Globally, information technology is far from mature. Advances in multimedia applications, innovative computing architecture, expert systems and artificial intelligence, the use of "fuzzy logic" for "embedded intelligence" in all types of products, and the convergence of computing with telecommunications, broadcasting, and high−definition television—all these developments suggest that information technology still has great potential for radical innovation. The diffusion of information technology is at an even earlier stage.

4.12 There clearly is much to learn, and the costs of not learning will be high. There is a new global business environment, with new business practices and requirements. Transactions are moving faster, and the speed and quality of delivery to the market are becoming as important to international competition as unit cost. Developing countries and the Bank need to plug into this new global system and learn to exploit these tools and associated managerial practices.

4.13 The special needs of developing countries should guide the Bank—and the borrowers—in experimentation and learning, which are likely to very by region.

Africa's challenge is to remain in the global information loop and to absorb and internalize investments in critical information and communication systems. Africa's information needs are little known. Its local information resources are inaccessible and underutilized. Its bureaucrats do not appreciate the relevance of information to decisionmaking. And its policies tend to control rather than promote information sharing and information technology diffusion.

Eastern Europe, countries of the former Soviet Union countries, and other socialist economies in transition (China, Viet Nam) are shifting from centrally planned to market−based economies. And this process involves fundamental shifts in the processes of information generation and distribution, in linking technological and marketing institutions to users, and in managing financial and public service institutions.

The NICs face different challenges, as they attempt to use information technology to improve their competitive position in fast−growing industries.

Island economies, such as Indonesia and the Philippines, have opportunities for novel uses of information

technology to educate and employ a dispersed population.

4.14 The Bank has Been moving—rather slowly—toward building a critical mass of staff in a central unit (cluster) to support information systems

applications.31 / This central unit has accumulated significant expertise in the general application of information systems to almost all sectors. Its assistance to nonspecialist Bank staff (and borrowers) aims at:

*Planning and appraising information technology investments:* figuring out *how to change institutions,* sectors and markets through information systems.

*Assessing absorptive capacity* of implementing agencies.

*Identifying institutional and sectoral priorities and aligning information technology investments with them.*

Scheduling, phasing, and coordinating *complex investments in human resources, hardware, software, and technical assistance.*

*Contracting technical assistance* for planning, design, and implementation of information systems.

Preparing *tender documents* and evaluating bids for complex information technology and technical assistance procurements.

Advising on *selection and use of technology packages* appropriate for all kinds of institutional environments.

*Discerning the potential for information technology in operational support, management control, and strategic applications.*

4.15 The creation of a new (January, 1993) Vice Presidency for Financial and Private Sector Development, with a unified division for Telecommunications and Informatics, and with two global departments for financial and private sector development, may represent an opportunity to consolidate and strengthen several segments of the information technology field. But, like all organizational arrangements, this new structure does not ensure synergy or overcome barriers to collaboration across various segments of the field, and among in−house suppliers of expertise and potential users (task managers in all other sectors). There is already growing awareness of the convergence of telecommunications and information technology applications (Wellenius, 1993), but this awareness has not yet shifted the focus of practitioners from the conventional dichotomy of telecommunications networks and users to ways that integrate telecommunications and computing to various sectors and businesses. Similarly, the various industry and finance divisions have yet to tailor technology policy and industrial extension strategies to the diffusion process required for this new technology and the special needs of the software (and information) services industry.

4.16 Other segments of functional expertise should be also reoriented and linked together. The Population and Human Resources divisions should begin to

31 / See Hanna and others (1990) for early proposals, which have since been revisited and reflected in recent relocations of the "Development Informatics" unit. This unit has already provided specialized assistance to project staff and borrowers in over 260 projects with significant information systems components. Some other aid agencies, such as USAID, are also exploring such organizational arrangements. The International Development Research Center (IDRC) continues to be unique among aid agencies, in its emphasis on information systems as one of its few core areas of development assistance.

devise more effective approaches and pilot efforts to promote computer literacy and skill development to support the effective use and diffusion of information technology and the development of specialized manpower in computer service and software engineering. The public sector management divisions may give attention to the information needs and communication processes within and among organizations and to the role of informatics in facilitating decentralization and creating responsive and accountable public organizations. As an influential player in the use of socioeconomic statistics for policy analysis, monitoring, and evaluation, the Bank should reorient and strengthen its limited ad−hoc assistance in the statistical field to build local statistical capabilities. Assistance should be guided by the needs of policymakers—and by a long−term view of institution−building.

4.17 The Bank also needs to link in−house experts in information systems, telecommunications, technology development, statistical services, human resource development, and public sector management to the growing number of current and potential Bank users in all sectors. This network can harness experience across sectors and regions and develop policy guidelines and operational procedures for nonspecialist user staff. It can also foster an organizational environment that support innovation and experimentation in information technology applications in lending operations. Such in−house expertise can also be used to monitor and disseminate best practices, build networks with the private sector and consultancy services, and support nonspecialist staff in their own learning and in envisioning where information technology could be used.

4.18 There is also a need to develop "hybrid" staff, with substantive knowledge of a sector and of the information and communication needs and best practices in information technology use in that sector. Information and communication (I&C) are critical dimensions of most economic sectors and organizations, and advances in I&C technologies have further increased the importance of these dimensions. Systematic analysis of I&C functions in a sector requires in−depth knowledge of the substantive problems of the sector: in planning, policy analysis, resource assessment, decisionmaking, monitoring and evaluation, operational management, education and training, service delivery, beneficiary participation, and so on. Such analysis would define demand and opportunities for information technology applications, including those utilizing GIS and CPM, as well as remote sensing, management information service, multimedia training, packet radio, and other relevant I&C technologies. On the supply side, sector−specific databases, application software, and expert systems are increasing so fast that consultancy services are pushed toward vertical specialization in information technology applications by sector or function. This "hybrid" staff could lead the development of demonstration projects that would systematically address the I&C problems, and associated managerial and productivity issues, on a sector−wide basis.

4.19 This blend of substantive knowledge of a sector (or a function) with awareness of the new technological options now available through advances in I&C systems is necessary to avoid automating the "wrong" practices or addressing the wrong problem. For example, we need to be particularly careful about the way information technology is injected into processes such as the education system. Here, measuring progress is especially difficult. The potential is great but so is the scope for mishandling the introduction by not

paying enough attention to pedagogical aspects or to the education system as a whole and the interrelated interests of the different participants. Successful assistance must combine the professionalism needed in the education field and awareness of competing priorities and constraints of the sector with those who understand what modern information technology has to offer in this field.

4.20 In addition to learning by using, the Bank—and other aid agencies and developing countries—may want to research key questions that remain unanswered. As information technology continues to spread globally, what will be the implications for employment in various developing countries? What type of policy and institutional framework is necessary for successful information technology lending? Should governments target certain sectors for accelerated diffusion of information technology, where market forces are weak and national priorities are high, such as education and environmental management? Research is needed to identify the payoffs from different types of information technology investments, and to develop evaluation techniques for information technology

project appraisal. Research on critical success factors for information technology investments could provide a basis for developing frameworks, guidelines, and tools for the Bank's information technology lending and advisory assistance. This research agenda is increasingly critical in view of growing investments in information technology in developing countries, common pitfalls and failures, and the high opportunity costs of slow and inefficient adoption.

4.21 Bank staff, borrowers, and the rest of the development community are increasingly aware of the information technology revolution, but there is little intellectual investment in reviewing country experience and developing analytical tools to improve assistance and country practices. The sector has not generated much research within the international aid agencies, perhaps because the novel, diffuse and complex impacts of information technology may have made them difficult to understand. There is no organized body of knowledge on the broader issues of informatics on which the Bank could base its advice and the extensive experiences of countries and the Bank (and other aid agencies) have not been systematically reviewed. The Bank is thus called upon to build intellectual capital, develop analytical frameworks and promote external cooperation in this new field of development assistance.

### Developing and Harnessing Core Competencies

4.22 The Bank is developing core competencies in applying some key generic information technologies in fields of special relevance to the Bank's strategic agenda. The process of building such competencies within the Bank has not been institutionalized, however. It is driven by individual interests and the convictions of a few staff who often work in isolation, with limited networks or institutional resources. Some of the measures recommended in support of experimentation and learning, such as the development of a central and critical mass of staff and a network of information technology experts and users, could also provide a common infrastructure in support of the strategic planning and management of the selected core competencies. These competencies represent areas with the highest payoffs. Therefore, they need to be systematically identified and developed. As stated earlier, an on−line information system to capture the technology skills and experience of Bank

staff in selected information technology areas might be useful. An in−house capacity to identify and monitor major new information technology trends that can have a significant impact on social and economic development in the medium term (such as multimedia) would also help in targeting core competencies for systematic development.

4.23 Synergies among the core competencies can improve the Bank's policy advice, project design, and implementation monitoring, and the lending for information technology. The development of the Basic Economic and Social Database (BESD) for the Bank's socioeconomic policy analysis has created an in−house competency in designing and using large−scale databases. This, in turn, has been adapted and made available to assist borrowers in establishing their own socioeconomic databases. Similarly, synergies may be sought from the internal use of computerized project development and management systems and geographic information systems. The Asia Technical Department has created an information technology laboratory both for internal Bank use and for advising borrowers on investments in such applications in Bank−assisted projects.

4.24 Such systematic development of core competencies would help both Bank staff and borrowers to understand how to benefit from the analytical power of such tools. The sharing of more of these tools between the Bank and its clients would provide common frameworks that would facilitate dialogue and Joint exploration of design options, as well as retool the Bank's internal processes, and promote effective investment in key generic technologies among borrowers. This would perhaps be an extension of the Bank's traditional role of sharing its intellectual tools and frameworks for project and policy analysis with borrowers through the Economic Development Institute.

4.25 Note in all this that the technologies required, the information needs, and the potential uses of information technology are far more diverse in developing countries than at the Bank. Note, too, that the Bank's experience with management information systems and office automation is strongly influenced by its managerial culture and institutional learning. These conditions are quite different for most developing countries, where skills, infrastructure, and support services are scarce and heterogeneous. Bank assistance to borrowers in information technology investments should be adapted to the diverse and specific institutional capabilities and managerial cultures of developing countries.

### Deploying Information Technology for New Development Priorities

4.26 Information technology can provide novel solutions or part of the answer to emerging challenges and new development priorities. Significant lags and gaps are likely to emerge, however, as these applications require a blend of skills (and experiences) that reflects in−depth understanding of the new sectors, of their information and communication needs, and of the capabilities of the new technologies. We single out three new development priorities for which information technology applications could provide novel and more effective solutions: environment, private sector development, and participation and governance.

4.27 The potential of information technology for promoting sustainable development has not yet been recognized. Bank lending indicates many examples of information technology use to improve information on natural resources for planning, policy analysis, and management control. But information technology could be deployed more broadly to make products and processes more environment−friendly. It could also be used to conserve on energy, transport, and raw materials. "Telecommuting"—dispersed office work—could be part of the answer for reducing congestion in major cities, as in Japan, Singapore, and Taiwan. It could also help disperse "back office" service activities, and thus contribute to more balanced regional and rural development and the provision of public services to dispersed populations.

4.28 Information technology applications to transport and traffic control are also critical in providing optimal routing, in the use of existing capacity, and in integration among various modes of transport. This is a tool not only to enhance competitiveness (through just−in−time and outsourcing practices), but also to provide qualitative changes and new solutions that would minimize the negative environmental impact of fast industrialization and urbanization. Bank support to policies and strategies that exploit information technology's potential for environment−friendly development would respond to the challenge of the "second industrial divide" (Poire and Sabel 1984) that may be emerging with the shift from energy−intensive to information−intensive economies.

4.29 The potential of using information technology to support the development of efficient markets and competitive private sectors also remains to be exploited. A few examples of innovative uses of information technology suggest the shape of things to come. Singapore's TradeNet suggests the power of new information infrastructures. It has facilitated the electronic submission of trade documents. It has coordinated and expedited the approval of imports and exports, port operations, cargo clearance, and statistics compilation. And it has stimulated traders and manufacturers to adopt information systems in support of their internal business management. This, in turn, has simplified coordination and the flow of information among many economic agents. Documents that used to take a day to process (in an already relatively efficient operation) are now cleared in 15 to 30 minutes. Another innovative application of relevance to developing countries is an on−line information network that provides profiles of technology and research capabilities of companies and public institutions in Texas and other states to promote Joint ventures and facilitate matchmaking. This type of information may be a key missing ingredient for centrally planned economies that are currently in search of foreign investment, strategic partnership, and technology transfer.

4.30 Information and communication technologies also offer new approaches to participation, extension, human resource development, and other aspects of social learning. A new paradigm for agricultural extension suggests a

participatory approach that starts from the farmers and their needs. Such an approach requires that the content and form of extension information be sensitive to the range of user (farmer) realities, personal and contextual—gender−specific, ethnic, ecological, sociocultural, and economic. The promise of information and communication technologies is that they can energize the collection, processing, and transmission of data, resulting in faster extension of quality information to more farmers and in bottom−up and

interactive means of communication. In current Bank lending, there are a few other cases of such shifts in development communication and popular participation, with a trend toward the use of packet radio, interactive multimedia, and geographic information systems in population, health, and nutrition projects, agricultural extension, natural resource management, and distance learning.

4.31 A new development priority is improved "governance," which is essential to participatory democracy and private sector development. A unique, recent (July 1992) example of a Bank−financed operation that supports governance through improved information systems in the Judiciary branch is the Venezuela Judicial Infrastructure Project. The project supports institutional development of the judiciary by strengthening the planning, budgeting, and management capacity of the Judicial council and by improving courtroom productivity and efficiency through reorganization and streamlining of courtroom administrative procedures. The share of information−technology−based modernization in total project cost exceeds 50 percent.

### Making Project Design Flexible and Improving Information Sharing

4.32 Building appropriate information and communication systems components in Bank−financed projects may open the way to new kinds of project development and implementation. Rather than relying on highly prescriptive covenants, inflexible upfront design, and detailed blueprint plans as the basis for the implementation of Bank−aided projects, these systems could be used to facilitate a process of continuous planning during the implementation of flexibly designed investment programs. This requires increased sharing or integration of the Bank's information infrastructure with that of borrowers' implementing agencies.32 /

4.33 Timely information, intensive communication, and shared tools and frameworks would be built into lending operations to enhance real−time shared learning and responsive implementation assistance. Information system components would thus be viewed not merely as tools for control and accountability (to donors and financing agencies), but more fundamentally as tools to facilitate information sharing, continuing dialogue, local empowerment, and adaptive learning−oriented implementation processes.

4.34 There are already spearhead examples that point to the potential use of information systems in foreign−aided projects in a way that would support the financing and management of complex, flexible program−type investments. In association with the bank, the Bombay Metropolitan Region Development Authority has developed a large numbers of software applications ranging from project design and monitoring to general administration of the Authority33 / .

32 / This would resemble an emerging paradigm in the private sector, where companies are reshaping their relationships with their clients (customers and suppliers) breaking the boundaries and freeing information sharing across the total value chain. This would be even more applicable to knowledge−based organizations.

33 / Systems for project formulation included support to technical and financial evaluations and investment programming of very large urban projects. Those for project monitoring have facilitated monitoring of financial and physical progress of Bank−assisted projects, and timely identification and control of implementation problems. Various analytical and GIS applications have enabled the Authority to analyze issues related to land management, environment quality maintenance, industry location policies, road network routing analysis, and other spatial planning activities. The computer−assisted design applications

*(Footnote continued on next page)*

Information systems components in lending operations could thus become key tools to manage complexity, enhance flexibility, devolve responsibility, ensure accountability and improve overall implementation of development assistance.

4.35 The Bank may also accelerate the process of retooling itself to become a truly knowledge−based learning organization. The increasing interdependence of national economies—and the increasing speed at which economic and financial decisions must be made—have intensified the demand for timely management of and access to information by Bank staff, both at headquarters and during field missions.

4.36 The emerging vision of information management within the Bank is to use information technology to foster the continuous development of the Bank as a knowledge institution, and to facilitate the building and dissemination of its professional experience. Other leading−edge knowledge−based organizations have begun to use information technology to redesign their core work flows or business processes and to manage their strategic asset—their knowledge. For example, McKinsey & Co. has implemented a strategy to systematically capture, codify, disseminate, and apply the knowledge its teams acquire during their engagements with clients. These organizations are also developing cross−functional information systems, redesigning core processes, creating tools and networks for cross−functional teams, and promoting knowledge−based learning cultures. At the Bank, such measures are particularly important for building new institutional competencies and for sharing best practices in such emerging fields such as informatics.

### Practices for Borrowers and Task Managers

4.37 The second set of recommendations concerns ways and means to improve the payoff from specific applications in information technology in Bank−aided projects, and to address the policy and infrastructural conditions necessary to sustain these applications and to exploit the potential of information technology much more widely. Measures may include: (1) addressing the human and organizational factors; (2) using IT to transform core public management and business processes; and (3) developing country−focused strategies and sector−wide assistance to information technology development and diffusion.

### Addressing the Human and Organizational Factors

4.38 Bank experience in information technology lending suggests that the primary constraints to increasing the returns to the use of information technology in developing countries lie in limited human and organizational capabilities. This suggests that efforts at improving Bank assistance in applying and diffusing information technology among borrowers must focus at least as much on the human and organizational factors as on the technological aspects. The challenges facing information technology lending are closely intertwined with those concerning institutional and human resource

*(Footnote continued from previous page)*

have supported the design of water supply and sewerage systems. In addition, a host of applications have been developed to manage procurement, project accounting and general administration. Many of these applications and particularly the resulting information are shared with the Bank.

development. It is disturbing that our survey of task managers revealed that training and technical assistance are relatively small percentages of information technology lending. Also, little attention is paid to anticipating and managing the important and deep organizational changes that usually accompany successful application of

information technology.

4.39 Often, organizational and managerial changes are needed to effectively apply information technology involving greater decentralization of decisionmaking, which in turn requires trained decisionmakers and changes in the managerial culture. Managerial skills and entrepreneurship are thus key to the effective use of information technology, particularly in the private sector. This calls for a sophisticated understanding of the managerial and organizational requirements of information technology use, and in particular, the "strategic" use. It also calls for more appropriate methodologies for information systems development to take account of the specific social, cultural, and organizational factors in developing countries.

4.40 Designers of information systems components, particularly in support of project management and accountability, must identify the stakeholders (users) and reconcile their information needs. In particular, they need to take account of local information, communication, and decisionmaking practices. They also need to develop approaches and processes to system design and implementation that would engender local ownership and sustainability.

4.41 As the Bank increases its lending to information and communication systems throughout development programs, it needs to understand the overall "information infrastructure" within the institutions, sectors, and economies of its borrowers. Introducing information systems components requires effective integration with or transformation of this underlying information infrastructure. As an institution's information infrastructure is shaped by past practices, knowledge, and power distributions, it has much inertia and changes only slowly. This points to the need to adopt a long−term view of information technology use and diffusion, to support experiential and institutional learning, and to phase and sequence such learning. Local capabilities should be also developed to manage this learning process.

4.42 The Bank's strategy for introducing and changing information and communication systems is critical to whether these systems will increase centralization or improve flexibility and responsiveness. The challenge is to address the institutional factors critical to successful systems implementation and to use information systems as agents of rapid organizational transformation.

### Transforming Core Public Management and Business Processes

4.43 The experience in both industrial and developing countries indicates three levels of computer applications in organizations: (1) for automation or operations support (efficiency); (2) for management control (effectiveness); and (3) for strategic contributions (transformation). There is plenty of opportunity in developing countries for improvements at the level of operations support where efficiency is the relevant consideration—for example in tax or billing collection—and progress is relatively easy to measure. The

second level, management control, makes more demands on managers to identify what information is most needed to improve their ability to manage. Here there is more risk that information systems investments will generate output that is not well suited to the needs of management. It is necessary to prepare management for their proper role to ensure that this does not happen. At the third level it is most difficult to assess the payoffs because the ability to be competitive is now the issue. Much of the disappointment about the payoffs from information technology investments in industrial countries was initially due to mishandling of investments for management control, but more recently it has been because in practice they have not created the sustainable competitive edge that was hoped for. Often, these investments have become necessary, rather than optional, to remain in business.

4.44 These levels of applications maybe also conceived of as stages in organizational learning (Hanna 1991). As organizations accumulate experience with information technology applications, they go through stages in learning how to capture more fully the potential benefits of the technology. In the first stage, the focus of the organization

is on automation of administrative functions and routine transactional decisions, with primary concern for efficiency gains. The second stage involves the use of information technology in the core business activities—to reorganize work relationships, to decentralize and create flexible structures, and to leverage the knowledge and managerial resources of the organization, thus enhancing overall organizational effectiveness. This stage requires mastering the institutional and behavioral factors that determine the effective use of information technology. In the third (most advanced) stage, information technology is used to transform relationships with clients, suppliers, and collaborators, and to develop new services and products. This is the most difficult and riskiest type of information technology application, but it often has the highest payoffs.

4.45 This review suggests that substantial improvements in efficiency are possible in developing countries, and the largest information technology components in Bank lending have been in automating major transaction systems that could no longer be handled manually. But the most common components were relatively small, and aimed at improving managerial control and effectiveness. As the Bank and borrowers move toward advanced stages of learning, the challenges of measuring and realizing the economic payoffs and progress toward increased competitiveness or responsiveness will be higher.

4.46 Information technology offers the potential of new forms of organization (flat, networked) and new patterns of communication and service delivery. Until recently, the use of information technology in public administration in industrial countries responded to concerns about internal productivity. More recently, there has been a shift from control to support for empowerment, service enhancement, and responsive governance. Realizing the potential of information technology at these stages will depend on harnessing the enthusiasm of stakeholders within institutions who will support and benefit from such change, and on mobilizing public or client pressures for responsive institutions.

## Developing a Strategic Approach to Information Technology Diffusion

4.47 A strategic approach is needed to promote the widespread and effective use of information technology in developing countries in support of their overall development priorities and strategies for several reasons:

With the increasing volume and criticality of information technology components in lending operations, it is important to complement assistance to such isolated information technology applications with measures to address the policy, institutional, and infrastructural constraints to effective implementation, use, and sustainability of these components.

Particularly for small and low−income countries in which donors are the major financiers of information technology applications, a strategic framework would ensure the focus of foreign assistance on priority application areas, establish a long−term perspective and appropriate sequencing for assistance, mobilize various sources of finance and specialized know−how, and harmonize various interventions to match absorptive capacity and enhance externalities. An economy−wide strategy for applying information technology would be likely to identify those areas of applications with the highest impact on the country's development strategy. Experience suggests that those areas of highest leverage vary among countries.

The rising information content in economic activities worldwide and the increasing role of information in competition and the functioning of markets call for a thorough appraisal of the fundamental information and communication problems facing developing countries and for systematic and innovative exploitation of information technology to address these pervasive problems.

As information technology is applied to basic manufacturing and business processes to gain strategic or competitive advantage, it assumes the role of an infrastructure or core competency that is a key to competitiveness for an increasing number of industries and services. Moreover, information technology (particularly software and

services) is a fast−growing industry that is likely to be the world's largest before the end of the 1990s, with bright export prospects for many developing countries. Accordingly, a sectoral approach to information technology assistance would focus on the enabling policies, institutions, and capabilities to develop this strategic industry, infrastructure, or core competency in support of an overall development strategy. This would be particularly relevant to the NICs and other industrializing countries.

4.48 There are many policy constraints and market failures inhibiting the wide diffusion of information technology in support of private sector development, and particularly among small and medium−size user enterprises. A strategic approach would extend beyond specific public or private institutions to address such market failures and draw on best practices among OECD countries and the NICs. It would help devise incentives, institutions, extension programs, and other support services to accelerate the diffusion of

information technology and improve the absorptive and learning capabilities of firms.34 / A strategic approach would also develop the necessary policies and local capabilities to draw on global expertise and to use international trade and investment flows as a mechanism for the transfer of best practices in this "international" technology.

4.49 This type of development assistance shares many similarities with general industrial technology development projects. It aims at building technological infrastructure in support of the development and diffusion of key generic technologies. The main differences stem from the unique dynamics of the IT (specially the software) industries and the versatility of IT use. The role of IT in public administration, infrastructure modernization, private sector development, financial services, and the social sectors goes far beyond the typical applications of other industrial technologies. But many of the issues and lessons are common with industrial technology development assistance.

4.50 An example of such a strategic approach to Information technology assistance is the proposed strategy for information technology development and diffusion in India.35 / The proposed strategy focuses on the development of key information technology policies, infrastructure, institutions, and capabilities in support of strategic−uses in the public sector, and effective diffusion within the private sector. For the public sector, the aim is to provide demonstration effects, modernize key infrastructures, invest in strategic applications that would complement ongoing reform in trade and finance, and promote best practices and institutional learning in adopting information technology, and managing information resources. The use of Information technology in support of private sector development would be promoted through incentives and knowledge transfer programs to support the effective adoption of information technology (and complementary inputs and managerial practices) among small and medium enterprises. It would also support programs to improve the productivity, quality, and marketing of software firms.

4.51 The Bank and developing countries may also conduct sectorwide reviews and formulate national information technology strategies and plans. These reviews would alert policymakers to the importance of informatics policies and strategies in development and provide support for national mechanisms to address cross−sectoral issues influencing the use and diffusion of information technology. Sector reviews would provide a coherent framework for Bank lending to information technology components across projects, and help address priority areas and key constraints, such as informatics infrastructure and policy. Such reviews also would adapt assistance to the country's level of development and encourage private users and suppliers as well as professional and trade associations to adopt best practices in Information technology management. They would define the role of government and private sectors in developing this strategic infrastructure and identify areas for partnership and coordination. In addition, the reviews would

34 / A global study, managed by the Asia Technical Department, is already underway to review the policies and programs of OECD countries (and selected NICs) for developing and diffusing information technology, and to

draw lessons of experience for developing countries.

35 / Asia Region, India; An Information Technology Development Strategy. World Bank. Nov. 1992.

mobilize and coordinate the resources of major donors and U.N. agencies (including sharing the cost of these sector reviews).

4.52 Demand for such strategic or sector−wide assistance is likely to increase, and such countries as Mauritius, the Philippines, and Turkey have already expressed interest in cooperation with the Bank. The Bank should further develop its capacity in information technology policy and strategy as this would leverage the Bank's lending to information systems components and existing strengths in general policy analysis and dialogue.

## Annex 1
## Study Rationale and Design

A1.1 Given the high levels of information technology investments by the Bank and country borrowers, two questions must invariably arise: What roles do such investments play in overall Bank lending? And what have been the paybacks?

A1.2 The lack of empirical analysis of information technology diffusion (and payoffs) in developing countries is remarkable, in view of the profound implications of this technology for comparative and competitive advantage. Some attempts have been made to measure information technology intensity in various industries and services in industrial countries. All OECD countries have developed some overall measures of the size (value added or employment) of the information sector in the economy.1 / Few attempts have been made to track information technology investments in multilateral lending and other official aid flows (Hanna and Schware 1990) Yet information and communication systems seem to have become integral components of most investment and technical assistance projects. The pervasive presence and "intangible" nature of these investments (e.g., for systems development, process streamlining, training and support) present a challenge to measure and track.

A1.3 There are many opinions about the subject of payback, but little in the way of hard data. This leads to the following kind of concern:

It is often said that there is a need to refine the way we analyze the payoff for information technology investments. I.T. can be used strategically to create new products, enter new markets, to offer timely service. While these efforts should, over a period of time, lead to higher productivity, the effects may not be evident in the short run (Dahlman and Mody 1992).

The above statement accurately speaks to a larger discontent with approaches and methodologies for mapping the payoffs (if any) of information technology that extends well Beyond the Bank staff or their developing country counterparts. In a 1992 survey of 160 chief information officers of U.S. companies, 66 percent reported dissatisfaction with the way in which system investments are evaluated and monitored (*Chief Information Officer* "Not Measuring Up," June 15, 1992, p. 85).

A1.4 This universal dissatisfaction stems primarily from two main factors:

Information technology costs for institutions have expanded rapidly throughout the 1980s. Annual investments in information technology equipment in the United States alone rose from $55 Billion to $190 Billion in the 1980s. This 350 percent rise in expenditure in 10 years occurred while net plant and equipment spending as a

1 / OECD has contributed to many studies to measure the size of the information sector in member countries. Japan has developed many indicators to track information technology investments throughout various industries and services, which are published annually in "Informatization White Papers", by Japan Information Processing Development Center (JIPDC), Japan, editions 1981−91.

percentage of U.S. GNP fell 25 percent. Investments in computers and telecommunication now consume almost 50 percent of the total annual capital investment budgets of large companies (Keen 1991). Similarly, World Bank lending in information technology has soared throughout the 1980s, rising 235 percent in just a five−year period (1986−91). This level and pace of expenditure puts a lot of pressure on managers to justify themselves.

Until quite recently, there have been few attempts to systematically develop and apply methodologies to measure the impact of information technology. Only in the last few years have such methodologies even been devised, let alone utilized in meaningful ways.

A1.5 This study attempts to address these issues, first, by analyzing a database on information technology components in Bank−financed projects and examining the various roles of these components in the Bank's overall lending program and, second, by employing a state−of−the art methodology to assess the impact of World Bank information technology lending.

A1.6 *Study Design.* Largely as a result of the total quality management (TQM) movement, a series of techniques to measure the impact of information technology have emerged. These techniques tend to share a common concern with capturing and analyzing both quantitative and qualitative data about process improvements and end−product performance enhancements. Concrete "before and after" metrics that describe process improvements and end−product performance improvements are matched with surveys of attitudes, perceptions, and satisfaction levels of process "owners" (customers and shareholders) in unified information technology impact assessments. The variety of such techniques now available is summarized in Table A1.1.

A1.7 There are two interrelated assumptions that all these techniques share:

The effective use of information technology is linked to effective organizational structures and management.

Tapping the effectiveness of information technology really means an organizational redesign effort, taking a broad look across the organization to analyze changes in strategy, management, operations, cost structures, and external transactions.

**Table A1.1:**
**Techniques for Measuring the Impact of Information Technology**

| **Technique** | Description |
|---|---|
| 1. Balanced Scorecard Approach (Nolan Norton & Company) | Four interrelated operational and financial measures are used: the customer's view of organizational performance; the line manager's view of internal processes; the strategi view of innovation effects; and the shareholder's view of financial rewards. Each of th has operational measures, or metrics, associated with it−a customer's perspective woul time for order fulfillment; and the innovation perspective would track the cycle time fo development of a new product or process. |
| 2. Information Economics Approach (International Business | Key corporate objectives and goals−both tangible and intangible—are assigned relativ importance and risk. Then information technology systems are scored based on their in |

| | |
|---|---|
| Machines) | each of those objectives. The final step is a peer−review process to evaluate the scorin or oversights. Thus, a single information system might receive positive or negative poi depending on its degree of impact on business objectives (economic coat impact; strat direction; competitive advantage; management decision support; other intangible bene support for new technology); or risk (competitive risk of system not being implemente project/organizational risk; technical uncertainty, current vs. new skills requirements; infrastructure risk, alignment with overall information system architecture. |
| 3. Impact Focus Strategy Approach (Systems Research Center, Boston University) | Relies on a listing of benefits anticipated by an organization at onset of systems imple and creates benchmarks the system must meet to deliver value—that is, to have an imp |
| 4. Impact/Value Framework Approach (Hammer and Mangurian) | Uses a grid to define multiple impacts of an information system based on two dimensi and value. The impact dimension includes time compression of processes and reduced float; overcoming geographic restrictions to recapture scale and penetrate new markets restructuring business relationships to de−layer the organization and flatten hierarchies better distribute knowledge. The value dimension includes increased efficiency (lower cost−avoidance, or higher units of output per worker); improved effectiveness (inform availability when it is needed); and innovation (additional service/product quality caus technology). A single information system may generate more than one type of value o thus may have multiple grid entries. |
| 5. Alternative Payoff Scenarios Approach (Emery) | The value of information technology investment is calculated by determining how the generated information led to a payoff and comparing that payoff with the payoff witho information technology. This is done by (1) quantifying impacts in nonmonetary terms improvement); (2) quantifying monetary benefits from the associated improvements; a comparing these net profit effects with whet would be expected in net profit from char decisions and processes without information technology. A classic application of this might be the U.S. airline computer reservation systems. Without real−time data on boo airlines could not fine tuna fares to demand, accommodating bargain−hungry travelers would have otherwise been empty. |
| 6. Return−on−Management Approach (ROM) (Strassman) | A ratio compares management outputs and inputs to arrive at management valueadded This ratio is based on the assumption that information technology is a tool primarily to managerial performance. Thus, in a business, the costs of purchased raw and finished parts, energy, services, interest, and taxes would be subtracted from revenues to calcul the public sector, ROM would be calculated by creating a ratio of operations costs to r costs; the lower the ratio, the lower the ROM. |
| 7. "Embedded" Network Productivity Measurement Approach (NPMA) | Rather than rely on external perspectives on an information system's operational and e performance, predefined measurement parameters are built into network management real−time indices of compliance with performance targets are generated. |

*Source:* CIO, "Justifying Technology: The Burden of Proof," June 15, 1992, pp. 59−85; (2) Hammer and Glenn 1987; Stra Emory 1987, pp. 214−217; and Omicron Corporation, Montreal, 1992.

A1.8 In short, all these techniques recognize that information technology payoffs of information technology are about: "Massive, multidimensional business change—instead of work fragmentation and task specialization, we have task compression and integration. Instead of linear and sequential process structures, we have parallel process structures (when information is captured on paper, only one person can get it at a time; but on−line databases of data, graphics or images can be accessed by many people simultaneously). Instead of having to make trade−offs between centralization or decentralization, we can have a hybrid of the two, in which decentralized units can operate with the scale economies of a centralized unit (Hammer 1992, p. 14).

A1.9 Thus, ultimately, measuring the payoffs of information technology is not about the technology itself, but about the major changes that organizations can bring about to "rethink and rebuild" themselves.

A1.10 These considerations have guided the formulation of this study's design. We have purposefully sought out data from highly diverse sources and perspectives within and without the Bank in order to gain as multidimensional a picture as possible of the changes made possible by information technology lending. Our study approach, processes, and products are detailed in Figure A1.1.

A1.11 Simply put, the study plan is designed to gather a variety or kaleidoscope of information sources, so as to assess the fit and the degree of convergence or divergence between them. Thus, quantitative data gleaned from project files are checked against qualitative data—perceptions of task managers, staff, consultants, and outside experts. To execute the study and share the findings relatively quickly, this study has placed a premium on intermeshing smaller data samples from a wider variety of sources. In that sense, we have attempted to execute a more rapid appraisal technique, rather than a more formal research methodology. As such, the study may be viewed as an exploratory research or progress report in a fast−evolving field that calls for more in−depth and continued research.

### Methodology for Estimating it Costs

A1.12 A database on information technology applications in Bank lending has been established and analyzed in the course of this study. So far, the database covers four fiscal years of Bank lending: fiscal 1986, 1989, 1990, and 1991. Because information technology components are often poorly documented in the Staff Appraisal Reports (or President's Memorandum when SARs are unavailable), and because of the limited time and resources available for the study, some simplifying assumptions had to be made to estimate the costs of these components. These assumptions have led to systematic underestimation of these costs, and future research may further improve on the database. The aim of this study is to create a database as quickly as possible for a rapidly evolving information sector, to test the utility of this information, and to begin to track the Bank's pervasive activities in this new and poorly understood sector.

A1.13 The methodology used, and the likely sources for underestimating information technology costs, are as follows:

Not all adjustment and financial intermediation operations are included, because information technology investments cannot be identified, even though part of the proceeds are likely to be used for information technology imports, or for onlending to subprojects with information technology investments.

Information technology costs in supplementary projects of under $10 million were not included.

Where information technology costs are *specified* in SARs, they typically do not include physical and price contingencies.

Where information technology costs are *estimated* from physical inputs, often only the hardware and software inputs are included; this may represent only about 20 percent to 50 percent of the total cost of an information technology component.2 /

The specified and estimated costs of information technology components are based on those reported at the time of project appraisal or approval (SAR). However, studies of other aid agencies have documented that actual costs often increase by as much as twofold over the appraisal costs.

Where information systems components are included, but not specified by cost or physical inputs, an annual average percentage of total project cost is assumed for information technology, based on the averages for projects for which information technology costs are specified or estimated.3 /

A1.14 There are several other sources for underestimating the demand for, or the share of, information systems in Bank lending:

Where borrowers cannot use Bank proceeds to finance information technology components because of trade or industrial policy restrictions that prohibit international competitive bidding for computers and software, and thus use their own local resources for financing the total costs of such components.

Where bilateral aid or UNDP assistance is available to finance information technology and associated technical assistance consultancy services through grants or export credit; fierce competition and "lock−in" strategies are common among donors and multinationals in this sector.

Where information technology is embedded in equipment such as microelectronics−based process control, numerically controlled and flexible or integrated manufacturing systems, microchips in

2 / In fiscal 1986, 1989, 1990 and 1991, each microcomputer workstation was estimated at $10,000, taking into account that technology upgrades have improved quality and functionality but kept total workstation coat about the same. Each staff month of technical assistance was estimated at $10,000 for fiscal 1986, 1989, and 1990, and at $15,000 for fiscal 1991.

3 / The percentage of information technology lending per project within information technology component was 2.6 percent in fiscal 1986, 3.0 percent in fiscal 1989, 4.2 percent in 1990, and 4.2 percent in fiscal 1991.

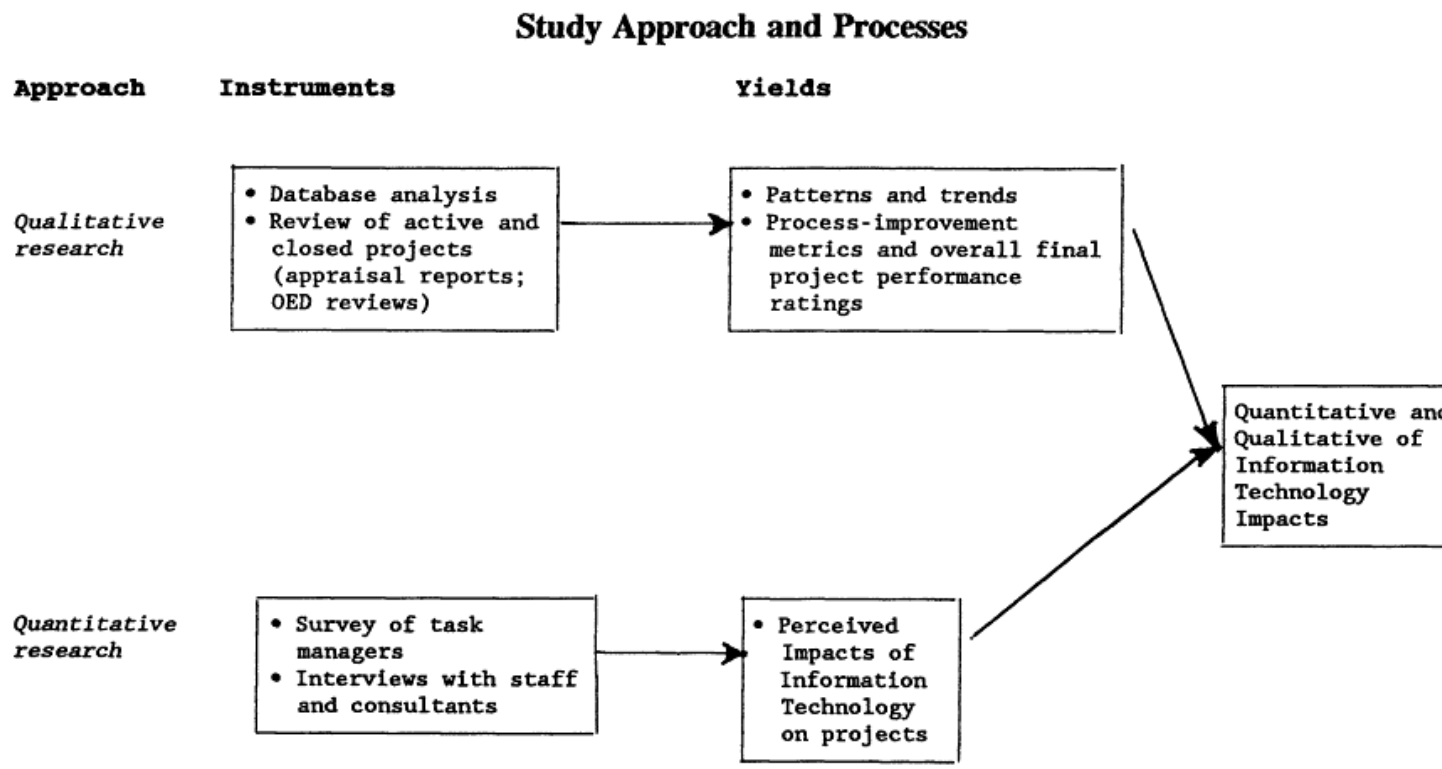



Figure A1.1

"intelligent" machinery and products, automated controls in energy generation and distribution systems and so on.

## Annex 2
## Measurements of Information Technology Based Productivity Improvements in OECD Countries and Developing Countries

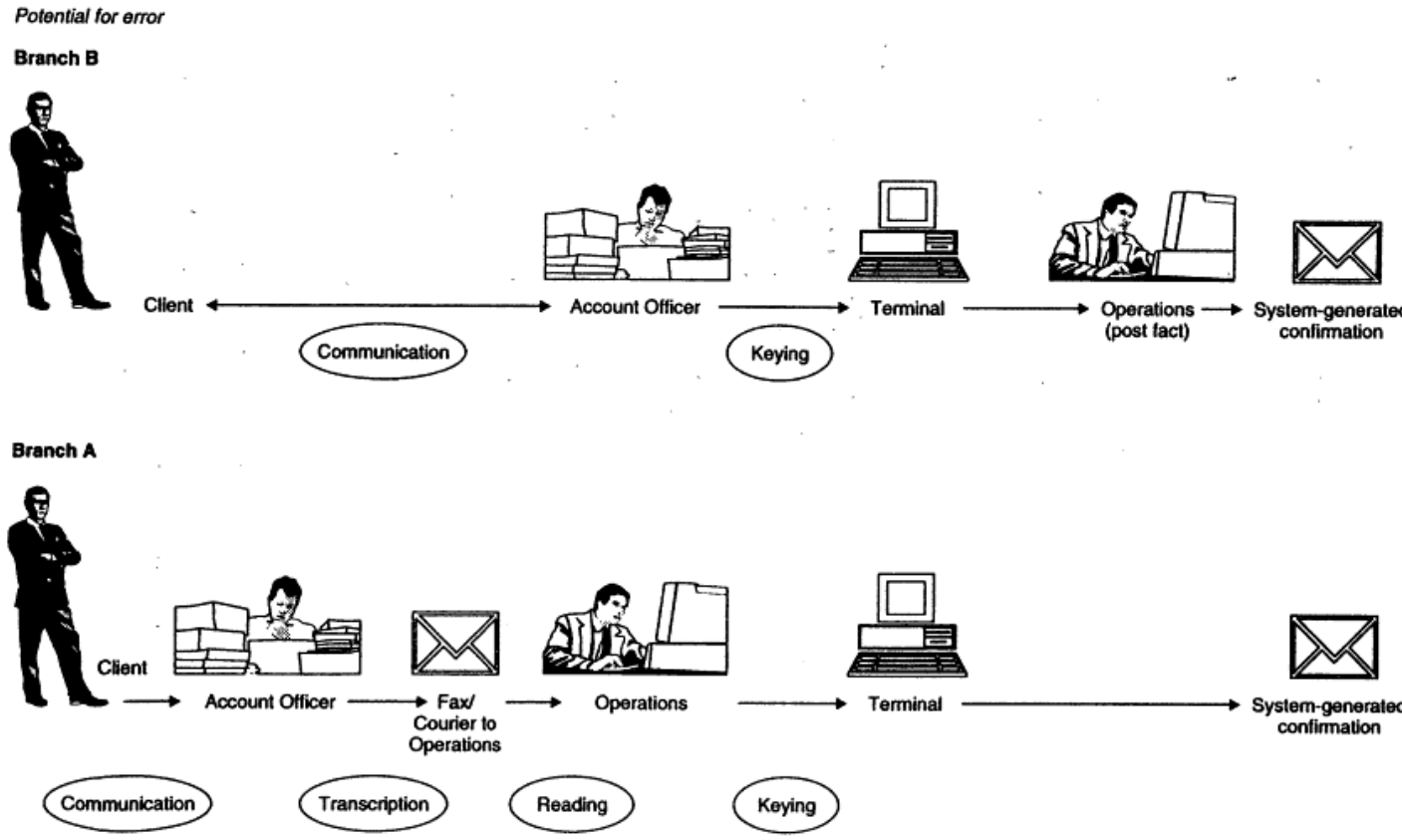
A2.1 *OECD Countries.* There is a body of evidence accumulating from impact audits of information technology systems in both industrial and developing countries that suggests that computerization accompanied by process reengineering can result in significant (even orders−of−magnitude) improvements. Both at the discrete application level—within a single process or local site—and at the level of the institution as a whole—across departments and geographic boundaries—system gains from computerization and reengineering have been reported. Computerization without reengineering will not enable maximum gains to be realized from investments. Thus, there has to be a clearly supportive environment and a keen top−down managerial interest in making the often difficult changes necessary to exploit computerization to its fullest.

A2.2 The following example vividly highlights the computerization−reengineering link. Financial institutions account for about 35 percent of information technology purchases in the United States, although though they have only 5 percent of its workers *New York Times*, "Getting the Electronics Just Right," June 9, 1989, sec. 3, p. 1). American Express Bank—a leader in computerization in the financial sector—has in place a global service quality measurement program to quantify two key indicators: timeliness and accuracy from a customer's perspective. Effectiveness is assumed if a service or process could deliver to the client "exactly the service requested the first time around" and the client receives that service "promptly." These measurements are obtained by flow−charting processes and cycle times for delivery of products in AMEX bank branches around the world. A significant program finding is that the specific business practices surrounding computerization affect productivity even on a branch−by−branch basis.

A2.3 In branch A, the cycle time involved in notifying customers that their fixed deposits (interest−bearing deposit accounts with a fixed date of maturity) had Just reached maturity averaged one to two days after the date of maturity. In branch B, the cycle time averaged two business days before maturity. Both branches had high levels of computerization, but the difference in productivity levels was in the streamlined process of branch B, as shown in Figure A2.1. Thus, even at local branch levels, major productivity differences can be found based on differing modes of computerization.

A2.4 As a company, AMEX has been able to combine computerization with reengineering to effect remarkable improvements in its processes on a corporation−wide basis. For example, since 1980, AMEX has cut processing time for new credit card applications by half to 11 days and has doubled revenue per employee throughout its travel division.

2.5 Nor is AMEX alone in orders−of−magnitude productivity leaps from computerization and reengineering. There are many examples of private and public institutions getting the "alignment" right between technology and management strategy (Table A2.1).




Branch A's fixed deposit process compared with Branch B's. The more streamlined Branch B process resulted in fewer errors, and its clearly stipulated client procedures made possible service delivery in superior time. Migration of these procedures to Branch A is resulting in operating savings and speedier client service.

Figure A2.1
Fixed Deposit Operating Flows: Branch B vs. Branch A

**Table A2.1:**
**Computerization end Reengineering: Some Examples of Improvement Metrics from OECD Countries**

| **Sector** | Metric |
|---|---|
| Services | |
| 1. IBM credit | Reduced time needed to approve requests for special credit terms from 6 days to 4 hours, while increasing amounts approved by 10 times and cutting staff. |
| 2. Mutual Benefit Life | Boosted productivity among clerical staff by 60 percent. |
| 3. Fidelity Union Life | With computerization, salesmen can offer potential customers a firm quote within an hour, a process that had taken several days previously. |
| 4. British Trustee Saving Bank | 25 percent of the workload of customer service representatives in 1,400 branch offices has been computerized and centralized, freeing up counter staff |

| | |
|---|---|
| | to deal with customers; TSB's pretax profit margins on retail banking have increased sharply while many British banks have been struggling. |
| 5. Burlington Northern Railroad | The Advanced Railroad Electronics System, a computerized train dispatching, communication, and control network in Minnesota, can calculate a new operational plan for the entire railroad within 30 seconds in the event of a train breakdown. |
| **Manufacturing** | |
| 1. Digital Equipment | Automated Internal Inventory Control Network has cut carrying costs by 50% since 1983. |
| 2. Navistar | Inventory control network developed with Goodyear has cut inventories from 26 days supplies to 5 days, reducing carrying costs. |
| 3. Mattel | The time it took for Inventory updating before computerization was 30 days, now it is one day. Financial consolidation went from 7 to 10 days to one day; production and engineering changes went from taking 7 to 14 days to one day. |
| 4. Norcom Corp. | Computer−assisted diagnosis of customers' problems manned by entry−level staff (instead of senior technicians) solves problems in an average of 3 minutes vs. 1 week previously. |
| 5. General Motor. | Using electronic data interchange (EDI) systems to Interact with 2,000 suppliers in seven countries now cost. $0.11 per transaction vs. $0.80 for telex and $0.40 per letter and is instantaneous. |
| **Government and the NGO Sector** | |
| 1. British National Health Service | A personal−computer system−DHSS Performance Analyst−allows a single staffer in nine minutes to do evaluations of medical care patterns in the country that used to take six experts two hours to do, a productivity gain of 890%. |
| 2. Ontario Ministry of Revenue | ESPRIT Program uses databases, electronic funds transfer and expert systems; the Ministry expects to raise an additional $2 billion in tax revenue over 5 years without raising taxes. |
| 3. Premier Hospitals Alliance, an alliance of 48 U.S. nonprofit teaching hospitals | Electronic Data Interchange Systems have reduced costs of processing a single purchase order from $40 to $11.20. This saves just one hospital up to $432,000 each year. |
| 4. Lutheran Hospital (Wisconsin) | Implementation of · computerized clinical information system allowed nurses to decrease time on paperwork by 22% and doubled direct patient care time. |

*Source: The Economist*, "Reinventing Companies," October 12, 1991, pp. 67−68.; *Business Week*, "Quality is Becoming Job One in the Office Too," April 29, 1991, pp. 52−56; Feigenbaum 1988, pp. 86−91; *Business Week*, March 21, 1988, p. 140; Strassman 1990, p. 176; *Information Week*, "How You Fit in Re−engineering & How You Don't," May 5, 1992, p. 29; *Washington Post*, "Looking Safely Over Engineer's Shoulders," August 24, 1992, p. A3; CIO, "Taking Care of Patient Data," April 1, 1992, p.64.

### Developing Countries

A2.6 Impact audits of computerization and reengineering projects in developing and newly industrializing countries have been painfully absent. As in industrial countries, systematic efforts to quantify and measure information technology impacts have been very few and far between. Despite this deficiency, many monographs and articles have been written making rather strong and blanket claims that computerization efforts have either been consistent failures, due to manpower shortages, infrastructure deficiencies, and lack of management support, or have had sweeping benefits and successes. Both claims have suffered seriously from a lack of real data. For example, a recent three−volume set on trends in information technology applications in Asian governments could not present a single quantitative metric of improvement to support its claims of diverse benefits. Another three−volume set on information technology applications in the Caribbean and Africa contained just one metric to support all its claims of information technology benefits. The critics of information technology in developing countries do not do much better. They, too, tend to make broad statements that are not backed by empirical measurements of operational processes or impacts.

A2.7 Until a sufficiently large body of impact audits has been accumulated, most claims will continue to be largely based on conjecture and not on real interpretations of facts. What we do know is this: there appears to be evidence that, as in advanced industrial countries, the combination of computerization and reengineering can lead to orders−of−magnitude improvements in specific projects at specific times.

A2.8 There are no shortages of explanations to explain these information technology−enabled productivity leaps. In our view, the most logical explanation relates to the following: a productivity and automation program aimed at IBM would tend to increase efficiency and effectiveness more at the margins, given the high levels of productivity already built into its entire system. But in developing country institutions—with weaker or perhaps nonexistent processes and sequential, mostly manual information—handling systems—the shift to automation and streamlined support processes could result in nonmarginal productivity gains. The effects of such "greenfield computerization" in high−performing projects can be seen in Table A2.2.

**Table 2.2:**
**Examples of Improvement Metrics in Developing and Newly Industrialized Countries**

| Sector | METRIC | | |
|---|---|---|---|
| Government | | | |
| 1. Computerization of the Postal Check System in Algeria | | Manual operations (1974) | Computer operations (1977)1 |
| | No. of operations | 24,360,000 | 33,620,000 |
| | Volume (millions DA) | 109.5 | 210.8 |

| | | | |
|---|---|---|---|
| | No. of accounts | 452,000 | 709,000 |
| | Waiting time at centers before processing of document | 15 days | 2 days |
| | Payment at cash desk | 3−6 hours | 2 minutes |
| | Employment | 856 | 680 |
| 2. Computerization of India Railway Passenger Reservation System | Computerized system in Delhi has reduced average passenger average waiting time to make reservations from several hours to 15 minutes; since 40,000 transactions take place each day, even a half hour reduction in waiting time per passenger means 20,000 man−hours per day are saved by the new system.2 | | |
| 3. Computerization of the Trade Permitting Process in Singapore (TradeNet) | Traders fill in a single electronic form, and transmit it to the Trade Development Board's mainframe computer, on a 24−hour long basis, where it is transmitted electronically to the appropriate government agency among the 18 Involved in trade permitting; approvals are sent to a trader's electronic mailbox within 15 minutes. Savings to traders from reduced paperwork have been estimated at $1 billion a year.3 | | |
| 4. Micro computer−Based Health Information System at the District Level In Ahmedabad (India) | Fieldworkers spent 25 to 40% of their time maintaining 15 to 18 health registers prior to computerization; now 8 to 10 registers have been eliminated due to automation, freeing up worker time.4 | | |
| **Services** | | | |
| 1. Computerization of Banco de Mexico's Agricultural Lending Trust (FIRA) | Computerization of the network of 10 regional offices in support of lending has reduced time for preparation of reports for major international donors from three months to 10 days, reduced time for preparation of client loan reports by field officers from two days to two hours, and increased by 20% the time technicians spend in the field with clients.5 | | |
| 2. Reserve Bank of India Computerization | Computerization of national interbank clearing function has reduced time spent in balancing accounts from four hours to 15 minutes per day while maintaining volume of I million checks cleared per day.6 | | |
| **Manufacturing** | | | |
| 1. Computerized customer order networks in the pharmaceutical industry in Puerto Rico | Smith Kline Beecham (Puerto Rico) has driven down response time to U.S. customers orders from 27 days in 1985 to 4 days in 1989; and increased inventory tums from 2 complete tums in 1985 to 3.8 in 1989.7 | | |
| 2. Electronic Data Interchange—Liz Clairbome's International Network | Hundreds of clothing factories in Hong Kong, Korea, Taiwan, (China) Singapore, the Philippines, and Shanghai have gone on−line in an EDI system with New York corporate headquarters. The 50 steps between raw good, delivery, and final product are all electronically coordinated, reducing sample approval and production changeover time from days to hours.8 | | |
| *Source:* (1) Secretarial d'Etat au Plan, Commissariat National a Informatique," L'Informatique on Algeria," Algiers, 1978 cited in Forester 1986, p. 58; (2) Commonwealth Secretariat, "Information | | | |

Technology Policy and Applications In Government," April 24−28, 1989, Lake Malawi, pp. 110−111; (3) Sleodis??, 1992; (4) *Murmy Nirmale??*, "Micro−Computer Based Health Information System," June 1991, p. 8; (5) *Digital Enterprise* , "A New Look In he Field," Spring 1989, p. 19; (6) Parthasami 1990, p. 19; (7) Boyson 1992, p. 143; (8) *New York Times*, "Networking Technology", Special Report, March 27, 1969, p. 36.

A2.9 We are well aware that the examples in Table A2.2 do not present a complete picture of the experience of computerization in developing countries. But they are representative of a growing body of cases in which the delicate alignment between information technology and organizational structure has been achieved with extremely positive results.

## Annex 3
## Task Managers' Questionnaire and List of Survey Respondents

A3.1 The survey instrument employed was adapted from an instrument developed and validated for reliability for testing small, homogeneous samples of managers who were familiar with the impacts of information technology on organizational strategic variables, such as internal organizational efficiency and inter−organizational efficiency.4 / The rationale for using a small, homogenous sample is the following: such a sample is more powerful than regular random sampling and can actually increase the power of a test; and the research is explanatory in nature and thus may not justify the resources necessary for the largest possible sample size.5 /

A3.2 Of the 62 questionnaires sent out, 37 (or 60 percent) were returned. Four were eliminated because of entry errors or other deficiencies, and 33 questionnaires (53 percent) were finally used in the analysis. For quantitative analysis, samples of more than 30 are considered adequate for most research.6 /

A3.3 The 33 projects represented by our survey respondents cover an extremely wide range of sectors and countries; there is no consistent pattern within the sample. Sectors covered include health, transport, power, urban development, employment and social welfare, agricultural credit, and technology development. Countries included are India, Pakistan, Indonesia, Malaysia, Korea, Papua New Guinea, and the Philippines in the Asian region; Kenya, Cameroon, Madagascar, Central African Republic, Ghana, and Mozambique in the African region; Tunisia, Morocco, Algeria, and Poland in the EMENA region; and Argentina, Uruguay, and Venezuela in the Latin American region.

4 / Mahmood and Soon 1991.

5 / Mahmood and Soon; Sawyer and Ball; Barondi and Orlikowski et al.

6 / Mahmood and Soon.

**Information Technology (IT) in Lending**

**Task Manager Survey Form**

Name of Task Manager _____

Project Name _____

I.T. Component Cost (estimated) _____

Date of Interview _____

Questions

1. The I.T. component cost of your projects has been estimated at $_____. In your opinion, does this represent an accurate estimate of the total costs of hardware, software and training/technical support for I.T. in your project?

_____ Yes _____ No

If you answered no, then what is the more accurate estimate of total I.T. costs in your project? $_____

What would you say is the percentage of total I.T. costs going just for training and technical support? %_____

2. To what extent do you think the information technology component of your project is critical to achieving project objectives? _____

Scale: [1]-No Extent [4]-Great Extent
[2]-Little Extent [5]-Very Great Extent
[3]-Some Extent

3. Would you characterize I.T. applications in your project as fostering:

_____ Minor organizational improvements
_____ Major organizational improvements
_____ Transformational improvements

4. Who first generated the concept for the I.T. component:

_____ Task Manager
_____ Country Borrower
_____ Other (Specify) _____

5. In what way do you think information technology is currently contributing or will soon contribute to the accomplishment of project objectives?

A. Raises Internal Efficiency in Client Organizations

_____ Improved process and content of decision-making
_____ Provides better coordination among functions
_____ Provides better financial management or reporting
_____ Speeds up overall response times of the organization(s)
_____ Increases flexibility and range of services delivered
_____ Reduces the cost of services delivered
_____ Improves productivity of labor through automation
_____ Other (Specify) _____

B. Improves Inter-Organizational Communications

_____ Enhances communication between organizations across wide geographic areas
_____ Helps the organization(s) coordinate activities regionally, nationally, globally
_____ Other (Specify) _____

C. Enables a Better Response to Markets or Social Needs

_____ Helps the organization(s) learn more about clients/constituencies and their social needs
_____ Helps the organization(s) identify & respond to domestic market needs
_____ Helps the organization(s) identify & respond to domestic market trends
_____ Helps the organizations(s) locate suppliers/buyers for products/services
_____ Other (Specify) _____

D. Other Current or Anticipated Benefits

_____

**Table A3.1**
**List of Survey Respondents**

| | | |
|---|---|---|
| 1. | E. Warner | Ghana Water Sector Rehabilitation Project |
| 2. | M. Zermeno | Venezuela Trade Policy Loan |
| 3. | A. Moussa | Morocco Public Administration Support Project |
| 4. | R. Klockner | Uruguay Power Modernization Project |
| 5. | G. Ellena | Tunisia Hospital Restructuring Support Project |
| 6. | A. Gulstone | India Northern Region Transmission Project |

| | | |
|---|---|---|
| 7. | D. Odeh | India Technician Education Project |
| 8. | R. Pinto | Mozambique Economic and Fin. Mgmt. Tech. Asst. Project |
| 9. | B. Mahmandi | Algeria Industrial Restructuring Demo. Project |
| 10. | B. Veuthey | Tunisia Fifth Urban Project. |
| 11. | M. Brickwell | Central African Rep. Economic Mgmt. Project |
| 12. | E. Vasur | Poland First Transportation Project |
| 13. | S. Scheyer | Philippine Health Development Project |
| 14. | B. Duces | Indonesia Public Works Institutional and Training |
| 15. | S. Singh | Hungary Financial Systems Modernization Project |
| 16. | J. Tillman | Pakistan Transport Sector Project |
| 17. | W. Rees | Korea Science Education and Libraries Computer Project |
| 18. | L. Effron | Algeria Agricultural Credit Project |
| 19. | S. Takeda | Indonesia Prof. Human Resource Development Project |
| 20. | D. Hamilton | Indonesia Second Secondary Ed. and Mgmt. Project |
| 21 | D. Fretwell | Poland Employment Promotion and Services Project |
| 22. | A. Shanmugarajah | Indonesia Third Telecom Project |
| 23. | M. Boissiere | Hungary Human Resources Project |
| 24. | L. Mosele | Madagascar Environmental Program |
| 25. | U. Marggraf | Yugoslavia Seventh Railway Project |
| 26. | L. Mejia | Argentina Tax Admin. Tech. Asst. Project |
| 27. | M. LeBlanc | Malaysia Highway Rehab. and Imp. Project |
| 28. | D. Bhattasali | Kenya Fin. Parastatals Tech. Asst. Project |
| 29. | H. Van Voorthuren | Papua New Guinea Land Mobilization Project |
| 30. | J. gauss | India Upper Krishna Irng. Project |
| 31. | S. Orlic | Hungary Second Transport Project |
| 32. | G. Darlan | Cameroon Economic Mgt. Project |
| 33. | J. Toureille | Poland Financial Institutions Dev. Loan |

**Staff Interviews − Partial List**

Rachel Weaving − DGO

Sverrir Sigurdsson − EMTPH

Stanley Scheyer − ASTPH

James Cowie − AFTIE

Claudia Fernandez − EAlIE

Carlos Ferreira − EMTDR

Tony Moussa − ASTIF

Eduardo Talero − ASTIF

Khalifa Ikramullah − ASTIF

Robert Schware − ASTIF

Robert Chavez − AF6CO

Mary E. Young − AFTIE

Luis Mejia − LATPS

Richard Skolnik − SA2PH

Thawat Watanatada − EA2TP

Evan Rotmer − ASTIN

John O'Connor − IECSE

Ali Hashim − ITFDR

Gordon Temple − CODIS

Francis Plunkett − SA2PH

**Consultant Interviews**

Peter Cook − Lukehart, Thornhille Associates, Inc.

Kurt Moses − Academy for Educational Development

Ron Epstein − Volunteers in Technical Assistance (VITA)

Henry Lucas − VITA

Mark Frazier − Services Groups

Gerald Britain − USAID

Ed Silensky − Team Technologies

Moses Thompson − Team Technologies

Dr. Philip Casper − Codman Research Group

Dr. R. Palel, President, Omicron Corporation

Michael Polley, Ernst & Young

Dr. Micha Pazner, University of Western Ontario

Tony Percy, Garmer Group

## Annex 4
## OED Evaluations

A4.1 A careful review of the documents led to a rating of the information technology components in each project based exclusively on specific comments about the component made by reviewers. These comments either indicated that the component performed satisfactorily and contributed to the achievement of project objectives, or that it did not and was therefore unsatisfactory (see Table A4.2).

A4.2 The prevalence of implementation difficulties noted in OED completion and audit reports has been confirmed by survey research. Mainly as a comparison, it is interesting to note that a major study by the Index Group study of 30 information systems efforts in the U.S. private sector found that only five (17 percent) "achieved intended business objectives and for the others the promised results remained undelivered" (cited in Strassman 1990, p. 392). A more recent 1989 survey of 300 European companies conducted by the Amadal Executive Institute found that more than two−thirds of the companies believed that they were failing to implement information technology systems to the level thought necessary to keep pace with future business needs (Gray 1991).

A4.3 In comparison with such findings, the seemingly high overall satisfaction of Bank reviewers with the achievement of information technology components in our sample of projects appears to provide a sharp counterpoint. This is likely due to the easier−to−obtain "first−order" benefits anticipated in Bank−financed information technology applications, compared with the more advanced learning and institutional changes required for the second−order benefits sought by industrial countries. But to address such issues with greater reliability would require the use of a larger sample and, ultimately, the development of a more comprehensive methodology, which might include site visits to information technology installations and customer interviews.

**Table A4.1**
**Obstacles to Implementation of Information Systems**

| Source | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hawk Dos Santos (1991) | | | | XX | | | | | | | |
| King & Grover (1991) | | X | X | X | X | X | X | X | | X | |
| Mankin, Gutek, Stasz (1988) | | | X | X | X | | | X | X | X | |
| Lucas (1981) | X | | X | X | X | X | | | | | X |
| King & Grover (1991) | | X | X | X | | X | X | | X | | |
| Corbitt & Norman (1991) | | | X | X | | | | | | | |
| Argyris (1977) | | | X | X | X | | | | X | | |
| Bean, et all (1975) | | X | X | X | | | | | | | |
| Dickson & Powers (1973) | | | X | X | X | X | X | X | | | |
| Galbraith (1979) | | X | X | X | X | X | | | | | |
| Narasimhan & Schroeder (1979) | | X | X | X | | | X | X | X | | |
| Radnor, Rubenstein & Tansik (1970) | | | X | X | X | | | | | | X |
| Rubenstein (1970) | | X | X | X | | X | | | | | X |
| Stabell (1975) | | | X | X | X | X | | X | X | | |
| Noble (1991) | | | X | X | X | | | | | X | |
| Kloppanborg & Plath (1991) | | X | X | X | X | X | X | X | | | |
| Total (16) | 1 | 7 | 15 | 16 | 10 | 8 | 5 | 6 | 6 | 2 | 4 |
| PERCENTAGE | 6% | 44% | 94% | 100% | 62% | 50% | 31% | 38% | 38% | 12% | 26% |

A. Apathy/Fear of Change
B, Funding Available or Justification
C. Management Support
D. Organizational Coordination & Conflicts
D. Organizational Coordination & Conflicts
E. Training (Understanding of Technology)
F. Staffing Available/Recruitment
G. Maturity of Technology
H. Technical Problems
I. Data Structure & Source Materials
J. Planning
K. Contractor/Customer Problems

Source: McFarland (1992).

**Table A4.2**
**Review of Operations Evaluation Department Final Reports**

| **Type of project** | Role of Information Technology | Information technology component implementation | |
|---|---|---|---|
| | | Satisfactory | Unsatisfactory |
| Telecommunications Technical Assistance | Computerized Project Mgmt end Financial | "Main result was improvement in overall efficiency." | |

| | | | |
|---|---|---|---|
| (E. Asia) | Mgmt System | | |
| Power/Water Project (Africa) | Management Info. System | "There were some improvements related to the introduction of computerization and auditing." | |
| Housing (EMENA) | Computerization of public financial institution that granted mortgages | | Proposed database architecture was too complex; loan officers did not receive requisite training. |
| Urban Management (East Asia) | Computerization of Transportation Mgmt System; project evaluation and planning; end long−term financial plan for city | "Computer project helped to streamline and strengthen city administration, particularly in financial management end transportation planning management." | |
| Rural Sector Technical Assistance | Computerized database of rural development projects | "First inventory of rural projects produced; and Planning Unit prepared and monitored consolidated investment budget from 1987 to 1991." | |
| Technical Assistance (South Asia) | Comprehensive computerization of Planning Commission | | "Computer hardware could not be utilized because of incompatibility between hardware & software and support services available in country." |
| Economic Financial Management Improvement (Africa) | Computerization of Ministries of Planning and Finance | "The project successfully put in place an external debt management system, computerized the fiscal and customs administration and introduced a methodology for public investment planning." | |
| Transport (Africa) | MIS/cost accounting | | "The project demonstrated that the combined procurement of computer equipment, software and technical assistance was not conducive to best−cost solutions." |
| Integrated Rural Development Project (Latin America) | Computerization of decentralized Rural Development Agency | "Agency has been significantly strengthened and its functions and procedures have been transformed." | |

*(table continued on next page)*

*(table continued from previous page)*

**Table A4.2**
**Review of Operations Evaluation Department Final Reports**

| Type of project | Role of information technology | Information technology component implementation | |
|---|---|---|---|
| | | Satisfactory | Unsatisfactory |
| Technical Assistance Project | Computerization of Ministry of Finance's debt management program | "The unit did receive a microcomputer but there is no evidence that advisory assistance was provided to firmly establish analytic capability to make projections and simulations. However, progress was made and the computer system was, in most respects, completed." | |
| Energy and Public Utilities (Africa) | Computer modeling of fuel requirements end pricing structures | | "The terms of reference did not require consultants to produce a computer model or format that could be updated by local authorities—in this sense, there is no project sustainability." |
| Transport and Tourism (EMENA) | Computerized national traffic census and training of computer users | "Traffic census completed on schedule; and trainees received the planned 150 hours of professional instruction with computer system; the project was successful." | |
| Education (Africa) | Computerized training to accountants and managers | "The output of trained accountants & administrators is having a noticeable impact on business practices in the country, particularly with respect to computers" | |
| Telecommunications Technical Assistance (East Asia) | Computerized network management | "The capacity to monitor & manage the radio frequency spectrum in the country has been enhanced with the help of computer facilities." | |
| Industry (EMENA) | IS for iron ore plants | | "MIS does not appear to have led to any tangible results in improving management." |
| Highways (Latin America) | Computerized information system | | "Failed to achieve efficient budget planning and administration" |

| | | | |
|---|---|---|---|
| Agriculture Credit Project (EMENA) | Computerized MIS | "The main achievement of the project is installation of the MIS, which is largely in place and operational at headquarters and will be complete in branches by 1990." | |
| Industrial Credit Project (Latin America) | Computerized accounting system | "These systems were installed and helped reveal the grave financial problems faced by the institution." | |

*(table continued on next page)*

*(table continued from previous page)*

**Table A4.2**
**Review of Operations Evaluation Department Final Reports**

| Type of project | Role of information technology | Information technology component implementation | |
|---|---|---|---|
| | | Satisfactory | Unsatisfactory |
| Agriculture (East Asia) | Computerization of Land Authority | "Project implementation was satisfactory and has helped authority develop into a strong and well−run organization." | |
| Irrigation (East Asia) | Computerized water allocation and monitoring system | | "There is a great difficulty in recruiting, training and keeping gate operators, since private sector is attracting technical graduates." |
| Development Banking (Latin America) | Computer information system | "Lasting improvements in computerization information, processing facilities and supervision of subprojects have been achieved | |
| Technical Assistance (Africa) | Computerization of Ministry of Planning and Civil Service and Energy | "Computers purchased under the project have been used to the full and are well maintained—they have improved working conditions in these agencies and enhanced their potential" | |
| Economic Management and Training Project | Computerized budget systems for Budget Office | "The system was developed and continues to be used effectively by the Budget Directorate." | |

| | | |
|---|---|---|
| Power (Africa) | MIS; computerization of billing and collection | "Satisfactory." |
| Education (Africa) | Established Information Services Data System Unit (ISDS) in Ministry of Education | "The project was crucial in strengthening the Education Ministry by establishing the ISDS, which has helped gather educational data for the finance ministry and established a computerized inventory system for textbooks." |
| Agriculture Research and Extension (East Asia) | MIS and database for research programming, human, financial and physical resources | "It is expected the project will maintain a high level of net benefits." |
| Technical Assistance Project (EMENA) | Computerization of Data systems for Oil, Electric and Meteorological Institute | "The energy component led to improvements in data systems. Those systems are becoming fully operational." |

Source: Evaluation Textbase, Operations Evaluation Department, World Bank.

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