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TRENDS IN INFORMATICS-RELATED SERVICE INDUSTRIES IN SELECTED DEVELOPED AND DEVELOPING COUNTRIES

Prepared for

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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by

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NOTE

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Tables referred to in the text will be found following the footnotes at the end of the chapter in which they are cited.

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INTRODUCTION

This study reviews the trends in the development of informatics-related service industries in selected developed and developing countries and the likely impact and implications of innovative applications in informatics on the growth of the service sector, particularly in developing countries. The pace of technological development in informatics has escalated rapidly in the last two decades and while the impact of such developments has extended to most production sectors, it has been particularly marked in various service industries and the service sector as a whole. These developments have primarily taken place in industrialized, developed economies, particularly the United States, West European countries and Japan, but the pervasive nature of technological applications has major implications for developing countries, both in industrial activities and in various service functions.

Informatics can be basically defined as the techniques and systems for efficient organization, storage, transmission and dissemination of recorded information. It includes all technologies used in the collection, processing and transmission of information, particularly micro-electronic and opto-electronic based technologies incorporated in a wide range of production, production processes and applications and increasingly in the service sector. Informatics covers, inter alia, computers and telecommunications, which are increasingly converging in data technologies, communications systems, office equipment, industrial robots and computer-controlled machines and operations, besides electronic components, and the software and systems utilized in different fields and applications.

Technical applications have, in recent years, increasingly focused on the service sector. This sector is extremely wide and diverse in its range and quite heterogeneous in terms of new technological applications. Services provide an enormous range of functions which are also vital for the development process, extending from production, marketing and distribution to provision and management of capital and to various activities designed to enhance social welfare and living standards. The service sector can be broadly categorized under two groups. Firstly, there are specific services such as financial services, transportation, tourism, merchandizing, including food-related services, healthcare and professional services of various categories. Secondly, the present study also covers informatics in industrial services and operations, which can be characterized as producer services, having direct impact on the manufacturing sector. The analysis of trends in developments has been considered for both categories, together with the implications of new informatics applications in these fields and their effects on the development process, particularly in developing countries. The policy implications for developing countries, both at national and international levels have, thereafter, been analyzed and discussed.

The study comprises four sections and several subsections. The first section deals with overall growth trends in the service sector, together with technological developments in informatics applications in this field. The second section, with a number of subsections, covers developments in informatics in relation to services in selected industrialized and developing

countries. The third section, with several subsections, concentrates on trends, experience and developments, firstly, with respect to computers and telecommunications, and secondly, in the application of informatics in major service sectors, namely: financial services; transportation, tourism; merchandizing, including food-related services; healthcare, professional services, and in industrial operations and producer services. Experience in both industrialized and selected developing countries has been examined under these categories, principally on the basis of secondary information sources. The fourth section comprises two subsections, which deal with, firstly, national policy issues relating to the application and development of informatics in the service sector in developing countries, and secondly, the international issues relating to informatics developments on the one hand and to the service sector, on the other.

Considerable literature has emerged in recent years on the effects of informatics on sectoral development in various fields, including various service branches. Most such information relates to trends and developments in industrialized economies and relatively limited material is available on developing countries, except in the publications of some international organizations. This is largely because informatics has been extensively applied only in a few developing countries, particularly in Latin America and in certain Asian economies. The implications and effects of informatics applications, however, are likely to be far-reaching for all developing economies in the coming decades and policies and programmes have to be oriented to meet the challenge of technological innovations and applications in informatics in relation to various service subsectors and activities.

The service sector has received prominent attention in international discussions in recent years, particularly on account of the Uruguay Round negotiations on trade. Trends and developments in this field have been highlighted and there is greater recognition in developing countries of the role and importance of the service sector in their respective economies. The analysis of contemporary trends and experience in this regard is, therefore, of considerable topical importance and significance.

SECTION I

GROWTH OF SERVICE SECTOR AND IMPACT OF INFORMATICS

Traditionally, services have been viewed as the tertiary sector of the economy, that is, all activities which are not production of primary or industrial goods. The World Bank, in its World Development Report, 1987, defines services as a residual, or total gross domestic product (GDP) minus agriculture and industry, defined in their broadest terms. 1/ It is not easy to define and measure services as they cover an extremely wide and diverse nature of activities. In balance-of-payment accounts, incomes from services are generally included under 'invisibles', without much disaggregation. At the same time, it is increasingly recognized that services play a vital role in national economies and in the global economy in terms of their contribution to gross national product (GNP), and growth of income and employment in individual economies. With greater globalization of markets and changing patterns in the international division of labour and production as a result of technological developments, the service sector is also becoming increasingly internationalized and is emerging as a vital and critical area of growth for all economies. This is reflected in the importance given to services in the international trade negotiations at the Uruguay Round. While definitions and coverage of specific services remain somewhat blurred and indistinct, and there have been conceptual differences on definitions as used for statistical purposes and for policies and negotiations, a broad consensus has emerged on the overall importance of the service sector. The specific coverage of this sector extends, firstly, to developments in information and communications and, secondly, to specific services such as financial and related services; transport, tourism, merchandizing, healthcare and social services and various professional services. It is also necessary to examine the impact of informatics on the industrial sector, particularly in relation to producer services impacting on manufacture.

The role of services in national economies and in international operations has been dramatically enhanced by revolutionary, innovative changes in informatics, comprising information and communications technologies. Advances in informatics have led to the emergence of a new techno-economic paradigm in which the intensive use of knowledge and information has emerged as the key factor, with a comparable decline in the consumption of energy and raw materials per unit of output. While factoral aspects of production continue to be of importance, emphasis is gradually shifting to a country's technological competitiveness and its capability in acquiring, adapting and utilizing knowledge and know-how involved in informatics and other new technologies. The new role of services has also to be viewed in this changing technological context.

The service sector has grown considerably in importance and significance during the last two decades. In the World Bank's World Development Report, the share of services in GDP for 1985 ranged from an average of 35 per cent for low-income economies, 47 per cent for lower and middle-income economies, 54 per cent for middle and upper-income countries and 61 per cent for industrialized market economies. 2/ For the industrialized economies, the

growth of services has been much higher than for industries. In developing countries also, the growth of the service sector has generally been fairly dynamic, though often less than the pace of industrial growth. Global experience so far suggests that the share of services in GDP tends to rise with the level of per capita income There is a clearly-discernible trend in industrialized countries to move towards a 'service' economy. This can of course also be translated, in certain country situations, into low-paid employment in service industries, particularly during periods of recession or industrial dislocation. Usually, however, the growth of the service sector represents an effective and improved combination of innovative technological applications which enhance production, marketing and distribution capabilities of agriculture and industry and also of specific service functions relating to the economy or its external trade.

The growing importance of the role played by the service sector can also be assessed in terms of foreign direct investments (FDI). Such investments in the service sector were estimated to be about $300 billion out of a total approximate FDI stock of $700 billion. 3/ It was also estimated that half the total annual flows of FDI is in services, approximating $25 billion per year for the period from 1980 to 1985. A more recent estimate, however, suggests that FDI in services constitutes 50-60 per cent of the current world stock of FDI, valued at around $100 billion and about 60 per cent of annual global flows of FDI. 4/ Differences in estimates are largely due to definitional reasons. Whatever the proportion or extent of FDI flows in the service sector, there can be little doubt that it is very substantial and constitutes a sizeable proportion of total FDI flows. Most such investments have taken place in finance and trade-related services and among industrialized market economies, with transnational corporations (TNCs) and their subsidiaries and affiliates playing a major role in service investments. The extent of outflow of FDI in services of major industrialized market economies during 1975-1980 and during 1981-1986 may be seen from Table 1, while inward flows of FDI in services in selected developing countries may be seen from Table 2.

Technological developments in informatics have played a highly significant role in the expansion of the service sector. The rapid growth of data-processing facilities on the one hand and in telecommunications and data transmission on the other has been a major factor contributing to the growth of this sector and has led to a wide range of innovative software and systems applications. The development of information systems and data bases in various fields to collect, process, store, retrieve, display and disseminate information on particular subjects, has been of particular significance.

Information systems can be variously classified and for different purposes. One method of classification is by the application area, such as government records, payroll, accounting, airline reservations and the like. Another classification could be by the type of service rendered. Broadly, the following six types of information systems can be distinguished in the services sector in different countries: (a) Computing Service Systems that provide general computing services to various users; (b) Information Storage and Retrieving Systems that are designed to store data and retrieve them in response to requests; (c) Command and Control Systems that are used to monitor given situations; (d) Transaction Processing Systems which process defined transactions and produce predefined outputs as well as maintain the necessary

data base, such as in a billing system; (e) Message Switching Systems that route messages over transmission lines; and (f) Process Control Systems that are designed to control operations and processes by monitoring the conditions and instructing appropriate action to the machines.

Apart from technological developments in computer applications, data processing and information systems, which extend to all service subsectors, developments in telecommunications have also had fairly extensive impact on various service functions and operations. 5/ The convergence of telecommunications, micro-electronics and computer technology has provided a new technological base for the communications sector. Old systems have been replaced and entirely new components, products and services have been developed. In place of earlier communications systems based on a set of telephones connected by copper wire through an electro-mechanical switching system, analogue electrical signals are increasingly transmitted between the exchanges via coaxial underground and undersea cable. Innovative developments in this field have led to the development of electronic programme-controlled, digital switching systems. Digital exchange technology is now generally accepted as being more economic and technically superior to conventional systems for use in both developed and developing countries.

As in exchange technology, the pace and scope of technical change in transmission technology in telecommunications services has been rapid and widespread. Microwave transmission systems exhibiting greater efficiency and capacity due to pulse code modulation (PCM) and time division multiplexing (TDM) transmission techniques are being utilized for medium capacity lines and difficult terrains. Likewise, radio telephone using Very High Frequency (VHF) and Ultra High Frequency (UHF) systems also does away with the need for physical conductors in rural areas. Fibre optics and laser transmission systems provide significant advantages over conventional systems in terms of greater capacity, speed, flexibility, resistance to interference and substantially reduced installation costs. Likewise, micro-electronics-based technology has made the use of satellite communications technology more economically viable for both public and private networks.

Peripheral equipment has also undergone major technological changes by the convergence of computer and telecommunications technology. The range of terminals and telephones, key systems, mobile radios, modems and a variety of office equipment, such as word processors, multi-function microcomputers, electronic messaging and other types of workstations, has expanded rapidly. Increasingly, it has become possible for major international, corporate and private users to use and adapt new telecommunications services and facilities to meet their particular needs. 6/ A combination of technological advances, reduced transmission costs, less regulatory restrictions, and growing user demand for sophisticated new services has led to the creation of several value-added networks and other specialized information services that operate internationally. These new data services "permit instantaneous, long-distance interactive interactions via transnational computer-communication systems. More specifically, by collapsing time and space (at decreasing costs), data services permit certain services to be produced in one place and consumed in another place. The result is an increase in the transportability and, consequently, tradability of certain services which can be delivered via the telecommunications network. 7/

The fusion of computers and telecommunications has created a large array of transactional services. Multinational and some national enterprises are using telecommunications services for a wide variety of transactions within firms and among user groups of related firms. Examples of networks of related businesses are the international banking network (Society for Worldwide Interbank Financial Telecommunications (SWIFT)) and the airlines data system of Société Internationale des Telecommunications Aeronautiques (SITA)). Electronic data interchange (EDI) is a new and rapidly expanding form of intrafirm transactional services. In North America, large retail clothing and food stores are rapidly introducing EDI systems. The system is also being used in major ports such as Hamburg, Rotterdam and Singapore and has reportedly reduced clearance time very substantially.

Until the 1960s, only a limited range of basic telecommunications services, mainly telegraph, telephone, and telex, were available to residential and business users, which were usually provided by government-owned and operated public telecommunications organizations. New technological developments have posed several issues relating to the maintenance of state monopolies in telecommunications. The present trend in industrialized market economies is that the basic telephone services continue to be maintained on a reserved, or monopoly basis, in most countries, except in the United States. Enhanced value-added services or clusters of services are, however, being opened to competition, in several industrialized countries. Available estimates for some member countries of the Organisation for Economic Co-operation and Development (OECD) indicate that the telecommunication sector's proportion of GNP is comparable to the share of the steel or the textile sectors. Even these figures underestimate the importance of the sector owing to the difficulty of evaluating private-sector investments related to telecommunications and of separating domestic from international income. In 1980-1984, the share of transport, storage, and communications in GDP was 7 per cent in developed countries and 6 per cent in developing countries. 8/ Digitization has vastly increased the speed and reliability of telecommunications, and has led to lower barriers to market entry for manufacturers of equipment and providers of data services.

Technological innovations in informatics, apart from telecommunications, in recent years have largely focused on micro-electronics which have applications in several service sectors such as financial services (banking, insurance, etc.), transport, tourism, merchandizing, health and social services, and professional services, besides industrial and commercial operations. Data technologies offer vastly improved capabilities for the processing, storage, retrieval, manipulation, and transmission of data for various purposes at generally declining costs. It would be useful to briefly assess the impact of technological developments in informatics in some of the major service subsectors.

Financial services: In the area of financial services, new informatics applications and usage have brought about significant changes in recent years in the operations of financial markets and on the activities of institutions operating in national and international financial intermediation, primarily in industrialized countries, but also in certain economies such as Singapore and Hong Kong. Financial services may be defined as comprising (a) deposit taking and lending, whether in domestic or foreign currency, from and to Governments, corporations, private individuals and others; (b) specialized forms of lending including trade financing, loan syndications, and participation; (c) trading

and dealing in domestic and foreign currencies; (d) various advisory and brokerage services and (e) insurance services. Financial services inevitably interact with a broad range of economic activities and agents and play an important part in the credit, monetary and payments systems. Informatics, comprising the flow and analysis of financial information, both directly between users through various financial and securities databases, are playing a major role in those activities.

In the last two decades, there has been dramatic growth of trade in financial services, specially among industrialized countries. This has taken place, to a significant extent, because of technological innovations in informatics and consequential product development and a changing pattern of financial services on an international scale. A detailed picture of the magnitude of national and international transactions in financial services is, however, difficult to obtain, owing to problems in measurement. Such transactions are mainly concentrated in industrialized countries, and generally undertaken by TNC subsidiaries and affiliates, particularly TNCs in the respective financial subsector. The trends in the 1980s suggest that such international transactions are likely to expand greatly as a result of new information technologies, through cross-border flows of services, as well as the expansion of activities of transnational banks and other financial institutions, wherever this is permitted under the regulatory environment. 9/

Financial intermediation is increasingly becoming an information industry, and thus, changes in the ability to gather, process, store, or exchange information are bringing about significant changes in the operations and markets of financial intermediaries. As Mehroo Jussawalla and Stephen Dworak observe, "the theoretical importance of information to financial intermediaries and their markets indicates that technological advances in the ability to gather, process, store, or exchange information would be quickly utilized by those trying to improve their profit/risk position, whether regionally, nationally, or internationally." 10/ Advances in informatics have provided the financial institutions with the ability to be more responsive to customers and markets and to offer a broader range of financial services and products. Changes in financial services brought about by the developments in informatics include features such as electronic funds transfer, "sweep" accounts, negotiable CDs, and money market accounts, and such new services as automatic teller machines (ATMs) and home banking. Informatics have also contributed to the tremendous growth in "plastic money" such as credit cards and related cash and "smart" cards.

An important element in financial services is provided by insurance services. Insurance services permit the transfer and sharing of risk, contribute to the accumulation of funds for investment, and provide a mechanism for private savings. Insurance enables individuals and organizations to pay an agreed premium to transfer risks of financial loss, arising out of specified loss-producing events to an insurer who, by pooling individual independent risks, reduces the overall risk. The boundaries of insurability can be extended by spreading large risks among a number of insurers by coinsurance or reinsurance arrangements which allow several insurers to share in the insurance of large industrial risks.

The use of computers and informatics has played an important role in the development of insurance services, both in national markets and in international insurance transactions. This has led to considerable

enhancement of efficiency and speedy processing of transactions in a number of countries, both industrialized and developing. At the same time, the introduction of insurance services, like other financial services, relies on a combination of financial, human and intangible resources. Though information technology is increasingly utilized in product design, risk evaluation, marketing, and administration, experienced management and skilled personnel remain essential to successful insurance transactions. The efficiency and competitive ability of an insurance company depends on the judgemental capability of its underwriting, claims, and investment management, combined with detailed knowledge about clients, products, and areas. In this regard, developments in information technology may exert conflicting influences on capital requirements for providing insurance services, 11/ though speed and efficiency in operations has undoubtedly been enhanced to a substantial extent.

Transportation: Transport services can be generally categorized as those provided by railroads, trucking, shipping and water transport, airlines, pipelines etc. For domestic transportation, railroads and road transport by trucks are generally the most important, while for international transportation, air passenger travel and ocean freight shipping greatly exceed, in value terms, other modes of such transportation. In air transport, passenger traffic accounts for three-quarters of all scheduled air traffic. Since 1978, total traffic has grown at about 6 per cent a year. Freight traffic has grown slightly faster, at 7 per cent a year. Developments in informatics have played an important role in the growth of transportation services, particularly through computerization of operations and rapid transmission of information. A major factor in the development of air transport services has been the key role of computerized reservation systems (CRS) as a strategic tool for airlines. An example is that of SITA (Société ... s Internationale Telecommunications Aeronautiques), which provides a network o leased lines carrying messages among over 200 airlines in 115 countries. R servation systems in the United States include SABRE of American Airlines (revenue $455 million in 1988), Apollo of United (revenue: $299 million), PARS used by TWA and North West (revenue $195 million) and DATAS II used by Delta (revenue $117 million in 1988). 12/ PARS and DATAS II merged in 1990 to form Worldspan.

International tourism: Informatics is playing an increasingly important role in tourism development. Tourism is not a unified service sector but brings together several different services for individuals and groups when they travel abroad. These services relate to various aspects of travel including charter flights, cruises, credit cards, travel insurance, personal accommodation, entertainment and the packaging of holidays, souvenirs, communications and advertising. The role of computers and communications systems has become essential in various tourism services, such as: (a) activities of tourism enterprises, including tour operators and travel agents which supply one or more tourism services; (b) most passenger transportation services; (c) enterprises providing reception, lodging and food facilities and services such as hotels, motels, camps, rented holiday apartments, restaurants, and cafés; (d) recreational, cultural, sporting and other entertainment services, and (e) supporting and auxiliary services such as tourist guide services.

Tourism enterprises from one country location need to install, maintain and interconnect with terminal and communications equipment in order to supply tourism services to other countries. The developments in informatics have led

to a great volume of tourism information moving across borders and have facilitated international service transactions in tourism not only directly through services such as data processing and telecommunications, but through banking and financial services. Computers are also extensively utilized both in developed as well as developing countries to maintain and process data on tourist arrivals and tourism investments and expenditure.

Merchandizing: Informatics has also had considerable impact on merchandizing and trade services, mainly in industrialized market economies, though also in some developing countries, in recent years. Large-scale introduction of electronic cash registers (ECRs) has brought about major changes in the running of retail outlets of various kinds, and considerable additional information about different transactions can be entered and recorded on the ECRs fitted with a so-called automatic reading wand or electronic scanner. This is a device that reads information encoded, optically or magnetically, on tags fitted to the goods on sale. Information on a shirt, for example. such as its code number, colour, style, size and price, can be encoded on a tag not much bigger than a conventional price tag. All this information can be entered into the ECR in less than a second and without error by the sales assistant passing a reading wand rapidly across the tag. The information, once entered, is recorded and can be analyzed either immediately or at the end of the day on the store's main computer. Retailers are thus provided with up-to-date and detailed information on progress of sales of different items, enabling better control of stocks and inventory.

New computer systems in use in the retail industry are designed to speed up actual store-level transactions, providing customers with more efficient service and using a computer system to prepare detailed accounting records. A new generation of Point of Sale (POS) machines has replaced the old-fashioned cash register. Various coding methods are used on actual merchandise to make the process of entering data into the POS terminal more efficient and accurate. The grocery industry in countries such as the United States is the biggest user of full-scale POS systems.

Food-related services such as supermarkets generally require different and more complex ECRs than those in department stores or other retail merchandizing outlets. Informatics has not only helped in faster checkout, but also helped in better control of stocks and in saving expensive floor space.

Healthcare: In the field of healthcare, medical electronics and informatics are performing increasingly important functions. The delivery of healthcare is essentially a problem-solving activity, depending heavily on the processing of information. Medical diagnostics and treatment entails collecting accurate information, formulating precise hypotheses and testing them, and efficiently managing several patients and large amounts of data. As medical care comes to depend increasingly on the co-ordinated activities of several professional and auxiliary personnel, timely and productive communication becomes increasingly vital. The mobility of people and a growing concern with the prevention of illness and the management of chronic disease makes the long-term storage and ready availability of data essential.

Trends and developments in the application of informatics in the healthcare system, particularly in industrialized market economies, have been remarkable and computer usage has been extended to a variety of applications,

apart from accounting, such as scheduling, patient monitoring, and automated laboratories, as well as to computer-assisted diagnosis and research and preparation and retrieval of medical histories. Several doctors are using computers as a diagnostic tool in hospitals and clinics and patients' data is increasingly fed into computers and processed. Computers are also being used for such diagnostic purposes as displaying heart functions on a terminal screen, or determining, by means of computer-aided tomography (CAT) scanner, the area in the brain that may have been damaged by a stroke. In addition to being a diagnostic tool, the computer is also a research tool that is providing insight into causes and prevention of strokes and other areas of healthcare.

Professional services: The professional services sub-sector has been gaining in importance in recent years in both industrialized countries and developing economies. Professional services that are significant in international trade, and which are utilizing informatics to an increasing extent, include accounting, legal services, consultancy services, and the like. Computer services are also growing significantly in importance, together with industrial informatics and producer services.

The principal services provided by the accounting industry are auditing and accounting services and tax-related services. In the United States, auditing and accounting, which are increasingly computerized, are estimated to account for 50 to 77 per cent of the revenues of major accounting firms. Some of the major accounting companies have operations in most developed-market economies, as well as in a number of developing countries, and developments in informatics have contributed significantly to this trend.

Legal services include the representation of clients in civil and criminal courts, the negotiation and preparation of legal documents, and other legal consultation and advice. Available information suggests that national legal services are highly competitive, including in the United States where the sector has been growing rapidly since 1979.

It is difficult to assess the international market for legal services because of existing national regulations on entry of foreign firms and the relatively limited nature of international legal service activities at present. 13/ Recent reports suggest that developments such as mergers and take-overs, privatization, and relaxation of restrictions in some countries have generated new demand for international legal services. In any case, it seems likely that there may be a growing trend toward internationalization of legal services in industrialized countries. There is no information to suggest that similar forces are at work with respect to legal services in developing countries.

Management consultancy and other consultancy services constitute another field of professional services that has been growing rapidly in industrialized countries in recent years and has been greatly facilitated by the application of informatics. As project planning and construction, and industrial applications, become more complex and require a greater degree of sophistication and informatics application, the role of consultancy engineering and of management consultancy is also becoming increasingly important. While consultancy engineering has, in general, been internationalized, for a considerable period, recent trends in informatics are providing greater competitive advantage for consulting organizations from

industrialized economies and a greater degree of specialization in consultancy and management services.

Industrial applications and producer services: Apart from specific informatics applications in particular service subsectors, there has been a very significant impact of informatics on manufacturing and production processes and in office management techniques and practices. While informatics applications in the manufacturing sector do not fall under the category of the service sector as such, such applications are not only having major impact in production and manufacturing operations, but are becoming increasingly specialized and serving a widening range of producer service operations and functions. The new applications are largely due to the entry of computers in production operations, through computer-aided design and manufacture (CAD-CAM) and computer-integrated engineering, leading to the use of increasingly complex computerized equipment, including robots and artificial intelligence devices. Major changes in manufacturing and production techniques have been combined with new and dynamic management techniques such as just-in-time delivery and total quality control. 14/ In all these aspects, informatics applications are playing an increasingly critical role, impacting on most industrial and business operations.

Industrial services in recent years are assuming ever greater importance because new, complex production technologies can only be efficiently operated within an overall system of support services, such as telecommunications; advanced repair and maintenance services; computer software specialists; and R&D inputs. With the 'service content' of manufacture increasing rapidly, through the use of computer systems for design, quality control, inventory-handling, etc., developments in informatics have brought about greater integration between manufacturing and various producer services.

Advances in micro-electronics and telecommunications occupy a central position in the technological transformation taking place in several industries and production sectors. Computer-based systems provide an enormous range of facilities, which are then transmitted by telecommunications with minimum transmission and transaction time. An example is the interfacing of U.S. designs with CAD facilities in Hong Kong and the Republic of Korea to reduce the lead time required between design and manufacture of garments.

Informatics technology has been introduced in a wide range of industrial processes involving both the transfer and processing of information and the control of machinery operations. Apart from informatics innovations in administration and co-ordination through office automation equipment, major areas of application have been computer-aided design (CAD) and computernumerically- controlled (CNC) machines. These can be briefly exemplified by developments in clothing manufacture and the machine tool industry.

In the clothing industry, though central production (that is, the assembly of pieces of cloth) has remained largely a domain of labour-intensive operations on traditional or programmable sewing machines, in the pre-assembly stage CAD systems are being extensively used and are now widely utilized for pattern-making, grading and marking. This enables much quicker responses to changing market requirements, a shorter turn-around time in grading and marking, and considerable improvement in fabric utilization. An overwhelming majority of CAD machines have been installed in industrialized countries and

in 1985, only approximately ten CAD systems out of a total of 700 were to be found in certain developing countries. Usage in some developing countries is increasing rapidly. The same broadly holds true for CAD diffusion in other industrial sectors. This has been significant only in a few developing countries, such as Brazil, Hong Kong, India, Republic of Korea, Mexico, Singapore and the Taiwan Province of China. 15/

The machine tool industry has, since the 1970s, become a particularly strong and effective user of NC and CNC machinery. For example, in the leading OECD-producing countries of metal-cutting machine tools, the share of NC machine tools has risen from one-quarter to two-thirds within jsut a decade (1976-1986). In the same period, the share of CNC lathes in total lathe production went up from one-third to almost four-fifths of the total. Here again, a considerable gap exists between most industrialized and the few developing countries which are significant users of NC machine tools. Some developing countries such as the Republic of Korea and Singapore have, however, achieved levels of 50 per cent of the density of such machines in the United Kingdom, the United States or in Germany. 16/

The emergence of information technology has made possible a number of key developments in the industrial services sector, enabling greater automation in manufacture. In contrast to conventional 'fixed automation' systems, which follow a pre-ordained sequence of steps in making a product, flexible manufacturing systems can be programmed to alter their procedures to suit varying production requirements. Flexible systems, by enabling automation of low-volume production, are critical for the development of automated factories of the future.

In recent years, there has been tremendous growth in the global information industry and in the market for computer services, including computer systems and software, data processing, and related advisory services. The development and use of software for a wide variety of applications is also leading to a growing demand for the services of computer professionals, who are involved in software development as well as in the actual provision of services related to use of software. These services are particularly important in the case of customer-specific software, where consultation and training are important factors. At present, the world market for standardized and packaged software is dominated by companies from the United States and certain other industrialized countries. Companies and individuals from both industrial and developing countries are, however, developing software to suit specific needs and modifying software packages for clients abroad. Such services are emerging as an important potential source of foreign exchange earnings for some developing countries, such as India and Brazil.

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14/ UNIDO, "The changing technological scene", op. cit., and Informatics for Industrial Development: Development and Transfer of Technology, Series No. 22, United Nations, UNIDO document ID/326, 1985.

15/ UNIDO, op. cit. Also see UNIDO Technology Case Study No. 2: Kurt Hoffman, "Technological and Organizational Change in the Global Textile-Clothing Industry", unpublished UNIDO document, April 1989.

16/ UNIDO, op. cit.

Table 1.

Foreign direct investment outflows in services of major home countries, by developed and developing host countries, 1975-1980 and 1981-1986

Home country and destination	Average annual flows a/				Share of services		Change between 1975-1980 and 1981-1986
	Total FDI		Services FDI				
	1975-1980	1981-1986	1975-1980	1981-1986	1975-1980	1981-1985	
	(Billions of dollars)				(Percentages)		
Canada							
All countries	1.5	3.1 (100)	0.3	1.3 (100)	20.2	42.0	21.8
Developed market economies	1.2	2.7 (87)	0.3	1.2 (92)	25.0	44.5	19.5
Developing countries	0.3	0.4 (13)	0.003	0.08 (6)	1.2	23.2	22.0
France							
All countries	1.7	3.2 (100)	0.7	1.4 (100)	43.8	45.2	1.4
Developed market economies	1.3	2.6 (81)	0.6	1.2 (86)	47.2	48.0	0.8
Developing countries	0.4	0.6 (19)	0.1	0.2 (14)	33.3	34.1	0.8
Germany, Fed. Rep. of b/							
All countries	4.6	4.3 (100)	2.1	2.2 (100)	46.0	52.8	6.8
Developed market economies	3.8	3.8 (88)	1.9	2.1 (95)	51.2	57.0	5.8
Developing countries	0.7	0.3 (7)	0.2	0.1 (5)	27.4	34.8	7.4
Japan							
All countries	4.0	11.6 (100)	1.6	7.8 (100)	40.8	67.0	26.2
Developed market economies	1.8	6.7 (58)	1.0	4.7 (60)	57.3	70.0	12.7
Developing countries	2.2	5.0 (43)	0.6	3.1 (40)	26.9	62.8	35.9
Netherlands c/							
All countries	3.9	3.1 (100)	1.7	1.1 (100)	43.6	35.8	-7.8
Developed market economies	..	2.7 (87)	..	1.0 (91)	..	35.2	..
Developing countries	..	0.3 (10)	..	0.1 (9)	..	41.0	..
United Kingdom d/							
All countries	4.0	11.6 (100)	1.6	7.8 (100)	40.8	67.0	26.2
Developed market economies	3.9	71.5 (82)	1.7	2.8 (76)	42.5	37.8	-4.7
Developing countries	0.9	1.6 (17)	0.5	0.9 (24)	54.5	53.4	-1.1
United States e/							
All countries	17.0	10.6 (100)	5.5	5.6 (100)	32.2	52.7	20.5
Developed market economies	11.9	7.1 (67)	3.1	3.8 (68)	25.7	52.9	24.4
Developing countries	5.2	3.5 (33)	2.4	1.9 (34)	46.5	52.9	6.4

Source: Adapted from UNCTC, Transnational Service Corporations and Developing Countries: Impact and Policy Issues, UNCTC Current Studies Series A, No. 10 (United Nations publication, Sales No. E/F.II.A.10), p.9.

a/ Since geographically separated data are based on a more restricted definition of services, the figures are not fully comparable with total figures and those reported elsewhere.

b/ Data are calculated as changes in foreign direct investment stocks. Foreign direct investment in services is the difference between total foreign direct investment and foreign direct investment in mining and manufacturing; 1977-1980 instead of 1975-1980.

c/ Based on the source of the Netherlands investor. The 1975-1980 figure is for 1980 only. The figure for 1981-1986 is for 1983-1986.

d/ Prior to 1984, oil companies are excluded. Services do not include banking and insurance.

e/ Excluding investment in finance (except banking), insurance and real estate in the Netherlands Antilles.

Figures in parentheses show percentages.

Table 2. Inward stock of foreign direct investment in services, selected host developing countries and territories, various years

Country/ territory	Year	Value		Share
		Total foreign direct investment	Foreign direct investment in services	of services in total foreign direct investment
		(Billions of dollars)		(Percentage)
Latin America				
Argentina a/	1981	2.4	0.6	25
	1983	2.8	0.8	27
	1986	2.7	0.7	27
Bolivia b/	1981	0.46	0.05	11
	1987	0.60	0.08	14
Brazil	1971	2.9	0.5	16
	1976	9.0	1.9	21
	1987	31.4	6.6	21
Chile	1973	0.4	0.1	27
	1987	2.9	0.9	33
Colombia c/	1975	0.6	0.2	29
	1980	1.1	0.2	23
	1985	2.2	0.4	16
	1987	3.0	0.4	12
Ecuador c/	1981	1.0	0.5	48
	1986	1.3	0.6	44
Mexico	1980	8.5	1.5	18
	1985	14.6	2.9	20
	1987	20.9	4.8	23
Panama	1975	0.3	0.1	32
	1980	0.3	0.1	37
	1985	0.5	0.3	68
Paraguay	1984	0.3	0.1	45
Peru	1978	0.8	0.2	25
	1980	0.9	0.2	27
	1985	1.4	0.4	29
	1987	1.2	0.3	29
Venezuela	1981	1.8	0.61	34
	1986	[illegible]4	0.65	27
Asia				
Bangladesh d/	1983	0.013	0.009	64
	1982	0.018	0.012	69
Hong Kong	1981	3.8	2.4	64
India	1980	1.2	0.05	4
Indonesia e/	1977	2.9	0.3	11
	1980	4.0	0.4	11
	1986	6.9	0.7	10
Malaysia f/	1972	0.7	0.2	37
	1984	2.9	1.2	40
Nepal	1986	0.1	0.007	7
Pakistan	1980	0.2	0.02	15
	1985	0.3	0.04	13

/...

Table 2. (Continued)

Country/ territory	Year	Value: Total foreign direct investment (Billions of dollars)	Value: Foreign direct investment in services (Billions of dollars)	Share of services in total foreign direct investment (Percentage)
Philippines	1976	0.5	0.2	34
	1983	2.0	0.5	26
	1986	2.7	0.6	23
Republic of Korea b/	1981	1.9	0.5	24
	1987	4.0	1.4	34
Singapore	1970	0.6	0.3	55
	1976	2.8	1.3	47
	1981	8.2	4.2	51
Sri Lanka a/	1985	0.7	0.4	57
Taiwan Province of China b/	1985	5.2	1.2	23
	1986	5.9	1.4	23
Thailand h/	1975	0.5	0.3	56
	1980	0.9	0.5	54
Western Samoa	1980	2.9	0.003	0.1
Africa				
Cameroon	1981	0.7	0.001	0.2
Central African Republic	1981	0.1	0.03	25
Côte d'Ivoire	1980	0.6	0.1	23
Egypt i/	1979	7.0	4.0	57
	1984	14.9	6.7	50
Gabon	1981	1.4	0.02	1.6
Kenya	1984	0.3	0.1	29
Liberia	1987	0.007	0.003	45
Malawi	1981	0.4	0.05	12
Morocco	1982	0.7	0.4	55
Nigeria	1975	3.0	0.6	20
	1980	4.9	1.9	40
	1982	4.3	1.6	37
Zimbabwe	1982	1.9	0.7	34

Source: UNCTC, Transnational Service Corporations and Developing Countries: Impact and Policy Issues, UNCTC Current Studies, Series A, No. 10 (United Nations publication, Sales No. 89.II.A.14), pp. 11-12, and data compiled by UNCTC from national sources.

Note: The shares of services were calculated before rounding of the stock figures. They may, therefore, differ from the shares which would result from the rounded figures.

a/ Cumulated approved foreign direct investment since 1 March 1977.
b/ Based on approvals.
c/ Excluding oil.
d/ Cumulative flows since 1977.
e/ Excluding oil, insurance and banking.
f/ Equity shares held by foreign residents in limited liability companies incorporated in Malaysia as of 31 December 1972 and 31 December 1984 (paid-up value).
g/ On approval basis. Cumulative flows since 1977.
h/ Cumulated flows since 1971.
i/ Projects established under the Investment and Free Zones Law, cumulative 1974-1984.

SECTION II

DEVELOPMENTS IN INFORMATICS IN RELATION TO SERVICES IN SELECTED INDUSTRIALIZED AND DEVELOPING COUNTRIES

Technological innovations in informatics and the pace of their application in services in recent years have varied considerably even in industrialized countries where they have been largely applied and utilized. For developing countries, extensive application of informatics in the service sector, even where possible, has been subject to several constraints and has various developmental and policy implications. Although there was rapid global growth of informatics during the 1970s, it is during the last decade that the pervasive impact of development in this field has been more pronounced in the service sector of industrialized and a few developing countries.

The production of informatics products and equipment has expanded enormously during the 1980s in the United States, Japan and Western Europe, which cover 80-90 per cent of global production. Production trends for various informatics subsectors in industrialized countries are shown in Table 3, which indicate that the production of computers and components has risen significantly both in the United States and Japan and, at a lesser pace, in Western Europe. During 1986-1988, similar trends continued, with the added factor of substantially increased production of consumer electronics and computers and components in certain South-East Asian economies, particularly the Republic of Korea, Hong Kong, Singapore and the Taiwan Province of China. While production of consumer electronics and computers and components has also risen substantially in some other developing countries such as, Brazil, India, Malaysia and Mexico, the proportion of their production in global output in these subsectors continues to be small.

Trends in informatics development and its application in the service sector in selected countries, together with policies followed in these countries, particularly in certain developing countries, are discussed in this section. This is followed by a review of developments with respect to informatics applications in major service sectors, in the next section of the study.

A. United States of America

Information technology has always played an important role in the service sector of the United States economy. In recent years, however, service-sector industries have dramatically increased their acquisition and application of computers, telecommunications and other informatics products. As a result, the broad segment of the economy that can be classified as providers of services now owns about 84 per cent of the total United States stock of information-technology items. 1/

It is generally recognized that services are central to employment, economic growth and quality of life in most industrialized economies,

particularly the United States. An analysis of the trends in service-sector investments from 1970 to 1985 shows that only information technology has experienced an increase in its share of the total service sector's capital stock. In 1970, information technology accounted for only 6.4 per cent of total service capital whereas, 15 years later, the share had risen almost 2.5 times to 15.5 per cent. The most intensive users of information technology in the United States are in the service sector. Tables 4, 5, and 6 provide an industry-by-industry assessment of shifting trends in the stock of information technology capital in the service sector. Benchmark assessments describing the concentration of technology ownership within various segments of the service groupings can be found in Tables 4 and 5. In 1985, the service sector as a whole owned 84 per cent of the United States economy's total stock of information-technology capital. Within services, about 45 per cent of this capital can be found in the communications industry (see Table 5), largely reflecting the sizable investment in a nation-wide telephone system. This is followed by financial services and the real estate subsectors, which accounted for about 25 per cent of informatics products in the service sector. Other major owners and users of informatics products and systems include wholesale trade, business services, and health-care providers. 2/

Among informatics products, computers and related systems and software constitute the single largest line item for the service sector. Apart from communications and nationwide telephone systems, computers account for 49 per cent of informatics products utilized by the service sector. This proportion has increased significantly during the 1980s from an average of only about 17 per cent in the 1970s. In fact, over the last decade, growth in the stock of computers used by the service sector has averaged 22 per cent per year, which is far higher than for other technology products.

Within the service sector, financial services in the United States own 49 per cent of all computers in this field. Financial services, as of 1985, are estimated to have 27.3 per cent of their total capital held in the form of computers and other office machinery, a share over seven times the ratio for all industries. 3/ Within the finance sector, securities brokers, investment holding companies and insurance companies have become highly dependent on computers, followed by banks and credit agencies. Outside of finance, wholesale trade and business services and retail merchandizing rely fairly heavily on computers. There has been rapid growth of networking and, by June 1989, 15 per cent of the 40.1 million personal computers (PCs) in United States' businesses had been networked. By 1992, such networking should extend to 41 per cent of the over 60 million desktop computers likely to be in use at that time. 4/ Under miscellaneous services, computer ownership is generally small, although both legal services and educational institutions have accelerated their purchases greatly over the present decade. There has also been extensive application of informatics in various sectors of manufacture, ranging from CAD-CAM and flexible manufacturing systems to use of robots. Though the United States is behind Japan in the use of robotics, the number of industrial robots being used is increasing, as may be seen from the comparative figures in Table 7.

The evidence relating to international sales and purchases of services by the United States, which is presented in Table 8, indicates that net exports in computer and data processing services from the United States are very

substantial. 5/ Sales total $629 million and purchases $61 million. Software services (excluding custom programming) account for two-thirds of the total and include prepackaged software and rights to use, reproduce, or distribute such software. These also include integrated hardware and software systems and system analysis, design, engineering, and custom programming services. The United States has a net export balance in database and other information services including business and other databases, with sales of $108 million and purchases of $28 million, which is likely to increase further with the high concentration of databases in the country. The United States also has net export balances for engineering, architecture, construction, and mining, legal services ($148 million against $56 million); management, consulting, and public relations ($379 million against $50 million); research and development, commercial testing, and laboratory services ($182 million against $127 million); and other services ($184 million against $52 million). Sales of medical services amount to $515 million, while data on purchases of such services are not available but are likely to be small. In financial services, the United States has exports of $3,731 million and imports of $2,707 million. In education, United States exports of computers and systems came to $740 million and imports were $48 million. Transactions within transnational corporations indicate a substantial net export balance for the United States, with sales of $14,988 million and purchases of $6,210 million. 6/

Apart from a favourable export balance for informatics products and services, the application of informatics to various services in the United States has been the most extensive among all countries. While financial services utilize informatics the most, usage of computers and informatics has extended to all service activities, including transportation, retail merchandizing, healthcare and education and a variety of applications in homes and offices and for sports and recreation. Operations such as electronic mail, graphics, and networking and groupware have expanded enormously during the 1980s and are likely to grow rapidly in the 1990s also.

The liberalization of trade in services has been a major objective of the U.S. Government's economic policy. While United States proposals for liberalizing trade in services conform to the general philosophy of deregulation in the United States, this is also an area of considerable comparative advantage at present. Trade liberalization in services was mandated by the Trade Act of 1974, which stated that "the term international trade includes trade in both goods and services". The efforts at liberalization are reflected in the United States initiative, supported by OECD countries, to include trade in services within the GATT framework, in the Uruguay Round negotiations.

B. Japan

During the 1980s, the technological leadership in informatics was largely shared between the United States and Japanese industry, though U.S. computer manufacturers, particularly IBM, still retained a substantial share of the global market. While Japanese computer manufacturers lagged behind the United States till the early 1970s, by 1974 Japan could produce general-purpose computers comparable with the IBM 370 models then available, and by 1978, Fujitsu and Hitachi introduced large and efficient computer systems. Almost 50 per cent of the world's robots were employed in Japan in 1979, and by 1981,

Japan's share of the world robot park had risen to 70 per cent, with Fujitsu Fanuc setting the pace for numerical-controls technology throughout the 1970s. Half of the world's ground stations for satellite communications were built by a single Japanese telecommunications equipment manufacturer during the 1970s. By the early 1980s, Japanese technology had achieved state-of-the-art technology in critical fields such as optical fibres, pulse code modulation and digital exchanges and had achieved an increasingly dominant position in the production of chips, as may be seen from Table 9.

Japan's computer companies were able to produce comparable equipment to IBM's new fourth-generation system and NEC brought out two models of the ACOS System 250 to compete with IBM Systems 38 and 4331, while Mitsubishi Electric unveiled COSMO 700 III and 700 S, claimed to be the first medium-sized general-purpose computers which can form multi-processing systems in which modular processors are connected. Fujitsu has developed a lead in 64 K bit memory applications and mounted the 64 K bit LSI on its network computers for Nippon Telegraph and Telephone Corporation (NTT), while applying high-density chips to its Model F general-purpose computers. The model F systems have considerable potential for processing Asian languages. It is reported that they can process Japanese Kenji (Chinese characters) and Kane (Japanese characters) as well as alphanumeric characters and promise to do the same with other languages such as Korean, Chinese and Thai.

In comparison with IBM's software strategy, Hitachi offers some 124 different software programmes designed for their new system of computers. Fujitsu entered into co-operative arrangements with European companies to capture a share of their market for informatics services, initially with Amdahl and later with Seconics in Spain; Siemens in Germany, and recently with ICL (U.K.).

Japan has pursued a highly deliberate strategy and well-designed policies to achieve its internationally competitive position in development and manufacture of informatics products. Government policies sought to establish the infrastructure necessary for private firms to expand, develop, and compete. Through the Ministry of International Trade and Industry (MITI), the Japanese Government actively intervened in developing a concensus on a long-term vision and projections in informatics development. 7/ At the same time, a highly dynamic and continuing initiative was taken by major Japanese corporations and groups to compete effectively in the informatics sector on a global scale.

Besides MITI, the principal government agencies dealing with informatics in Japan include the Ministry of Posts and Telecommunications (MPT), MITI's Information and Technology Promotion Agency (IPA), the Science and Technology Agency, and prior to its privatization, NTT. All these agencies have played a significant role in informatics development in Japan. During the 1970s, through a series of co-operative research and development projects, Japan's major electronics firms developed state-of-the-art semiconductor memory capabilities. Preferential loans and targeted tax incentives for production also encouraged the rapid addition of manufacturing capacity. Japanese policies played a key role in the rapid growth of the telecommunciations segment of informatics. In the communications sector, till April 1985, NTT was Japan's domestic, common-carrier communications monopoly under the administrative control of the MPT. Despite the end of its monopoly over common-carrier communications, including data transmission, NTT continues to

hold a dominant position in the field and also offers data-processing time-sharing services, licenses all communications and runs five advanced electronics R&D and systems engineering laboratories. NTT has helped to develop pilot and mass production systems for manufacture of products jointly researched and developed. With the telecommunications market closed to foreign companies, until the 1980 United States-Japan Agreement on NTT Procurement, the Japanese were able to achieve a high degree of success in telecommunications technology and applications, as in steel, automobiles and consumer electronics. Japanese success on global markets in this field also rested on the ability of Japanese producers to move rapidly to volume production with limited risk in a fast-expanding domestic market initially insulated from foreign competition. 8/

Japan's computer industry has undoubtedly achieved very impressive growth in the recent past. Many second-tier United States producers are reported to rely partly on Japanese producers to supply them with computer hardware ranging from peripherals to PCs and even to mainframes. In addition to major suppliers of computers and related equipment, such as Fujitsu, NEC, Hitachi, Toshiba, Oki, Mitsubishi, IBM (Japan) and NCR (Japan), Japanese corporations such as Matsushita, Seiko-Epsom, Sharp, Sony and Sanyo are also major producers of personal computers and computer peripheral equipment. Japan is also a major global competitor in telecommunications, particularly of microwave transmission, fiber optics, and customer-premises equipment.

While there has been spectacular growth in Japan of informatics products, the usage of informatics in the service sector has not kept pace, except with respect to financial services. While informatics usage has been extended to the entire service sector, ranging from transport and tourism, education, healthcare and social services and applications in the home, growth in usage has been much slower than in the United States, particularly in home aplications and merchandizing. For example, cellular phones which are exported by Matsushita and NEC were installed in only 56,000 cars in Japan by 1987, against 1.1 million car phones in the United States. Laptop computers, which are exported in large numbers by Toshiba, are used only to a limited extent in Japan and Toshiba exports 80 per cent of its production. Personal computers also were used only in 20 per cent of offices by 1988. 9/ However, facsimile machines are popular in Japan, though telecommuting has still only limited appeal. On the other hand, informatics applications have been extensively applied in industrial processes and the manufacturing sector.

In 1989, the United States for the first time became a net importer of computers, running a small deficit, with imports covering 30 per cent of the United States' domestic market. The computer trade balance with Japan changed from a small surplus ten years ago to a $6 billion deficit in 1988, and continues to deteriorate. According to Charles H. Ferguson, the information systems industry "is being destablized by its own technological trajectory". Digital technology is progressing at very high speed, ushering in a new era of standardized, inexpensive personal systems designed and assembled from low-cost, mass-produced components. Companies with excellent process technology, capital-intensive components production, and flexible high-volume assembly are expected to dominate the hardware value chain. 10/ With a few corporate exceptions, most United States and European manufacturers are presently lagging behind Japanese industry in rapid, integrated design and in flexible mass manufacture.

C. Germany

The former Federal Republic of Germany initially pursued a policy of nurturing national computer production and in the first EDP programme (1967 to 1970), the largest computer producer, Siemens, along with AEG Telefunken, received a large share of the funds provided by the Government through the Ministries of Economics and of Research and Technology for new product development, production, and marketing and for basic research and advanced development. Siemens, at the centre of this strategy, was allied with RCA in the 1960s. In the second EDP programme (1971-1975), significant changes were made in building up basic technological infrastructure. Besides Siemens, Nixdorf emerged as a major producer of minicomputers by the early 1980s. In recent years, Siemens has undertaken major acquisitions in the informatics sector, including takeover of Plessey (U.K.) in collaboration with General Electric PLC, and of Bendix Electronics and, most recently, of Nixdorf, when the latter ran into difficulties. Siemens is now a major producer of informatics products, ranging from telephone switches to magnetic resonance imaging equipment, and with growing sales of 1-megabit chips and computer memories. The Siemens-Nixdorf combination, supported by other Siemens acquisitions and joint ventures, is quite formidable and has given a new impetus to informatics applications in most service sectors in Germany.

Informatics applications in Germany have extended to most service branches and extensively to industrial and production operations. Apart from office automation and a variety of industrial applications, informatics is being extensively utilized in financial services, healthcare and transportation. The use of home desktop computers and of informatics in retail trade and merchandizing is, however, much less than in the United States.

D. France

Informatics in France in the early 1960s was composed of small, specialized companies serving the domestic market. Certain foreign firms, such as IBM, ITT and later Texas Instruments, also established French subsidiaries during this period. The French Government launched the Plan Calcul with the main objective of promoting selected 'national champions' that could meet international challenges. A new company, Compagnie Internationale de l'Informatique (CII), was formed through the merger of two small French firms. In 1967, a five-year agreement between the Government and CII was signed, which provided about $80 million in State aid for R&D and another $8 million in other assistance. The following year, the Government launched a similar effort to stimulate the fledgling semiconductor industry, and the company SESCOSEM was assured financial assistance for developing integrated circuits for computer applications. During the mid-1970s, the French Government permitted a joint venture of CII with Honeywell's French subsidiary, Honeywell-Bull (HB). CII-HB's product range continued CII's line and also expanded into minicomputers and office automation.

By 1978, CII-HB, with a turnover of $900 million, had a 25 per cent share of the French market in mainframes. Cumulatively, CII-HB and its parent companies accounted for 29 per cent of small, medium and large computers by number. The French performance was most impressive in software and computer services; with over 400 active firms and $450 million in 1978 sales. During

this period, IBM retained 55 per cent of the $5.2 billion domestic market in computers, with Burroughs, Control Data Corporation (CDC), Univac and NCR also taking significant shares. In minicomputers also, the three largest French firms (SEMS, CII-HB, and Intertechnique) were unable to take over the 45 per cent market share of the four leading American imports. In semiconductors, the largest French producer, Thomson, ranked far behind Philips and Siemens among European producers, with 1980 sales of $190 million. Although exports of computers and peripheral equipment rose 110 per cent in the 1976-1979 period, imports rose 80 per cent and still accounted for nearly half of the domestic market. 11/

During the 1980s, most of the major informatics companies, namely, Thomson, CGE, and Saint Gobain, came under State ownership. In addition, the Government took controlling interest in Matra and in CII-HB, reducing Honeywell's holding in the latter company from 47 per cent to 20 per cent. With over 70 per cent of the electronics industry under State control, major priority was accorded to this sector. Projects receiving special emphasis included consumer electronics, design and fabrication of large-scale integrated circuits, and development of consumer systems related to user needs in education, engineering, translation etc.

The use of informatics in France has, as in other industrialized market economies, extended to most service sectors, particularly financial services, but also in communications, transport, in education and healthcare, and in professional and industrial services, though to a lesser extent than in the United States or in Japan.

E. United Kingdom

The British computer industry tended to decline in the 1960s and led to the merger of several small firms into larger entities. This development resulted in the creation of International Computers Limited (ICL) in 1968. However, the local industry's market share continued to decline. The Government came to the industry's assistance and ICL and a government-backed semiconductor producer, INMOS, were major recipients of such assistance, which mostly went into industrial research and computer applications. ICL turned to Japanese suppliers for technology and its line of computers utilized semiconductors built by Fujitsu to ICL-supplied specifications.

Britain's Alvey programme was announced in 1982 in response to the announcement of the Fifth Generation of computers in 1981 by the United States and Japan. The Alvey Programme was designed to support long-term and collaborative basic research in four technological areas, among which are Very Large-Scale Integration (VLSI) and Computer-Aided Designs (CAD) during the period 1983-1988, with a total fund of 100 million pounds sterling.

The United Kingdom, a traditional provider of international financial services, also has important domestic banking and insurance services sectors. Developments in informatics played a key role in the development of these and other service branches in the United Kingdom. Among the EC countries, only the United Kingdom and, to a lesser extent, Germany, Ireland and the Netherlands, have been able to undertake unilateral liberalization in airlines, banking, securities, and telecommunications.

The United Kingdom is an important exporter of services and supported the United States in discussions on services in international forums. The Liberalization of Trade in Services Committee (LOTIS) has been the principal focal point of the private sector. LOTIS was formed by the British Committee on Invisible Exports (now the British Invisible Exports Council) in 1982. Since that time, its principal aim has been to press for the removal of obstacles to trade in services since this "should be in the interest of the U.K. economy and to the net advantage of the U.K. in the long term". Since many of the obstacles to trade in services are common to several service industries, the issues deserving priority attention were identified in 1982 as access to markets and right of establishment; the prevention of new restrictions in the service sector; the removal, as a first step, of restrictions to those services that are related to trade in goods; and international initiatives, on a priority basis, on transborder data flows.

It may be relevant to note that in order to strengthen Europe's technology base in informatics, regional co-operative efforts were also undertaken, such as the European Strategic Programme for Research and Development in Information Technologies (Esprit), and RACE (for Research and Development in Advanced Communication Technologies for Europe). The European Community also funds co-operative research projects in narrower information-related areas such as CAD and very large integrated circuits.

F. Brazil

Informatics in Brazil during the early 1970s grew at a very rapid pace. The number of computers of all categories installed in Brazil grew by 76 per cent between 1973 and 1974 and by 39 per cent between 1974 and 1975. However, the market was served almost entirely by imports from such TNCS as IBM, Burroughs, CII/Honeywell-Bull and Sperry UNIVAC. In order to prevent unnecessary imports and inefficient utilization of data-processing equipment by Brazilian government agencies, the Government created the Co-ordinating Commission for Data Processing Activities (CAPRE) in 1972, to co-ordinate and increase the efficient use of the informatics in the Federal Government. From 1972 until it was dissolved in 1979, CAPRE also conducted an annual survey of national computer availability and periodic surveys of Brazilian computer resources. CAPRE's successor, the Secretariat of Informatics (Secretaria Especial de Informatica - SEI), continued this activity.

The first important change in Brazil's informatics policy took place in 1975 and involved a provision that all imports of computers, parts, accessories and components required the prior authorization of CAPRE, which created the basis for reserving the micro/mini computer market and related peripherals for national firms. As Claudio Frischtak points out, "CAPRE had three basic instruments to shape the production and sale of systems, peripherals and software: import controls, market reserve and government procurement". 12/ They allowed CAPRE (and later SEI) to attract domestic manufacturers into reserved market niches by slowing import authorizations which, in combination with government procurement, created substantial demand to make domestic production by national firms financially viable. In the non-reserved areas of the market, granting and withholding import licenses, in particular, allowed CAPRE (and SEI) to establish operational goals for multinational firms, including obtaining a positive trade balance. By December 1979, CAPRE issued new criteria for the manufacture of CPUs beyond

the minicomputer range, effectively prohibiting IBM and Burroughs from producing medium-sized computers in Brazil.

Brazil recognized the strategic importance of informatics for national development and created the Special Secretariat of Informatics for, inter alia, the following functions: (a) control of imports of finished products, parts and components as well as of capital equipment; (b) control of entry and expansion of firms into various segments of the informatics market; promoting the establishment of national firms in those segments characterized by relatively less complex technology and high growth prospects; (c) control of government acquisitions of informatics products and services, with preference given to national suppliers; (d) preferential treatment to domestic suppliers of numerical control equipment, programmable controllers, systems of instrumentation, test equipment, etc. and (e) review and approval of individual applications for technology transfer contracts with foreign technology suppliers.

The new Informatics Law of October 1984, incorporating the above provisions and regulations, codified the existing regulatory structure, and established the protective measures to be time-bound. Protection from import competitition was provided for a period of eight years, during which SEI would have a prior say on imports of informatics goods and services.

The Brazilian market for computers and peripherals is of considerable size, with sales of about $1,700 million in 1984. Shipments from the national segment of the industry totalled $881 million in 1984; and included 1,082 minicomputers; 61,680 home micros; 11,218 business micros; 25,857 serial printers; 1,114 parallel printers; 10,267 video terminals; 35,273 financial terminals; 1,824 cartridge disk drives; 2,348 Winchester disk drives; 20,965 floppy disk units; 439 magnetic tape units. Large systems, on the other hand, were mostly produced and/or imported by TNCs, with the exception of Novadata, the sole national producer of mainframes. However, although Brazil is the largest market in Latin America, followed by Mexico and Argentina, it represents only 3 per cent of the United States market.

Data presented in Table 10 shows the growth in installed computer capacity of different categories of machines in Brazil during 1970-1981. Apart from high rates of growth in the aggregate number of machines, there was a relative shift from the larger and more expensive systems (classes 4-6) to smaller and more flexible equipment, which has continued during the 1980s. The number of minicomputers, in particular, grew at an annual average rate of 50.8 per cent between 1977 and 1981. The number of national firms supplying data-processing equipment progressed from 13 in 1975 to over 100 at the end of 1984. Among the national firms, a joint/national private-sector enterprise, Cobra retained, until 1983, overall sales leadership, as can be seen from the data presented in Table 11. By 1980, the state-owned data-processing companies accounted for 72 per cent of the total market ($420 million) and foreign affiliates for 10 per cent. 13/

The use of informatics in Brazil has extended to most services. Since Brazilian banks are important stockholders in the five largest national data-equipment corporations, the informatics industry has placed considerable emphasis on commercial data processing and the development of hardware for banking services.

Prior to 1979, integration of telecommunications and informatics was restricted to a few private networks established by banks, airlines and some data-processing firms. The only publicly available commercial telematics services were provided by teleprocessing networks owned by a computer manufacturer. These services were not widely used because of their high degree of specialization and cost. The Ministry of Communications introduced the first specialized network, EMBRATEL's TRANSDATA, and took up the first telematic service designed to reach the general public: VIDEOTEX.

Knowledge-based service industries have been among the most dynamic sectors in the Brazilian economy in the 1980s. However, the available data on trade in services for selected years during 1950 to 1988 showed no increasing trend during the 1980s either as a proportion of trade in goods or in relation to GDP. 14/ At the global level, Brazil's participation in trade in nonfactor services remains marginal. In 1984, for example, Brazil was ranked thirty-fourth among exporters of non factor services, with a share of 0.85 per cent of world imports. Nonetheless, international trade has always been important for Brazilian service industries such as shipping, tourism, and motion pictures. For others, such as engineering and construction services, the degree of involvement has increased significantly since the mid-1970s. Furthermore, several Brazilian companies are important actors on the international scene. In 1986, VARIG was the only developing country carrier to rank among the top 15 international air freight carriers, as classified by metric ton-kilometers logged. A few Brazilian construction firms have emerged as leading international contractors in the early 1980s.

A significant feature in Brazil has been that foreign direct investments in services have been growing at a faster pace than trade in services, as defined for balance-of-payments purposes. The overall environment for FDI in Brazil remained favourable until the early 1980s. Service industries, however, were increasingly affected by government regulations and, by the late 1970s, FDI in services, including reinvestments, accounted for only 19 per cent of the total stock of foreign capital in the Brazilian economy. The participation of foreign capital in financial services has increased faster than in most other service subsectors.

G. Mexico

Mexico is the second largest producer and consumer of computers in Latin America. In 1985, the Mexican market for computers was nearly $45 million. Although the country has used data processing equipment since the 1960s, and has produced electronic components and telecommunications equipment since the 1970s, Mexico imported essentially all its computers until 1981. That same year, the Government issued a sectoral decree on the manufacture and trade of computers and peripherals, and the implementation of the policy began in 1983. 15/

Since 1982, the first year of local production of computers in Mexico, the market for microcomputers and minicomputers has grown rapidly and local production of computers has increased to supplying about 30 per cent of market needs. In 1981, only one company was authorized to produce microcomputers, and by 1984, this number rose to 12. In 1984, there were about 20 companies authorized to produce minicomputers, including IBM, Hewlett-Packard, NCR, Burroughs and Digital. According to Mexican Department of Commerce data, in

1985, 70 companies were authorized to produce computers and peripherals in Mexico and 100 could produce software. It is estimated that, between 1984 and 1988, software sales increased at an average annual rate of 26 per cent, whereas hardware sales grew 17 per cent a year. Purchases of computer software in Mexico were estimated at approximately $135 million by 1987. 16/

Several Mexican firms are developing competence in software designed in Spanish for the Mexican and United States markets. Both markets represent $42 million and could be expanded rapidly by adding other Spanish-speaking countries. Another area in which Mexico could have a comparative advantage is in data processing, a field in which it could compete successfully in the United States market.

Mexico exports computers to Canada and Latin America, with the exception of Brazil, Argentina and Colombia, which have protected informatics sectors. The Mexican Government has forbidden the importation of finished minis and micros to Mexico, thus affording Mexican producers of computers a high degree of protection. Although the Foreign Investment Law forbids greater than 49 per cent foreign equity participation, significant exceptions have been made to this law. For instance, Hewlett-Packard produces its 3000 series minicomputer in Guadalajara as a wholly-owned subsidiary, and IBM produces minicomputers in Mexico on a similar basis. However, Hewlett-Packard, Apple and Commodore all adhere to the 51-49 rule for the production of microcomputers.

There has been considerable increase in informatics usage in Mexico in recent years, particularly in services, such as banking and insurance, and transport and tourism. Numerically-controlled machine tools are also increasingly being utilized, though the number of such machines is considerably lower than in Brazil or Argentina.

H. India

The development of informatics and its role in services is a recent phenomenon in India. The Government of India established the Electronics Commission in 1970 to lay down policy guidelines for the entire field of electronics, to plan a positive and balanced growth of the electronics industry, and to promote self-reliance. Till then, the market for computers in India was dominated by two companies, IBM and ICL (U.K.), with a market share of 65 per cent and 25 per cent, respectively.

In computers, the Electronics Commission decided in the early 1970s that the import of second-hand obsolete equipment by multinationals would be discontinued and that a viable programme of production of computer hardware and software would be initiated. As a consequence of this policy, indigenous computer manufacturing activities grew substantially during the 1970s. The State-owned Electronics Corporation of India (ECIL) started manufacturing the first TDC 12 (second generation computer) and then the TDC 316 (third generation computer with a 16-bit word size), and subsequently, the 32-bit TDC 332, with overall system performance comparable to an IBM 370/145. Presently, ECIL computers constitute one-fifth of the country's total computer population.

By 1983, 42 companies were manufacturing computer systems including microprocessor-based systems. Between 1973 and 1983, the annual production of

computers and allied equipment increased from Rs.220 million to Rs.3,290 million. Large systems were, and continue to be, imported mainly from the United States (Burroughs, DEC, UNIVAC, CDC). The National Centre for Software Development and Computing Techniques (NCSDCT) was established in Bombay in 1975 for catalyzing development of sophisticated software. The National Informatics Centre (NIC) in Delhi was established in 1979, with the main CDC Cyber-171 computer system. This Centre serves as a centralized facility and has developed methodologies for designing and implementing national information sytems in government and associated agencies.

Most software is now developed indigenously, and a substantial amount is also exported to the United States, USSR, Western Europe, Middle East countries and to Australia, New Zealand, and Singapore.

The Computer Maintenance Corporation (CMC) was established in 1976 as a State-owned unit to undertake maintenance of all imported computer systems in India. Currently, CMC maintains almost 400 computer systems consisting of 100 models and 20 makes.

India's informatics industry has expanded substantially during the last two decades. The pace of growth in office information systems, telecommunication technology and consumer electronics has been about 25 per cent per year in the early 1980s. During the Seventh Plan (1985-1990), this growth rate was expected to step up to 35 per cent per year. In monetary terms, the production of electronics has increased from Rs.20,810 million in 1984-1985 to Rs.92,100 million in 1989-1990. This increase in production is also reflected in the country's exports. Electronics exports have grown at a cumulative annual rate of 40 per cent during the period 1985-1990, compared to 27 per cent achieved during 1980-1985. Exports of software are estimated to have increased from Rs.300 million in 1985-1986 to Rs.1,750 million in 1989-1990. 17/

The production of computer systems and peripherals rose to Rs.7,000 million in 1989 from that of Rs.4,360 million in 1988. At present, there are 85 units manufacturing computers and minicomputers and microprocessor-based systems in the country. The wide manufacturing base consists of micro, mini, supermini, and mainframecomputer systems including engineering workstations. Technology has also been developed for an operation and maintenance centre for the E 10 B exchange, small-sized PABX and telephone instruments. The data communication industry is posed for rapid growth as non-voice communication usage has shown steady progress over the last few years. Various network efforts (NICNET, INDONET, ERNET) and others have been spreading their applications, ranging from database access, MIS and electronic mail to distributed information management. As many as 400 organizations are presently engaged in software activities including 150 software exporters. Three software technology parks are being set up to cater to the requirements of software development units for 100 per cent exports. 18/

Trends in services in the Indian economy, however, indicate that applications of informatics have tended to be slow. In the nationalized banking and insurance subsectors, only limited efforts were made to extend informatics to improve services offered by the nationalized banks and the Life Insurance Corporation of India. The issue of liberalization of trade in services in a multilateral framework such as GATT is also viewed with caution, and even concern, by policy-makers in India.

I. Republic of Korea

During the 1980s, the Republic of Korea achieved very rapid developments in the informatics sector. The development of 64K DRAMs by Samsung Semiconductor and Telecommunications, a subsidiary of one of Korea's four major conglomerates, was achieved indigenously with the only exception of the mask design provided by Micron Technology, Inc. of the United States. Samsung, which also developed 256K DRAMs for the first time in Korea, started to market the chips in May 1985. The other three conglomerates in Korea (Hyundai, Goldstar, Daewoo) are equally poised to develop and market 16K SRAMs, electronically erasable programmable memory (EEPROM) chips, microprocessors, and other memory chips. Data presented in Table 12 shows the trends and developments in informatics in the Republic of Korea.

Informatics in the Republic of Korea is a relatively new development. Hardware earlier used were large-frame computers used primarily for statistical compilation by non-private organizations. It was only in the late 1970s that private business began to utilize medium- and small-frame computers, which were imported. From a total of only $200,000 worth of computer hardware in 1979, the industry experienced explosive growth in the production and export of both computers and peripherals and, by 1984, total output rose to $428 million, as shown in Table 12. Exports which began only in 1980 with $6 million increased to $285 million in 1984. Total output of computers and peripherals increased at an annual rate of 363.6 per cent during the five years between 1980 and 1984. 19/ Another indication of the growing importance of domestic production of informatics in the Republic of Korea is the fact that domestic sales have been growing much faster than imports and domestic output has increasingly to meet the fast-growing domestic informatics market.

The broad development plan for informatics development has been supported by special legislation covering the electronics industry. The Electronics Industry Promotion Law, first enacted in 1969, was revised in 1981. The legislation provided the basis for government assistance by creating a promotion fund, creation of industrial estates, and for the establishment of the Electronics Industries Association of Korea (EIAK) to stimulate domestic production and promote exports. Korea has actively promoted foreign direct investment by providing special tax and other incentives. Under the "Regulations Concerning the Imports and Utilization of Computers" issued on 24 May 1982, various specific government regulations protecting the domestic personal computer industry came into effect from August 1983. These regulations sought to promote the indigenization of minicomputers, microcomputers and personal computers as well as such peripherals as magnetic disks and tapes (including floppy disks), terminals and printers.

The need for foreign capital and technology in informatics was recognized in the Republic of Korea and a number of electronic firms are either foreign affiliates or joint ventures, though non-affiliate licensing is becoming more popular in recent years. Government policies that have been crucial for the rapid development of informatics include the five year economic plans, trade barriers, subsidies, special tax concessions, substantial R&D expenditure, educational and manpower policies, and foreign capital and technology inducement policies. In the Fifth Five-Year Plan (1982-1986), the electronics industry was designated as one of the country's ten major strategic industries, with the principal targets being to increase value-added and the

international competitiveness of home electronic appliances; developing and achieving self-sufficiency in the production of industrial electronic equipment, and domestic development of the principal electronics parts. These goals were translated specifically into promotion of production of such electronics products as computers and terminals and other peripherals, wire communication equipment and electronic measuring instruments, VCRs, audio equipment, and colour TVs in consumer electronics; and semiconductors, speakers, lead frames, switches and connectors, and other components, mechanisms, cartridges, etc.

Together with extraordinary growth in production and exports of informatics products, there has been considerable increase in informatics usage in the service sector, particularly financial services and transportation and in industrial and office automation in the Republic of Korea.

J. Philippines

There has been considerable growth of the informatics sector in the Philippines and computers and telecommunications are well-developed branches and extensively utilized. The importance of the service sector in the Philippines can be judged by the fact that the share of services in GDP in 1960 was 46 per cent. However, by 1986, the share of services in GDP apparently declined to 42 per cent, although the service sector is still the dominant sector, compared with 26 per cent share of agriculture and 25 per cent share of manufacturing and 7 per cent share of other industries including mining, utilities and construction. 20/ Another study of the service sector in the ASEAN (Association of South-East Asian Nations) region found that wholesale and retail trade, restaurants and hotels were the major service activities in the Philippines (with a share of 15 per cent of GDP in 1975, rising to 19.4 per cent of GDP in 1984), followed by finance, real estate and business services (with a share of 9.2 per cent of GDP in 1975 and 8.5 per cent of GDP in 1984). Transport and communication services accounted for a share of 4.2 per cent of GDP in 1975 and 6.2 per cent of GDP in 1984. According to available data from national sources, the service sector in the Philippines accounted for 27.4 per cent of the FDI during the period 1971-1985. 21/ The major share of foreign direct investments in this sector (64.5 per cent) was accounted for by the financial and business services.

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Table 3.

Electronics production in the United States, Japan and Western Europe, 1980 and 1985

(Millions of US dollars)

Item	United States		Japan		Western Europe	
	1980	1985	1980	1985	1980	1985
Consumer electronics	6 066	5 970	18 704	32 652	13 338	10 399
Computers and components	51 700	85 500	24 447	62 804	26 397	33 100
Factory automation	13 619	20 570	3 430	5 195	10 331	9 885
Communications and telecommunications	25 983	43 780	91 209	19 937	24 100	23 600
Automobile electronics	3 630	5 520	2 942	4 656	5 284	4 557
Medical electronics	2 709	5 130	931	1 269	2 922	3 086
TOTAL	103 826	167 450	59 653	126 413	82 450	84 720

Source: Organisation for Economic Co-operation and Development, based on national statistics.

Table 4.

America's Information Technology Capital (billions of constant 1982 dollars)

Business Sector	1950s	1960s	1970s	1985
ALL INDUSTRIES	28 8	61 5	142 7	423 6
Goods producing	4 7	6 4	17 2	66 7
Services providing	24 1	55 1	125 5	356 9
Transportation	1 0	1 2	1 5	3 1
Rail	0 4	0 6	0 8	0 6
Nonrail	0 5	0 6	0 7	2 4
Air	0 1	0 1	0 1	1 2
Trucking	0 1	0 1	0 0	0 2
Other	0 4	0 4	0 5	1 0
Communications	10 5	30 6	73 4	159 7
Telephone and telegraph	10 4	29 9	71 3	154 4
Broadcasting	0 2	0 7	2 1	5 3
Public utilities	0 8	1 4	3 9	13 4
Electric	0 6	1 1	3 4	11 0
Gas and other	0 2	0 3	0 5	2 5
Total trade	0 5	1 1	5 7	41 1
Wholesale trade	0.3	0.7	4 0	33 9
Retail trade	0.2	0.4	1 6	7 2
Finance, insurance, and real estate	8 1	13 7	24 6	90 3
Finance and insurance	0 8	1 3	4 2	46 4
Banks (including Federal Reserve)	0 2	0 4	1 6	20.5
Credit agencies	0.1	0.3	1.1	15 6
Securities brokers	0 0	0 0	0 1	0.9
Insurance carriers	0.2	0 2	0 7	6.1
Insurance agents	0.2	0.3	0.3	1.0
Investment holding companies	0.1	0 1	0.4	2.3
Real estate	7 3	12.4	20.4	44 0
Services	3 1	7 1	16.4	49.3
Hotels and lodging	0 0	0 0	0.1	0.9
Personal	0 1	0 8	1 6	1.5
Business	0 3	1 2	4 3	22.3
Auto repair	0.1	0 1	0.1	0.8
Miscellaneous repair	0 0	0 0	0 0	0.2
Motion pictures	0.1	0.4	1.4	2.4
Amusement and recreation	0.4	1 1	1.9	3.8
Health	1 2	2.4	5.4	13.7
Legal	0.0	0.1	0.1	0.7
Educational	0.1	0.1	0 2	0.7
Other	0.7	1 0	1.3	2.1

NOTE: Figures are averages over designated intervals and are Morgan Stanley estimates derived from the Industry-Commodity Capital Stock Matrix of the U.S. Department of Commerce.

Source: Technology in Services - Policies for Growth, Trade and Employment, National Academy Press, Washington, D.C., 1988.

Table 5.

Industry Shares of Information Technology Capital (USA)

Business Sector	Percentage				Change: 1985 vs. 1970s	
	1950s	1960s	1970s	1985	Percentage Points	Ratio[a]
ALL INDUSTRIES	100.0	100.0	100.0	100.0	0.0	1.0
Goods producing	17.1	10.6	11.4	15.8	4.3	1.4
Services providing	82.9	89.4	88.6	84.2	-4.3	1.0
Transportation	3.6	2.0	1.1	0.7	-0.4	0.7
Rail	1.6	1.0	0.6	0.1	-0.5	0.2
Nonrail	2.0	1.0	0.5	0.6	0.1	1.1
Air	0.3	0.2	0.1	0.3	0.2	3.3
Trucking	0.3	0.2	0.0	0.0	0.0	1.7
Other	1.4	0.7	0.4	0.2	-0.1	0.6
Communications	36.1	48.8	52.0	37.7	-14.3	0.7
Telephone and telegraph	35.5	47.8	50.5	36.5	-14.0	0.7
Broadcasting	0.6	1.1	1.5	1.2	-0.3	0.8
Public utilities	3.0	2.2	2.7	3.2	0.5	1.2
Electric	2.2	1.7	2.3	2.6	0.3	1.1
Gas and other	0.9	0.5	0.3	0.6	0.2	1.7
Total trade	1.8	1.8	3.7	9.7	6.0	2.6
Wholesale trade	1.1	1.1	2.6	8.0	5.4	3.1
Retail trade	0.8	0.7	1.1	1.7	0.6	1.5
Finance, insurance, and real estate	27.8	23.0	17.5	21.3	3.8	1.2
Finance and insurance	2.7	2.3	2.7	10.9	8.2	4.0
Banks (including Federal Reserve)	0.6	0.6	1.0	4.8	3.8	4.8
Credit agencies	0.5	0.5	0.7	3.7	3.0	5.5
Securities brokers	0.1	0.1	0.1	0.2	0.1	2.1
Insurance carriers	0.6	0.4	0.5	1.4	1.0	3.1
Insurance agents	0.6	0.5	0.2	0.2	0.0	1.2
Investment holding companies	0.4	0.2	0.3	0.5	0.3	1.8
Real estate	25.1	20.7	14.8	10.4	-4.4	0.7
Services	10.5	11.6	11.7	11.6	0.0	1.0
Hotels and lodging	0.0	0.0	0.0	0.2	0.2	5.9
Personal	0.5	1.2	1.2	0.4	-0.8	0.3
Business	1.1	1.9	3.0	5.3	2.2	1.7
Auto repair	0.2	0.1	0.0	0.2	0.1	4.5
Miscellaneous repair	0.0	0.0	0.0	0.0	0.0	2.6
Motion pictures	0.5	0.6	1.0	0.6	-0.4	0.6
Amusement and recreation	1.4	1.8	1.4	0.9	-0.5	0.7
Health	4.1	3.9	3.8	3.2	-0.6	0.8
Legal	0.1	0.1	0.1	0.2	0.1	1.6
Educational	0.3	0.2	0.1	0.2	0.1	1.7
Other	2.3	1.7	0.9	0.5	-0.4	0.6

[a] 1985/1970s average.

NOTE: Figures are averages over designated intervals and are Morgan Stanley estimates derived from the Industry-Commodity Capital Stock Matrix of the U.S. Department of Commerce.

Source: Technology in Services - Policies for Growth, Trade and Employment, National Academy Press, Washington,D.C., 1988.

Table 6.

Information Technology Capital as a Share of Each Industry's Overall Capital Stock

Business Sector	Percentage				Change 1985 vs 1970s	
	1950s	1960s	1970s	1985	Percentage Points	Ratio[a]
ALL INDUSTRIES	2.5	3.7	5.8	12.5	6.7	2.2
Goods producing	1.1	1.1	2.0	6.1	4.1	3.0
Services providing	3.3	5.2	7.7	15.5	7.8	2.0
Transportation	0.4	0.5	0.6	1.1	0.5	1.9
Rail	0.2	0.5	0.7	0.6	-0.1	0.9
Nonrail	0.8	0.7	0.5	1.4	0.9	2.8
Air	1.5	0.7	0.4	3.0	2.5	7.3
Trucking	0.5	0.5	0.1	0.4	0.3	3.7
Other	0.8	0.8	0.8	1.3	0.5	1.7
Communications	20.0	30.6	40.8	53.4	12.6	1.3
Telephone and telegraph	20.8	31.9	42.1	54.5	12.5	1.3
Broadcasting	5.7	10.6	19.9	32.9	13.0	1.7
Public utilities	0.5	0.6	1.1	3.1	2.1	2.9
Electric	0.5	0.6	1.2	3.2	2.0	2.6
Gas and other	0.5	0.4	0.6	2.8	2.3	5.0
Total trade	0.7	0.9	2.5	11.1	8.7	4.5
Wholesale trade	1.6	1.8	4.9	22.5	17.6	4.6
Retail trade	0.4	0.5	1.1	3.3	2.1	2.9
Finance, insurance, and real estate	6.1	5.7	6.0	14.4	8.5	2.4
Finance and insurance	4.1	3.5	4.7	27.3	22.7	5.9
Banks (including Federal Reserve)	1.7	1.9	3.9	26.3	22.4	6.7
Credit agencies	3.1	3.1	3.3	25.0	21.7	7.6
Securities brokers	2.6	3.9	8.3	31.6	23.3	3.8
Insurance carriers	6.0	4.4	7.2	38.0	30.8	5.3
Insurance agents	17.9	15.6	12.0	32.7	20.8	2.7
Investment holding companies	14.2	8.0	10.2	31.2	21.0	3.1
Real estate	6.4	6.1	6.3	9.7	3.4	1.5
Services	5.8	6.5	8.3	16.1	7.9	2.0
Hotels and lodging	0.1	0.1	0.1	1.7	1.6	11.5
Personal	2.7	9.3	13.6	11.5	-2.1	0.8
Business	3.1	7.9	10.9	28.4	17.5	2.6
Auto repair	0.6	0.5	0.2	1.5	1.3	7.6
Miscellaneous repair	0.5	0.4	0.5	2.7	2.2	5.3
Motion pictures	8.3	15.0	31.5	42.2	10.6	1.3
Amusement and recreation	5.3	9.7	12.3	19.7	7.4	1.6
Health	21.2	16.0	19.2	29.5	10.3	1.5
Legal	1.9	2.9	4.0	13.3	9.3	3.3
Educational	10.0	9.5	12.2	46.8	34.6	3.8
Other	19.0	10.0	6.6	10.5	3.9	1.6

[a] 1985/1970s average.

NOTE: Figures are averages over designated intervals and are Morgan Stanley estimates derived from the Industry-Commodity Capital Stock Matrix of the U.S. Department of Commerce.

Source: Technology in Services - Policies for Growth, Trade and Employment, National Academy Press, Washington, D.C., 1988.

Table 7.

Use of industrial robots, 1974-1986

Year	Japan	Europe		United States
		Total	Federal Republic of Germany	
1974	1 500	800		
1978	3 000	2 000		
1980	5 500	4 000	1 255	4 500
1981	8 500	6 000	2 300	6 000
1982	12 000	9 000	3 500	7 000
1983	30 000	13 700	4 800	8 000
1984	44 000	20 500	6 600	13 000
1985	65 000	30 000	8 800	20 000
1986	90 000	40 000 a/	12 400	26 000

Source: Reproduced from D. Kimbel "Information technology in OECD countries", OECD Reporter (October 1987).

a/ Including 3,000 robots installed in Eastern Europe.

Table 8. United States international sales and purchases of services, 1987

(Millions of U.S. dollars)

Services trade	Sales	Purchases
With unaffiliated foreigners	66,482	66,256
Passenger fares	6,882	7,423
Other tansport	16,989	18,164
Freight	4,700	10,999
Port services	11,575	6,360
Other	714	805
Insurance	2,285	3,168
Primary insurance, net	1,596	552
Reinsurance, net	689	2,616
Travel	23,505	29,215
Royalties and license fees	2,171	522
Business, professional, and technical services	4,270	1,425
Accounting, auditing, and bookkeeping	27	37
Advertising	108	140
Computer and data processing	629	61
Database and other information services	138	28
Engineering, architectural, construction, and mining, net	936	368
Installation, maintenance and repair of equipment	1,023	506
Legal services	148	56
Management, consulting, and public relations	379	50
Medical services	516	n.a.
Research and development, commercial testing and laboratory services	182	127
Other	184	52
Telecommunications	2,105	3,701
Financial services	3,731	2,077
Education	3,804	513
Film rentals	740	48
With affiliated foreigners	14,988	6,210
With foreign parents	2,923	3,150
Royalties and license fees	240	1,083
Other services	2,683	2,067
With foreign affilaites	12,065	3,060
Royalties and license fees	7,049	150
Other services	5,016	2,910
Total	81,470	72,466

Source: The Uruguay Round: Services in the World Economy, edited by Patrick A. Messerlin and Karl P. Sauvant, The World Bank and UNCTC, Washington and New York, 1990.

Table 9.

The world's biggest chipmakers , 1987

(in million dollars)

	Company	Semiconductor sales	Total sales
1.	NEC	3,240	19,665
2.	IBM	3,100	54,217
3.	Toshiba	2,980	26,027
4.	Hitachi	2,560	34,919
5.	Motorola	2,380	6,707
6.	Texas Instruments	2,150	5,595
7.	National Semiconductors	1,725	1,868
8.	Philips	1,550	26,021
9.	Fujitsu	1,450	14,965
10.	Matsushita	1,435	34,051
11.	Intel	1,350	1,907
12.	Mitsubishi	1,185	15,543
13.	Sharp	1,065	8,314
14.	AT&T	1,000	33,598
15.	AMD	997	997

Source: Fortune, June 20, 1988.

Table 10.

Growth rates of numbers of computers installed, by class, 1973-1980
(Brazil)
(Percentage)

Year	Growth rate				
	Class 1	Class 2	Class 3	Other classes	Average
1973/74	158	326	22	23	76
1974/75	42	114	36	17	39
1975/76	46	53	26	8	36
1976/77	23	34	-1	9	16
1977/78	12	84	6	13	15
1978/79	12	55	8	11	15
1979/80	-17	63	13	13	10

Source: "Computadores - Evolução do Parque Instalado no período 1970-1980", Special Secretariat of Informatics, Boletim Informativo, No. 5 (August/September/October 1981), p. 12.

Table 11.

Gross Sales of the Largest National Firms 1979-83 (Ranking and Proportionate Shares)
(Brazil)

Rank	Firm	1979	1980	1981	1982	1983
1	Cobra	58.8	30.4	27.7	22.3	16.6
2	Sid	16.1	13.3	6.3	7.3	12.1
3	Labo	3.8	10.8	8.3	8.4	6.8
4	Prologica	1.8	1.6	1.9	6.0	6.5
5	Digirede	-	-	1.5	4.3	4.4
6	Sisco	0.5	3.9	4.9	4.2	4.2
7	Itautec	-	-	1.2	0.4	4.1
8	Scopus	4.2	5.2	5.4	5.0	4.0
9	Elebra Informatica	0.4	3.0	5.8	7.1	3.9
10	Racimec	-	-	3.2	3.3	3.2

Source: SEI, Panorama da Industria Nacional (1984), p. 23.

Table 12. Production, exports and domestic sales of informatics industry: a breakdown, 1983-1984
Republic of Korea

	1983			1984			Growth rate (19884/1983)		
	Production	Exports	Domestic	Production	Exports	Domestic	Production	Exports	Domestic
	(Thousands of U.S. dollars)			(Thousands of U.S. dollars)			(Percentage)		
I. Hardware	207,247	120,249	66,833	427,496	285,224	105,154	106.3	137.2	57.3
Percentage of total	99.1	99.3	98.7	99.7	99.9	98.9			
a) CPU	72,888	35,727	32,992	149,707	84,255	52,201	105.4	135.8	58.2
Percentage of total hardware	35.2	29.7	49.4	35.0	29.5	49.6			
Analogue machines				380	-	374			
Medium-size computers				158	-	79			
Minicomputers	8,148	145	8,294	11,896	-	12,034	46.0		45.7
Microcomputers	20,409	16,332	-	26,826	16,554	6,969	31.4	1.4	
Personal computers	38,564	18,789	19,430	108,333	65,548	32,547	180.9	248.9	67.5
Word processors	5,767	461	5,268	2,652	2,153	601	-54.0	367.0	-88.6
b) Peripherals	134,359	84,522	33,841	277,789	200,969	52,953	106.8	137.8	56.5
Percentage of total hardware	64.8	70.3	50.6	65.0	70.5	50.4			
Auxiliary storage units	4,892	-	3,880	7,983	1,907	6,000	63.2		54.6
Printers	12,959	-	9,033	15,058	124	15,252	16.2		68.8
Terminals	112,980	84,521	18,072	248,651	198,077	27,141	120.1	134.4	50.2
Controllers, modems	3,528	1	2,856	6,097	861	4,560	72.8	86000.0	59.7
II. Software	1,862	830	891	1,463	266	1,215	-21.4	-68.0	36.4
Percentage of total	0.9	0.7	1.3	0.3	0.1	1.1			
III. Total informatics	209,109	121,079	67,724	428,959	285,490	106,369	105.1	135.8	57.1

Source: EIAK, Statistics of Electronic and Electric Industries (1984), February, 1985.

SECTION III

TRENDS IN DEVELOPMENT AND APPLICATION OF INFORMATICS IN MAJOR SERVICE SUBSECTORS

A. Developments in computers and telecommunications

Any comparative assessment of trends and experience in informatics applications in service subsectors and in different countries must necessarily be viewed in the context of development of computers and communications, particularly telecommunications, in various country situations. Innovative processing and transmission facilities constitute the two critical elements in informatics development and application. The informatics sector comprises a wide range of technologies, processes and products, extending from hardware, components, software and systems to a wide range of technological applications in the service sector. The miniaturization of electronic components and applications of digital technologies has resulted in substantial price reductions for products such as microcomputers, peripherals and other hardware and enabled extensive usage in various services. The convergence in developments and applications between computers and telecommunications has resulted in integration in these two fields and, in place of a high degree of segmentation about 15 years earlier, there are now powerful microcircuits, which serve as systems in themselves, together with specific operational systems, such as private-branch switching.

At the same time, it must be emphasized that informatics applications in several services can be extended to a substantial extent, without a high degree of local technological development in computers or telecommunications equipment. The basic hardware has, of course, to be acquireo and must be capable of efficient utilization but the software and systems can, and are being, acquired or developed in a number of countries.

Perhaps no other branch of electronics has grown so rapidly in recent years as computers. The volume of information shared and retrieved is now so large that information systems have become indispensable. Apart from the hardware comprising the central processing unit (CPU) and peripherals, software packages have become of vital importance to extending and expanding the application of computers in a wide variety of situations, including in most service subsectors and for a variety of functions and operations, ranging from simple reservations for hotels or airlines to complex computations in financial and other services.

Computers are generally categorized under mainframe computers (including supercomputers), minicomputers and microcomputers. Microcomputers constitute the fastest growth area in computers and the demand for microcomputers is expected to exceed $25 billion by 1989-1990, with the market for minicomputers being around $28 billion. Storage capabilities are being raised to 100 million bits per square inch, using tiny magnetic devices called Josephson junctions. The micro field is dominated by personal computers using 8 and 16 bits, together with small business computers with more bits and storage capability.

The production of mainframe computers and supercomputers and related systems remains largely confined to major corporations in the United States, such as IBM with respect to mainframe computers, Japan where integrated manufacturers such as Fujitsu and Hitachi have expanded their share in global markets, and in Western Europe, where Siemens is playing an increasingly important role. With nearly 50 per cent of the global market, IBM continues, however, to be the major manufacturer of mainframes. With respect to minicomputers, several manufacturers have emerged, particularly in the United States and Japan. It is, however, in microcomputers that growth of production and usage has been the most explosive and is likely to continue to be so, during the 1990s. While steady growth of the mainframe market is likely in the United States, Japan and Western Europe for performance of complex computing functions, the pace of growth of mini- and microcomputers is expected to be much greater, particularly for various services where computer applications are being rapidly extended to factories, retail merchandizing and households. In the United States, about 28 milion workers have personal computers on their desks, while another 8.2 million personal computers (PCs) are used in schoolrooms. As against 24 per cent of the 93 million households in the United States which have computers, the percentage of households owning home computers is still only 3 per cent in industrialized West European countries. 2/

There has been considerable growth in computer usage in a number of developing countries, together with production facilities for micro and minicomputers in some of these countries. The experiences and trends in certain developing countries have been discussed in the previous section. A broad classification can be made of developing countries in terms of usage and application of computers and development of computer production and technological capability. The first group comprises certain countries in South-East Asia, in particular the Republic of Korea, Hong Kong, Singapore and the Taiwan Province of China and, to a lesser extent, Malaysia, the Philippines and Thailand. These countries, which have had considerable initial inflow of foreign direct investment and technology, mainly in offshore electronics assembly and production of components, have developed considerable capability in usage and production of computers and related systems. The Republic of Korea and the Taiwan Province of China have, in particular, emerged as major exporters of microcomputers, peripheral equipment and components. The second group comprises some of the larger developing countries, including Argentina, Brazil, China, India, and Mexico, in which there has also been considerable increase in usage of computers and other electronic equipment and varying levels of growth in indigenous electronics production. Among these countries, the development of micro-electronics and informatics has been the highest in Brazil. In some countries, particularly India, special emphasis has been given to software development, especially for exports. Local production has been established in these countries for assembly of personal computers and peripheral equipment and for manufacture of various components. The overall pace of development in computer production and applications has, however, been relatively slow, except in Brazil. The third group comprises several middle-size developing countries in Latin America, Asia and North Africa, including oil-producing countries. The level of technological developemnt differs from country to country, but there has been rapid increase in usage of computers. The fourth group comprises a large

number of developing countries, including several African countries and island economies, in which there has been relatively little development of computer production, though usage has increased in recent years.

The above classification is, by its nature, only indicative. The range and extent of new applications has undoubtedly become fairly broad, though very far behind the usage in industrialized market economies. Apart from increased computer usage in offices, informatics is increasingly being utilized in finance, banking and financial operations, tourism, etc. and, to some extent, in factory management and in design and manufacture of garments, footwear and some other industrial products. At the same time, it must be stressed that, with the exception of certain countries in South-East Asia, and some of the large developing countries, the growth of local production and technological capability in computer applications among developing countries is still fairly limited and there have been major resource and other constraints in usage and in development of local production of computers and related systems.

Communications

Communications includes both telecommunications and other facilities for two-way communications, including telephone, facsimile, telex, mobile radio, paging systems, etc., as well as broadcasting of both sound and video. Closed circuit and cable television systems are also expanding coverage of their services just as new techniques such as citizen band radio, cellular and mobile communications facilities and local area networks are being rapidly expanded and are increasing the capabilities of communications systems. 3/ Fibre optics, which provides a new means of transmission, and wide bank communications are increasingly being used to carry simultaneous single-voice circuits. Satellite communications technology has also developed into a powerful medium with considerable potential for flexibility, processing, switching and growth. By the mid-1980s, Intelsat IV was able to provide 25,000 circuits at a cost of $5,000 per year per circuit and the system included 12 satellites and 300 earth satellites in 125 countries. In addition, many countries, such as Canada, India, Indonesia, Japan, the Union of Soviet Socialist Republics and the United States and others, operate domestic satellite systems for communications and TV services.

New developments in communication capability such as videotex, electronic mart, teleconferencing and CATV (Community Antenna (Cable) Television) are leading to automated offices and increased home-office facilities in the United States, as also in Japan and industrialized market economies in Western Europe, where a great deal of information can be generated, processed and used for business operations and for recreation. Electronic publishing and video data are being rapidly extended in place of the conventional media of books, journals and newspapers, with customers obtaining information on demand from central data sources. Viewdata public service is now available in several industrial economies, while agricultural information sytems have been widely extended in the United States and several other countries. While transmission equipment required for these services is fairly complex, auxiliary equipment and components can be assembled and made locally.

The extension of new communication facilities has been most rapid in the United States, together with Japan and several industrialized Western European

economies. At the same time, global telecommunication facilities have been greatly expanded, with new technological systems and applications, including satellites and increased use of fibre optics. These facilities have been extended in several developing countries; international communication facilities from metropolitan areas in many of these countries are becoming comparable to those in industrialized economies Problems of maintenance and increased technological absorption regarding the facilities that have been installed may, however, pose some difficulty and may take considerable time to solve, together with production capability for manufacture of the sophisticated hardware and development of new systems that are emerging in this field.

It is estimated that global production of informatics technology systems covering computers and telecommunications, besides systems and software, will increase to $1.197 billion by 1995. This may be seen from Table 13.

B. Financial services

Finance and banking services cover a wide range of financial activities, ranging from retail banking, corporate financial services, securities-related services, underwriting operations and inter-bank services to international financial services, including import and export financing, foreign exchange trading and various other international operations. In the last two decades, there has been rapid evolution in these services, and informatics applications have contributed significantly in such developments. In industrialized countries, particularly the United States, the extension of financial services has included innovations such as securitization and the growth of financial intermediaries outside the banking system, and deregulation of national financial markets leading to new entrants and expansion of activities of financial institution. This has resulted in mixed benefits and difficulties. In the United States, where commercial banking has total assets of $3.2 trillion, nearly 8 per cent of the nation's 12,588 banks are characterized, since 1987, as problem banks. A combination of factors, including the declining value of high risk 'junk' bonds utilized in corporate mergers and leveraged buyouts and of third-world debts, together with the collapse of the United States real estate market during 1988-1990, may pose serious difficulties for a number of banks in the early 1990s. Japanese banks are now, by far, the most dominant, with 14 Japanese banks, led by Dai-chi Kangyo, being among the largest 20 banks in the world. Several European banks have expanded considerably, particularly Germany's Deutsche Bank and through merger, the Allgemeine Bank/Wederland and the Amsterdam-Rotterdam bank in the Netherlands.

Banking operations and financial services have become, and are increasingly becoming, highly globalized, with enormous growth in international financial transactions during the 1980s, which are likely to further expand after 1992, particularly in the European Community. The extent of such activities during 1982-1988 may be seen from Table 14. At the same time, such services are strongly influenced by the regulatory environment, public policy and other aspects of national economic policies.

Informatics has played a major role in facilitating banking and financial transactions. Extending from the use of computers by bank tellers and automatic machine banking facilities in most industrialized countries to

instantaneous provision of information on currency movements and transactions and simultaneous transfer of funds across national and intercontinental boundaries, new informatics applications have transformed banking and financial operations and techniques.

Electronic banking, for example, is becoming widespread and includes banking from free-standing automated teller machines (ATMs) abroad. Their number worldwide was estimated at 103,000 in 1984. In principle, various local and national ATM systems can be linked relatively easily through co-operative agreements of various banks, thus permitting international electronic funds transfer (EFT) on a routine basis. The banking services that can be provided via ATMs, either locally, nationally or via transnational computer-communication networks, now amount to a full branch service. They include bill payments, cash and cheque deposits, travellers cheque dispensing, money transfers, cheque book or statement ordering, fast-cash dispensing, immediate statements and branch inquiries. Increasingly, such services as lending to firms, consumer finance, mortgage lending, securities underwriting, currency bond trading, foreign-exchange services, brokering, custody services, cash letters, and fund collection and disbursal services are becoming available electronically.

The number of ATMs in the United States alone increased from 4,000 in 1975 to 43,300 in 1983, handling about 3 billion transactions, worth approximately $260 billion in 1983, and to 4 billion transactions in 1984. The ATMs in the United States are organized in 8 national and over 200 regional systems. The number of ATMs installed by the national systems increased from 23,090 in December 1984 to 34,000 in August 1985, an increase of 45 per cent over an eight-month period. The growth in automated teller networks in the United States may be seen from Table 15. In other industrialized market countries also, ATM networks have reached a high level of penetration. In one development in this field, banks from 17 countries in Western Euorpe decided in January 1985 to link their payment systems in order to permit customers to use a single credit card to obtain cash from bank machines virtually anywhere in Western Europe. Since then, post office banks from six Western European countries and from Japan agreed to link their cash machines. The network will accept "smart cards", a new generation of plastic cards containing a small microchip which enables more complex transactions than possible with magnetic-strip cards. Both networks may also become the basis for an international cashless shopping system; this would allow shoppers to pay with their credit cards at points of sale (POS); such as in supermarkets, with the amount being instantaneously debited to the person's home account.

The spread of personal computers further strengthens the above trend. Although home banking has progressed slower than originally predicted, it already plays an important role in France, Hong Kong and Sweden, as may be seen from Table 16.

Developments in the application of informatics have also played a significant role with respect to cash management services. With high interest rates, fluctuating exchange rates and narrow profit margins, cash management has become a crucial corporate function and many corporations have strengthened their capacities in this respect. Banks can utilize their computer-communication networks and software for cash management to service the corporations and thus relieve corporations of a major responsibility. United States banks have been leading in the provision of cash-management

services. After developing these for the domestic market, they began, in the late 1970s, to export them to Western Europe. European banks also developed their own cash-management services and tend to rely on commercial transnational value-added networks and timesharing bureaux, such as GEISCO, ADP, and UNINET.

In the development of credit and charge card services, informatics has played a significant part. With greater national mobility of card holders, there is growing demand to use a card issued in one country to make transactions in other countries. A growing number of persons also wish to utilize credit and charge cards, together with a widening range of establishments which accept them. Competition in the provision of credit and charge card services involves increasing the number of both customers and receptive establishments, encouraging greater use of the cards, and reducing the delay between the use of a card and payment. Informatics has played a key role in providing credit and charge card services with high-speed procedures for transmitting transaction information and for card verification and authorization procedures which minimize risk of fraud.

The application of informatics to banking and financial services in developing countries has extended to the use of computers and databases in several countries and the use of ATMs in some of these countries. Banking technology in relation to usage of informatics can, and is being, extended by central and commercial banks in a number of developing countries. The extension of facilities such as ATMs will of course be more gradual and will have to be related to consumer demand and requirements. The extension of credit cards, which has been greatly facilitated by developments in informatics, as well as other financial services, is likely to be introduced gradually among certain sections of the community in these countries, as is already being done in certain developing countries. As for securities databases containing instantaneous price quotations for stocks and bonds and financial databases, these can be accessed by institutions in developing countries. Such databases include International Finance Statistics, World Bank Debt Tables, Exchange Database, and several United States databases, as also from Japan and West European countries. The technological aspects of extension of informatics usage in banking and financial services in these countries cannot, however, be viewed as being of great complexity, which would pose serious difficulties for local banking institutions in developing countries. The technical processes involved are relatively simple and straightforward and can be undertaken in most developing countries once computer usage has become relatively commonplace and provided there is adequate demand for services which are considered necessary in industrialized economies.

The broader policy issue relating to financial and banking services is whether the rules of entry for foreign banks should be liberalized in developing countries. Existing protectionism in many of these countries takes the form either of exchange restrictions or restrictions on the establishment of foreign banking affiliates, including discriminating barriers to entry and discriminatory operating constraints. The issue of free trade in financial and banking services is fairly complex and raises major policy issues. Foreign banks are already operating in several developing countries at present, as may be seen from the Table 17.

Whether there should be increased liberalization or free trade in banking and financial services is beyond the scope of this study. The technological aspects of extension of informatics to this subsector do not appear, however, to pose any serious difficulty to banking and financial institutions in these countries.

Insurance

In the case of insurance and reinsurance, there is transfer of risk and insecurity from losses because of particular events. Business insurance can improve the efficiency and competitiveness of the industrial sector. Other forms of insurance can similarly provide greater security against losses due to events such as death, accident or sickness.

The size of national insurance markets, measured by premium expenditure as a percentage of GDP, ranges from less than 1 per cent in many developing countries to more than 3 per cent in some leading industrial economies. National insurance markets differ widely in their structures and competitive behaviour. State-owned insurance monopolies have existed in most centrally-planned economies and continue in a large number of developing countries. Many developing countries, after gaining political independence, have excluded foreign and foreign-owned companies from their domestic markets or permit only locally incorporated subsidiaries with substantial local shareholdings. By contrast, insurance markets in most industrialized economies contain a large number of domestic and foreign companies. In most countries, however, a relatively small number of insurers dominate the main classes of business. A number of countries, including industrialized economies such as France, Italy and the United States, prohibit residents from placing any insurance abroad with non-admitted insurers (that is, insurers not licensed to write insurance business within that country) or allow them to do so only if insurance cannot be purchased locally. Several countries insist on compulsory insurance to be purchased only from locally authorized insurers. In addition, more than 20 developing countries require imports, and in some cases exports, to be locally insured. In some cases, the exclusive right to place reinsurance is retained by a state-owned reinsurance organization.

As in the case of banking services, informatics is extensively utilized in the insurance subsector also, particularly with respect to product designs, risk evaluation, marketing and management. At the same time, informatics usage through computers and rapid transmission of information can also be extended by national insurance companies in developing countries, once the basic hardware is in position and there is need for such techniques.

The contrast between industrialized market economies and selected developing countries with respect to insurance density and penetration may be seen from Table 18. Total world insurance business by region may be seen from Table 19.

State-owned insurance monopolies exist in the centrally-planned economies, where rules of entry for foreign companies are being liberalized, and in 38 developing countries. 4/ It can be argued that the presence and participation of foreign insurance companies could significantly expand terms and conditions of insurance of various forms. Liberalization of entry should include transparency, equality of opportunity, national treatment and market

access. This does not, however, prevail even in several industrialized countries. Whether such liberalization should be extended by developing countries is a national policy issue, which would need to be assessed and determined in the context of particular country situations.

C. Developments in transportation services

Developments in transportation have to be considered under the three categories of land, sea and air transport. Technological innovations in these fields include developments in high-speed railways and long-haul road transportation, and transfer of goods by sea and air transportation.

In industrialized West European countries and in Japan, a well-developed and intricate system of rail transport has been combined with major computerized applications in signalling and operations. Technological innovations introduced in Japan, France, Germany, the United Kingdom and other industrialized European countries also include high-speed transportation of both passengers and goods. This has been combined with an extensive network of roads and long-haul transport of goods by privately-operated trucking operations where informatics and digitized innovations are also being extended. Most such transportation, except among European countries, is internal to the country, with sea and air transport largely accounting for international transport transactions. In the United States, most internal transportation is through long-haulage trucks, often operating over long distances and through various States. Rail transportation is largely on the Eastern seaboard and between major urban centres in the United States, apart from coast-to-coast transportation.

The transportation sector in developing countries varies considerably. In certain countries, such as India, Pakistan, Bangladesh and in South-East Asian countries, as also in several African countries such as Kenya and Nigeria, rail transportation is fairly well-developed and the largest proportion, by far, of passengers and goods is transported by rail. Rail services are obviously not as well-developed as in West Europe and Japan in terms of track standards or of high-speed rail transport, but are generally adequate to meet local requirements and are available at fairly reasonable cost. In several Latin American and some African countries, as also in West Asia, rail transport is available only to a limited extent and long-distance road transport is more popular. In the case of most developing countries, except those that are land-locked sea transportation is the common form of transport for imports and exports of goods. Technological innovations, such as containerized transport, have been extended to most countries and are commonly utilized. The extent of world seaborne trade by country groups in 1970 and 1987 is given in Table 20.

There may be some difficulty in interpretation of data relating to international transport transactions. 5/ Since freight charges are generally paid by importers, net payments for imports are to foreign carriers while net revenue from exports are from exporters, as transactions between local importers and exporters and local carriers are between residents of the same country. The mode of delivery may not, however, be very clear and the nationality of operators of vessels or airlines may have to be determined.

International negotiations relating to maritime transport have continued for several years. Despite the adoption of a United Nations Code for Liner Conferences in 1974, complaints about discriminatory freight rates and cargo reservations continue to persist. Various issues relating to rights to establishment, dealing with state monopolies, national treatment and transparency with respect to tax subsidies and other measures are under consideration in the Uruguay Round negotiations. 6/

In recent years, air transport has assumed increased importance, not only with respect to international passenger traffic but for transport of manufactured goods. Exports of electronic hardware, and components in particular, between-South East Asian countries and the United States, Japan and West Europe are largely transported by air. Passenger traffic by air has also increased enormously in recent years and the number of passengers flown in 1987 range to over 118 million by Aeroflot, nearly 57 million by Delta, 55 million by American, over 19 million by British Airways, nearly 15 million by PAN-AM and over 10 million by several United States, Japanese and European airlines. 7/

D. Trends and developments in international tourism

Tourism constitutes one of the fast-growing service sectors, having major impact on the balance of payments of a large number of tourist-receiving countries, both industrialized and developing economies.

According to the definition of the World Tourism Organization (WTO), international tourism receipts cover the receipts of a country resulting from consumption expenditures, that is, payments made by international visitors for goods and services for their own use or to give away but which exclude international fare receipts. In 1987, international tourism receipts amounted to $ 159 billion or one-quarter of total trade in services. 8/ Travel and tourism (including related transportation) can account for substantial portions of private service exports of a country. Keeping in mind that private service exports are not measured accurately given the deficiencies in the data, the following figures may be considered as orders of magnitude. In 1987, according to the IMF, the figures for France, the United Kingdom, the United States, India and the Republic of Korea were between 22 per cent and 27 per cent. For other countries, both industrialized and developing, the figures may be considerably higher, such as 35 per cent for Argentina, 46 per cent for Canada, 52 per cent for Thailand, 67 per cent for Jamaica and 69 per cent for Spain. According to WTO, the industrialized countries account for 66 per cent of tourist arrivals and 72 per cent of receipts and provide the base for the large majority of international tourism enterprises. However, a number of developing countries are also significant participants in international trade in tourism, particularly Mexico, Thailand, Hongkong and Singapore, which are placed among the top 20 revenue earners in 1987. 9/ In all these countries, the application of new information technologies has contributed to and facilitated the growth of tourist services.

The implications and magnitude of tourism can be assessed from the increased receipts from tourism during the 1980s, which rose from $104.4 billion in 1984 to $195 billion by 1988. 10/ The growth trend may be seen from Table 21.

The projected growth of tourism up to 1997 may be seen from the Table 22, which indicates a rise in world tourism receipts to $334 billion by 1997.

Most international tourism, nearly 83 per cent, takes place between industrialized market economies, as may be seen from Table 23.

It will be clear, from the above, that the potential for international tourism development is very substantial and can have far-reaching implications for individual economies. The principal elements in tourism-related services can be broadly categorized under hotel and restaurant services; land, water and air transport; auxiliary transport services, such as tour operators; communications; financial services, including insurance; business services; recreational, cultural and sporting facilities, and administrative services of the government concerned. Computerized and communications facilities play a vital role in most of these functions.

Hotels and restaurants for various categories of tourists are fairly plentiful in industrialized market economies. The operations of international and national hotel chains mainly based in the United States, United Kingdom, France, Japan and some other countries, are quite extensive in most of these countries and are supplemented by privately-run small hotels, boarding houses and restaurants. For developing countries, with the exception of some countries, including the Caribbean islands, suitable hotel accommodation is often lacking and can be a major constraint. Air transport limitations can also pose difficulties in several developing countries, particularly in Africa. Tour operators and travel agencies are increasing in developing countries but are still inadequate and need to be better organized, by standards in industrialized countries. Communication facilities, particularly for long-distance communications, are now increasingly available in a number of developing countries also, but can still pose problems in certain countries, such as India or China. Financial services can be time-consuming in several developing countries, though there has been some improvement in recent years. Currency restrictions can, however, be irksome in a number of developing countries and often act as a disincentive for tourism. Auxiliary services such as taxis, rent-a-car facilities and land transport arrangements can also be a significant constraint and disincentive in a number of developing countries. Business services, though available, are difficult to arrange in a number of these countries, except where international hotel chains are operating and provide such facilities. Recreational, cultural and sporting facilities are being given major emphasis, particularly in countries such as Kenya, where considerable safari facilities are available and in several Caribbean islands, where casinos and sea-sport facilities are fairly well-developed. Administrative arrangements by governments, however, including delays in issue of visas, customs formalities and other requirements can be very trying in a number of developing countries and can be major disincentives for tourism development.

While international tourism has been accorded increased emphasis in most developing countries, and has achieved considerable success in certain developing countries such as Mexico, Kenya, Singapore, Thailand, Hong Kong and the Caribbean islands, there continue to be serious gaps in the tourism-related facilities that are required and those that are available in a large number of developing countries, where there may be major potential for tourism. This may be particularly applicable in some of the large developing countries such as Brazil, China and India, and in several countries of Africa, where major tourism potential remains unexploited.

It may be emphasized that informatics facilities, including worldwide reservations and communications, are presently available in most developing countries and technological limitations cannot be cited as a significant constraint. Major investments are, however, required in luxury hotels and restaurants and in travel facilities to particular countries. Where such investments are not locally available, it may be necessary to invite hotel transnational corporations, and other international tourist-service facilities such as international airlines, automobile renting companies, tour operators etc. The fast-expanding global tourism industry is becoming increasingly competitive and internationalized and, with the new technological facilities and developments, several developing countries can substantially increase tourist revenues, with well-planned and advertised programmes for tourism development, supported by administrative and other measures designed to attract international tourists.

E. Developments in merchandizing

Informatics applications are being extensively applied in trade and merchandizing in industrial market economies, both in wholesale and retail trading operations internally and in export/import of products and commodities. In industrialized economies, computers are commonly utilized in various merchandizing operations, the nature of usage varying from accounting and inventory control to detailed assessment of various marketing and distribution features in particular products which affect consumers and sales. According to some estimates, sales increase arising from advanced marketing and sales technology can range from 10 per cent to more than 30 per cent, and investment returns have often exceeded 100 per cent. 11/ Informatics is playing a growing role in services such as (a) planning and reporting of sales, reporting of expenses, entering orders, checking inventory and order status, managing distributors, tracking leads, and managing accounts; (b) merging, updating, and maintaining mailing lists; (c) telemarketing; (d) providing automated sales management reports. It is reported that, in certain stores, sales persons use laptop PCs to access the corporate database for up-to-date inventory and order status information on thousands of stock-keeping units, resulting in substantial reduction in the company's order cycle. It also has made ordering more accurate, resulting in greater customer satisfaction and improved sales. 12/ Computer usage is even more extensively applied in food-related services, particularly in the United States, extending from assessment of demand for particular products in specific locations and supermarkets to review of changes in the demand pattern and adjusting product supplies to changing demand patterns. Apart from wholesale and retail distribution of food products, the rapid increase in franchising of food products in the United States and, to a lesser extent, in industrialized Western economies, and of franchized food outlets in these countries has been greatly facilitated by computerized operations and speedy transmission of information.

The use of informatics in trade and merchandizing is much less in developing countries, except in Brazil and in certain South-East Asian countries where computers are now being utilized in this subsector, particularly for exports and in large department stores and food supermarkets. Increased computer usage in food and product distribution and marketing has not been extended so far in most developing countries, primarily

due to overall constraints in computer availability and usage. As such availability and usage grows, informatics applications in the merchandizing subsector can also be expected to increase substantially in these countries in the next few years.

F. Healthcare and social services

As pointed out in Section II, there has been extensive application of informatics in healthcare, education and social services in industrialized market economies. This is particularly true of the United States and some West European countries where, in healthcare in particular, there has been rapid increase in informatics applications. Similar developments have taken place in West European countries and in Japan, though to a lesser extent. Informatics applications and systems presently relate both to usage of diagnostic equipment - such as bioelectric recording equipment, monitoring machines, imaging equipment, such as X-rays and ultrasound and laboratory equipment - and with sophisticated therapeutic equipment in various fields, and have increased enormously in recent years, particularly in the United States. The two Tables, 24 and 25, indicate the growing size of the healthcare market in selected industrialized market economies and the value of shipments in the United States of different categories of medical equipment during the mid-1980s.

One field of healthcare, which is of special significance for informatics, is that of digital imaging, which is growing rapidly. New imaging techniques involving informatics applications include magnetic resonance imaging (MRI), positron emission tomography (PET), ultrasonic imaging, and digital angiography. These techniques, together with integration of image sources through local-area networks, involve varying degrees of complex informatics applications. 13/ The applications of digital imaging and other medical electronics will inevitably be a gradual process in developing countries because of the high costs involved. Similarly, techniques such as nuclear magnetic resonance, which has had considerable considerable impact on medical diagnostics, will be gradually extended. The major market for imaging and diagnostic equipment will continue to be the United States, which accounts for roughly 45 per cent of the global market of about $5.5 billion, followed by Japan and West European market economies, where the pace of growth in usage has tended to be higher than in the United States in recent years. 14/

Developments in informatics have played an important part in the growth and internationalization of healthcare services. International transactions in health services take several forms, including cross-border movements of physicians, nurses, and related professionals; cross-border movement of patients or consumers, and international activities of hospital managers, consultants, and others involved in the planning, design and operation of healthcare facilities. Several large health management companies, specially United States concerns, entered the international market in the early 1970s. These companies drew on their considerable comparative advantage in technology and management expertise to deliver a variety of services ranging, from the design, construction and operation of healthcare systems to the provision of auxiliary services to individual hospitals. Such companies have established branches, subsidiaries, or joint ventures and are active primarily in Western Europe, the Americas, the Middle East, and the Pacific area.

Informatics applications in healthcare and social services are fairly limited in most developing countries at present and sophisticated equipment for diagnostics and therapeutic applications are usually available only in a few major hospitals in some of these countries. In view of cost constraints, it is likely that informatics applications in healthcare would be extended in these countries only gradually, during the 1990s. Such extension would also take place primarily in those developing countries which have the resources to import both equipment and skills, as in the oil-producing countries, or developing countries where computer usage and applications become increasingly commonplace, as in Brazil or in South-East Asian countries.

Among social services other than healthcare, the use of informatics in the education system will be of growing significance for technological absorption and adaptations in informatics during the 1990s. This is a fairly vast subject and is not specifically covered in this study. The increased usage of computers in schools is a major feature in certain industrialized economies, such as the United States. In some secondary schools in the United States, the proportion of computers to students at the secondary school stage has come down to 1:3, in addition to the emergence of libraries as media centres, offering electronic card catalogues, encyclopedia entries on compact disks and links to database services. 15/ These facilities can have significant impact on mathematics and science education and applications and for computer literacy. In some States in the United States, high school graduates are required to pass an examination on word-processing, database and spreadsheet programmes and a programming language. Software development for education has, however, made only slow progress. Teacher training in computer usage also needs to be substantially increased. In general, informatics usage up to the secondary school stage is still in the process of being integrated with the overall education system, even in the United States and, though 96 per cent of public schools in the United States have computers, a large number of students use these for only an hour a week. In Japan and West European countries, the use of computers has also been extended to the secondary school level. At the college and university levels, of course, informatics is increasingly being utilized and applied in most industrialized market economies.

The extension of informatics to the education system has made only a beginning in some developing countries, particularly in South-East Asia and in certain countries such as Brazil and India, where desktop computers are locally manufactured and have been set up in selected schools and colleges. Informatics usage is also still in its early stages in most developing countries, even at the university level, though increased facilities are being developed. In other fields of social services, including social welfare, child-care facilities, counselling services and the like, computer usage is increasing in industrialized market economies, as against very limited use and application of informatics in most developing countries. Usage in such fields is largely reflective of overall usage of computers and advanced communications systems in the economy as a whole. As long as there is a large and growing gap in such overall usage between industrialized and developing countries, the use of informatics in social services in the latter countries will remain limited.

G. Professional services

There is a growing trend towards internationalization of professional services, particularly between developed market economies. This is particularly applicable in professional services such as advertizing, accounting, legal services and management consultancy with firms in these fields gradually extending their operations in several countries. The trends in internationalization may be seen from the following tables cited in the UNCTC study on Transnational Corporations, Services and the Uruguay Round relating to operations of major international firms in advertising (Tables 26 and 27), accounting (Tables 28 and 29), and management consultancy (Table 30).

The Management Consultancies Association (MCA), United Kingdom, which groups 29 of the largest consultancy firms totalling 65 per cent of the business in the United Kingdom, has, for example, reported that its members' fee income increased by 36 per cent in 1986, amounting to 340 million ECU, and by 32 per cent in 1987 to nearly 425 million ECU, almost four times the 1981 figure of 112 million ECU. Currently, the European Federation of Management Consultants (FEACO) comprises 15 national associations representing 46 per cent of the total management consultancy market in Europe. Estimates of the number of EC consultancies range from 1,800 to 2,300, employing more than 3,300 consultants. In the United States, during the four-year period from 1982 to 1986, the management consulting revenues for the "Big 8" accounting firms more than doubled, growing from $690 million (704 million ECU) to more than $1.5 billion (1.52 billion ECU). In some EC Member States (Belgium, France and Italy), government regulations require that auditors should not render non-auditing services to their clients, and the accountants are obliged to create separate legal entities to carry out consultancy services. There is no such barrier preventing the software companies from entering the management consultancy services sector. Other professions such as banks, law firms and advertising agencies also continue to enter the consultancy sector. 16/ All these trends, comprising an expanding market, good profitability, other professions entering the market and broadening of management consultancy areas, will further encourage professional service companies to develop integrated consultancy services on an international basis.

The internationalization of professional services such as advertising, accounting, legal services and consultancy services is likely to pose important policy questions in most developing countries, where such services would have a growing substantial market. The growth of local capability in professional services is a recognized and major policy objective in several developing countries. In the case of legal services, for example, most countries have an adequate number of local professionals and it is difficult to justify import of legal expertise. In advertising and accounting, considerable internationalization has already taken place, with the extension of operations of large international advertising and accounting firms in several developing countries, though here also there may be a shift to increased use of local advertising services and auditors and accountants. In the case of consultancy services, local facilities are being increased in a number of developing countries. However, this service subsector is already fairly internationalized and foreign consultancy services are being extensively used in a number of developing countries. The possible technological benefits from extension of operations of specialized international corporations in these fields to developing countries may vary

considerably, depending on the subsector and the country involved. Such benefits, which will be facilitated through informatics applications, will need to be carefully assessed in particular country situations.

With the fast growth of the informatics sector, service functions relating to computers are also growing rapidly. Computer services are also becoming more internationalized, as may be seen from Table 31. Adequate facilities for computer services will need to be set up in developing countries also, though these may tend to be largely local, because of costs and other considerations.

H. Industrial operations and producer services

Informatics technologies are likely to have a major impact on international competitive capability in industrial production. The extent of such impact would depend on the production subsector and the effects of new technological processes in that field. These developments have brought about significant changes in comparative advantage, particularly in the reduced factor advantage of labour. The application of CAD/CAM and FMS (Flexible Manufacturing Systems) has also introduced much greater precision and dynamism in design and engineering and in production processes in most fields of manufacture. The impact of these developments needs to be viewed specifically in three critical fields, namely, (a) integrated manufacture, (b) changes in machine tool applications, and (c) developments in information and telecommunications.

Integrated manufacture 17/

Increasing competitive pressure in manufacture is now combined with the powerful range of informatics technologies which have become available during the 1970s and 1980s. The increasing use of computer-based systems greatly facilitates production management activities such as planning, scheduling and programming of production. The functional areas of manufacture, such as design or quality control are being brought closer to manufacturing, while the overall co-ordination of production is increasingly being linked to other business functions through computer-integrated manufacturing (CIM) in which all the functions of a manufacturing business are integrated with each other via a range of networks and communications software. This includes: (a) design and pre-production, which includes all the tasks necessary to identify and prepare products for manufacture, (b) production, where the information is translated into physical form, and (c) co-ordination, extending to various managerial tasks needed to support the manufacture of the product from initial design activity to sales and distribution.

As demand for increased production flexibility increases, the potential applications of such integration also become increasingly extended. This represents a major change from earlier generations of automation which were confined to larger scale and high-volume industries. The pressure now is for greater flexibility and agility. Increasing use is being made of programmable controls and flexible manufacturing sytems; CAD/CAM; and other technologies. At the same time, organizational changes are leading to smaller workforces and plants producing with greater flexibility and quality through the application of alternative management approaches such as just-in-time (JIT) manufacture

and total quality control (TQC). These changes are most evident in the engineering industry. However, in other fields, such as semiconductor production, the pressure has been growing for high quality, rapid product changes and increased variety to suit user-specific needs. This has led to growing integration in the manufacturing process.

There are, however, several factors which can serve as constraints on integrated manufacturing operations. These factors, which can be greatly accentuated in most developing countries, include (a) investment costs, (b) technological problems, (c) lack of in-house skills and resources, and (d) organizational factors. Investment costs of integrated manufacturing technology are high and may generally extend from over $1 million to several million dollars. Lack of in-house skills and resources constitute an obvious shortcoming, which would be all the more applicable in developing countries.

A number of important organizational innovations are increasingly linked with integrated production facilities. The most important of these techniques is just-in-time (JIT), which has now been adapted and is being used in a variety of sectors in industrialized countries. JIT allows for minimal batch sizes and inventories and components are delivered by suppliers at the point where they are needed just-in-time to be used. The direct benefits are clearly in the area of inventory savings, which are of growing importance because of increasing materials costs. JIT techniques enable reduction of set-up time, particularly for multi-product operations; use of multi-function workers, with a high degree of skills and flexibility; and uniform output rates, achieved by standardization in various elements of the manufacturing process.

Apart from JIT, the concept of total quality control or "zero defects manufacturing" is another system that is being applied widely in industrialized countries. Its overall aim is to entrust responsibility for quality to the shop-floor and make it a direct part of the process. The objective is to guarantee zero defects in production.

The development of computer-integrated manufacture can take alternative routes. One approach involves installing islands of automation based on advanced technology, gradually working towards linking these into an integrated factory. The alternative approach is to introduce organizational and management changes first. This implies an incremental approach based on low-risk, high-return organizational changes building up gradually to higher-risk technological changes such as CAD/CAM and CIM. Manufacturing competitiveness in future years is likely to depend considerably on the ability of firms to exploit computer integration in manufacturing technology and techniques within an integrated organization.

Computer-integrated manufacturing technology offers a powerful weapon for tackling various problems facing manufacturers. Enterprises in developing countries have to overcome significant difficulties in moving away from applications of programmable automation and towards integrated solutions. These may involve problems of high cost, lack of skills, lack of suitable technology and a supply market that is still maturing. Obviously, production enterprises with limited resources and experience should initially concentrate at the technological level on well-proven programmable automation applications, such as numerically-controlled machinery, low-cost CAD, low-cost

production management aids and basic microprocessor controls for process operations and use these to enhance flexibility, quality and productivity. Wherever possible, however, there should be a gradual shift to integrated manufacturing operations.

Changes in machine tool applications 18/

An important aspect of introducing CAD/CAM and CIM techniques arises from the major changes that have taken place and are occurring in machine tool technology. This affects not only machine tools, but also the capability to integrate machine tools with other machinery. Numerically-controlled machine tools (NCMTs) have become standard machine tools for a range of primarily metal-cutting functions such as turning (lathes), milling, drilling and boring.

The two most important NCMTs are CNC (computer-numerically- controlled) lathes and machining centres. These two types of machines account for over 60 per cent of the value of production of NCMTs in the leading OECD countries. Computer numerically controlled lathes increased from 23 per cent of the total output of lathes in 1975 to nearly 80 per cent in 1986. The same trend applies to machining centres as substitutes for conventional milling machines.

While rapid increase in NCMTs has been the main feature of the diffusion of new technology since the mid-1970s, it is the diffusion of NCMTs incorporated into systems which will dominate the future. These are flexible manufacturing modules (FMMs) and flexible manufacturing cells (FMCs), comprised of several machine tools linked by an automatic material-handling unit and controlled by a common information system. In addition, there are also larger systems, commonly called flexible manufacturing systems (FMS) which consist of several FMCs or a larger number of machine tools, with automatic material-handling facilities and a common information system.

Numerically-controlled machine tools are increasingly utilized in both the industrialized, developed economies and in some developing countries. Among the latter, the Republic of Korea is the largest single user of NCMTs, with a stock of 2,680 units in 1985, followed by Brazil and India. Among the developed countries, Japan is the largest user with 118,000 units installed by 1984. In terms of density in the use of NCMTs, the newly industrializing countries are still far behind developed countries. The leading developing country in terms of using NCMTs, the Republic of Korea, had a density of only about half the value for the United Kingdom.

The largest producers of machine tools are Japan, Germany, the Soviet Union, the United States and Italy. These countries accounted for more than 70 per cent of the global production of machine tools in 1985. Among developing countries, China ranks highest as number 10, while the Taiwan Province of China is 13th, Brazil 14th, and the Republic of Korea and India follow at 18th and 20th positions, respectively. Jointly, the developing countries accounted for not more than 6 per cent of the output of all countries. The industry is, on the whole, fairly internationalized as far as trade is concerned. Smaller countries generally have a higher export ratio than most of the larger countries. With the exception of Taiwan Province, the developing countries have low export ratios, largely because of growing internal demand. 20/

Industrial policy in developing countries could aim at removing obstacles to faster diffusion of NCMTs. As far as information is concerned, a number of developing countries, such as India, the Republic of Korea and the Taiwan Province of China, have set up national institutes which diffuse information about new machine-tool technology. As for knowledge and skills, this relates to the functioning of the vocational training system. Greater emphasis should be given to educating operators of NCMTs and to the associated programming, setting and maintenance staff. While the present diffusion of NCMTs in developing countries is far from optimal, this may be largely due to greater availability of conventional machine tools. In the Republic of Korea and the Taiwan Province of China, only 20 per cent of the production of machine tools was in the form of NCMTs in 1986. Large production capacity in conventional machine tools also exists in China, India and Brazil. Accordingly, access to conventional machine tools will probably not be a problem in these countries, even in the long term, and the issue is that of timing and extent of shift to NCMTs in the next few years.

There is considerable production of NCMTs in some more advanced developing countries, including China. The largest producers are the Taiwan Province of China with a production of 1,917 units in 1986, the Republic of Korea with 1,124 units and Brazil with a production of 710 units in 1986. India produced 193 units in 1987. To the extent that development strategy aims at integration with the world economy, government policy for the machine tool sector could aim at fostering internationally competitive firms which eventually develop as full-scale participants. Imported technology may be required to ensure that the local metalworking industry keeps up to date in production technology. The pressure to rely on imported technology, be it embodied in products or through licensing agreements, would, of course, tend to be greater the smaller the size of the local machine tool industry. To the extent that import of embodied technology is prohibited, it is necessary to ensure adequate diversity of choice for the local engineering industry, necessitating multiple foreign technology supply arrangements. The experience of India for machining centres might be illustrative here. Till the end-1970s, there was only one producer of machining centres offering only a limited range of models. In the early 1980s, consequent on considerable liberalization of industrial policy, eight Indian manufacturers obtained licensing agreements with international producers of machining centres. As a result, the diffusion of machining centres has now increased significantly.

Information processing and dissemination

Apart from the development of competitive production capability, an area where developing countries may face a growing technological gap unless remedial measures are taken is with respect to information processing and communications. Developments in informatics necessitate a review of national strategy as to the stage and level of development which particular countries should seek to achieve within a reasonable period. The digitalization trend of public information transmission networks and the integration of services have led to the development of specialized equipment for the establishment of networks and the proliferation of terminals. The increased usage and local production of such equipment has considerable potential in several developing countries, apart from the need for keeping pace with developments in communication technologies for access to international databases and information systems and networks. The widespread diffusion and application of

digital micro-electronic technology has given rise to a number of new products and services that have proved to be far superior than those based on electro-mechanical technology. 21/

The telecommunications sector in most developing countries has suffered from considerable underinvestment. In many countries, subscriber density is extremely low, ranging from a high of 40 telephones per thousand people in Latin America to only 7 per 1,000 in many African countries, with large areas often averaging less than one telephone per thousand people. Most of the services that do exist are concentrated in urban centres. Apart from inconvenience, the economic costs are substantial due to major efficiency losses. There can be little doubt that lack of access to basic telecommunications services is a major constraint for industrial development and overall economic growth.

Technological developments in telecommunications have been very widespread. Three aspects of implications that are particularly important for developing countries are: (a) lower barriers to entry in production and more sources of supply; (b) changing cost structure for other industries, including falling unit costs and the proliferation of alternative communications options, and (c) creation of new services and new ways of delivering traditional services. Traditional service industries (banking, insurance, consulting engineering, tourism, shipping etc.) are now able to offer a greater range of services, at greater speed and at lower cost through a greatly expanded international telecommunications network. A new category of data services and supplying industries has developed in fields such as data processing and software, and databases have developed to meet specific user needs. Economies of scale have emerged in the provision of access to flows of data, knowledge and services on a national and international basis.

For a number of developing countries, certain areas can be identified as being broadly suited for changes in current policy and practice. These include: (i) supply of telephones, PABXs and other subscriber equipment by local and/or foreign suppliers, (ii) establishment of separate business networks to meet urgent demand and provide high-quality voice and/or data transmission; (iii) provision of value-added services, such as electronic mail and computer databases, inventory monitoring, banking networks etc., (iv) allowing private or State operators of dedicated networks to offer services to other users thereby using up spare capacity but within a framework established by the PTT, and (v) allowing the contracting or sub-contracting of activities habitually carried out by the PTT. 22/

Several developing countries are currently installing and expanding their basic telecommunications infrastructure. However, even the scale of investment currently planned is such that developing countries face the task of managing projects of very large dimension. Together, the ten largest countries spent at least an estimated $9.5 billion on telecommunications equipment in 1987, which is expected to rise to $11.5 billion by 1990. The pervasive role of information technology indicates that any digital capacities created for the telecommunications infrastructure will have wide applicability throughout the economy. The wide range of capacities required to design, manufacture, install and operate digital equipment can also act as an important factor in the development of human resources and skills. Certain developing countries have achieved notable successes, such as the Republic of

Korea and the Taiwan Province of China, where considerable production capability has been developed. Similarly, import-substituting countries such as China, India, Brazil and Mexico have developed considerable production capacity for products based on digital technology.

The changing technology market

The market for technology is undergoing considerable transformation with the advent of fast-changing technologies, processes and products in informatics. A new class of entrepreneurs has emerged, and a substantial proportion of innovative processes and applications have been developed or adapted by such new entrepreneurs operating initially through small, research-intensive enterprises in specialized fields of informatics. In microelectronics and informatics, several new entrants have grown, during the last decade, into major competitors in desk-top and related equipment, systems, and software and in communications and data processing. While major TNCs have been able to retain their position in specific sectors of electronics production, the range of technological innovation in informatics has extended in several directions and has provided opportunities for several electronics companies, both in hardware and software, to achieve rapid and successful growth. This pattern is likely to continue during the 1990s. In informatics, the technology market is marked by several alternative sources, though with a high level of product differentiation. A large number of comparatively new entrants are in a position to supply technology and know-how for various industrial processs and service functions, besides software and systems. In telecommunications also, while major TNCs still have a fairly dominant role, technology for new processes and products, including peripherals and microelectronic components, are available from a number of additional sources.

Informatics, competition and employment

It must be stressed that if developing country industries and services are to compete in global markets, they must incorporate present-day technological processes in production and service activities. Without these facilities, they could face considerable competitive disadvantage in a period of rapidly changing products, processes and service functions. For effective competition in the major segments of international markets, varying degrees of computerization may become increasingly necessary. It also appears that new economic activities, particularly in services in developing economies, will, for the most part, be based on factor conditions other than cheap labour, except where pools of special skills, as in computer programming and operations, can be developed. With increased automation, there has been a decline in the establishment and expansion of offshore production units for electronic components, textiles and the like set up by TNCs during the 1960s and 1970s. Such offshore production, which peaked during the late 1970s, particularly in South-East Asian economies, still continues to be an important feature in these countries and contributes significantly to local employment and export earnings. The number of new offshore units, not only in South-East Asia but also in the Caribbean and in Latin American countries, has, however, tended to decline. At the same time, new opportunities in data-processing across national boundaries, as initiated in Jamaica and Barbados, may become increasingly available.

While the developments towards greater automation may have considerable impact on new industrial investments in developing countries, these countries will continue to have certain factor advantages. National markets will still need to be served, mainly through local production enterprises. Wage differentials continue to be substantial between industrialized countries and even semi-industrialized developing countries; and if skills in computerized and other operations can be developed, the cost of labour, particularly in the informatics sector, will still constitute a significant advantage. This is exemplified in the successful export activities of the Republic of Korea and the Taiwan Province of China in computers, peripheral equipment and a wide range of components to the United States and other developed economies. The cost of introducing robotics and high degrees of automation is also high and the extension of robotics will be a gradual process even in industrialized countries. In the service sector, on the other hand, the usage of informatics may grow rapidly once an adequate number of computers are locally available and skills in usage are developed in particular developing countries.

The use of computers and advanced automation and communications systems have obvious implications for local employment. There may be some labour displacement, though the labour displaced can usually be absorbed easily. At the same time, new jobs are created with higher skills and income, since new products and services of higher quality and efficiency can be developed. Several sectoral studies in industrialized countries have highlighted the fact that substantial rise in productivity can be achieved through informatics usage with the same or smaller number of employees and increase in workforce in the particular enterprise or operation may tend to be reduced. It may, nevertheless, be difficult to draw categorical conclusions regarding the impact of informatics on employment. 23/

In developing countries, the effects on employment are even more difficult to assess. Use of automated office equipment, for example, may involve little or no job displacement, but the initial impact may be negative in terms of new employment opportunities. However, if informatics is utilized for new and additional functions, new jobs involving higher skills and wages would become available. The increased use of computers in banking, insurance and other financial services, as well as in travel, tourism and hotel operations, has now become fairly commonplace in most countries, despite its effects on local employment. In government offices, as well as in industrial enterprises, the use of computers, word processors and the like have been accepted as essential features. There has been little job displacement and retraining programmes and facilities have generally been adequate to meet local requirements in most countries. A suitable balance should be achieved between traditional, labour-intensive operations and informatics usage in various production and service activities.

The skill requirements for informatics technologies highlights the need for an extensive programme for development of new skills and capability in most developing countries. New curricula have to be evolved from the secondary stage of education and in vocational institutions, while specialized training programmes have to be implemented for development of skills and capability in computer applications and programming and related skills. This would, to a large extent, enable gradual absorption of such technologies. In some developing countries there may be socio-economic problems, which may delay the usage and application of computers and microprocessors. Similarly,

the use of numerically-controlled equipment and flexible manufacturing systems and machine centres may be limited only to certain fields. Yet, the trend towards greater usage of informatics, particularly in services, appears to be inescapable. Differences in approach would primarily relate to the timing of such change, even in countries with considerable surplus labour.

I. Information processing and dissemination

Several references have been made in various sections of this study to the impact of new technological developments in informatics, particularly computers and telecommunications in various services and functions. The direct implications of information packages and systems in fields such as banking and financial services, transportation, hotel and airlines reservations, healthcare and social services, and retail merchandizing have also been discussed. It would be useful, however, to review the overall technological and other trends in information processing and dissemination and the further developments in this field which are likely to have major impact on the service sector in the immediate future. The role of the principal corporations involved in these developments and the nature of global competition in this field is also of considerable interest and relevance.

The most important feature of developments in information processing and dissemination is the enormous range and flexibility that these represent. Apart from increased productivity and competitive advantage, particularly in service sectors, information technology is providing a growing degree of responsiveness for most functions. 24/ Computers can be utilized for a tremendous range of activities while instant communications have provided extraordinary facilities for utilizing the latest data and material for decision-making. The levels of automation necessary or appropriate for particular service subsectors obviously vary considerably and may range from the need for a high degree of centralized control, as is necessary in fast-food restaurants, to the decentralization required in investment banking. By and large, however, the advantages of increased productivity, competitive advantage and responsiveness provided by informatics are of special importance and relevance in all service branches and functions, ranging from financial services to retail merchandizing.

The principal elements of an information processing system, apart from communications, are composed of processors, storage components and software. Processors range from general-purpose processors to parallel processors and super-computers. A major development in this field is that of massively parallel processing, which breaks up a computing problem into several parts, processes each part, and then integrates these parts into one solution. Parallel processing is already being utilized but massively parallel processing can break down the parts to a much greater extent, using as many as 64,000 microprocessors at a time. While such complicated problems may be most relevant for major operations such as economic or defence planning, the concept is also increasingly being applied to complicated and large-scale service operations. Several United States and Japanese companies are actively engaged in developing such facilities. 25/ Parallel processing is also being incorporated in supercomputers, which are essentially very high-powered processors with much greater numerical processing capabilities than general-purpose computers. Supercomputers range from multiple data processors to vector processors and data-driven processors, with large storage capacity and with very high-speed integrated circuits.

The development of mass storage and retrieval systems is proceeding side by side with developments in parallel processing and supercomputers. These include electro-optical devices such as video discs and various other types of data-base processors. These systems can cover a very wide range, extending from small to very large systems, using certain levels of intelligence. The so-called "fifth generation" computer systems, presently under research and development mainly by Japanese and United States companies will increasingly be based on artificial intelligence and knowledge-based systems. These developments, which are expected to be commercialized during the 1990s, will be accompanied by development of specially-designed, large-scale chips, including chips for highly-specialized operations such as voice recognition and response and graphic data processing. Other technological developments in information processing also cover a very considerable range. These extend from development of parallel processors using very large-scale integrated chips and specialized processors for specific purposes, to supercomputers with storage size in the range of 50 to 500 million words and to mass storage systems, as well as development of high-capacity workstations using design chips. Competition in these fields is primarily between United States and Japanese companies, including 64 megabit chips and the development of custom chips, often produced in very small volume.

Developments in the micro-chip industry are likely to have considerable impact on information processing and dissemination. New customized chips are being developed for a wide range of specific functions in various services such as banking, transportation, tourist operations and merchandizing. While Intel's 80486 microprocessor has had great success, present trends are increasingly towards RISC (reduced instruction-set computing) being developed principally by several Japanese and United States companies. The extent of networking and workstation operations will be considerably enhanced by design RISC chips, as well as customized chips often produced in small quantities. Greater flexibility in designs and operations are provided through logic chips, which enable communications between chips and also externally. The range of logic chips includes programmable array logic (PAL); erasable/programmable logic devices (EPLD); electrically erasable/programmable logic devices and programmable gate array (PGA). It is estimated by Dataquest that PGA sales alone will increase from $28 million in 1988 to $507 million by 1994. 26/ The development of programmable logic chips provides much greater flexibility and enables a do-it-yourself approach, which can be much more economic and can result not only in much shorter product cycles but in greatly-increased applicability in various service functions. At the same time, the $13 billion market for logic chips is still highly fragmented and there is considerable scope for greater customizing. Further developments in the chip industry also include the growing use of gallium arsenide in place of silicon by several companies. The development of quantum-effect, computer-on-a-chip, is likely to be the next stage of technological revolution in this field during the 1990s.

An area of major growth is also represented by increased networking and workstations through micro-computers, which constitutes the fastest growing subsector in computers. Workstations extend over a great range of activities extending from needs of university students to networking linkages of the size of mainframe operations. The workstation market had risen to about $3.6 billion by 1988, with major United States manufacturers comprising Sun

Microsystems, Hewlett Packard, Apollo and Digital Equipment, as well as IBM. While Sun Microsystems has acquired 30 per cent of the United States market, IBM RS 6000 workstations claim 34 per cent. 27/ Networking is also being substantially extended in the minicomputer sector by Digital Equipment (USA) and in the mainframe subsector by IBM. An important element in IBM's present operations is to extend networking facilities between its older system 370, which is still in fairly extensive usage, and various desk-top and other computers, so that information on any of these machines can be interconnected. Expansion of workstations and networking constitutes a major operational development in information-processing, which would be of major relevance in most service branches. It is estimated by Dataquest Inc. that, by 1992, 47 per cent of the over 60 million desk-top computers in the United States will be networked. 28/ Since neutrality is a key issue in networking there is a growing trend towards open systems, with emphasis on networking to connect various computer brands. At the same time, however, software development for networking has tended to lag behind.

An important development is also represented by the reduction in size of computers and the rapid growth of 'laptop' computers. Such computers have greatly increased the convenience and versatility of computer usage in various service functions. Japanese companies have played a dominant role in marketing of laptop computers and Japan's five major integrated computer companies had captured 43 per cent of the United States market for laptop computers by 1989, which had grown to $2 billion and expanded at 40 per cent annually during 1988-1990.

An important development in information dissemination is the rapid growth of electronics mail or E-mail, covering exchange of messages between computers. One estimate expects that, by 1992, nearly 16 billion messages will be sent by E-mail, while the growth rate in such messages is expected to be 30 per cent during the 1990s. 29/ Major public networks are being developed in this field through Western Union's Easylink, GTE Telenet's Telemail, British Telecom's Dialcom, MCI's MCI Mail, and AT&T's AT&T Mail, apart from corporate E-mail services developed by companies such as IBM and Digital Equipment, and by Japanese and some West European companies. A new communications standard, X-dot 400 (X400) has been adopted, since the mid-1980s, by the International Telephone and Telegraph Consultative Committee, which prescribes the technical design of E-mail hardware and software. There is also considerable increase in local area networks (LAN), particularly in the United States. The growth of networking is also likely to lead to rapid expansion in E-mail. Programmes such as groupware, which provides communications between workers, can have major impact on decision-making and assessment of performance in various service branches. A good example is that of Mrs. Fields Inc., a chain of 650 "cookie" shops in the United States, which uses E-mail extensively and has largely eliminated paperwork, except for government forms. 30/ Groupware programmes have been extended in a large number of corporations, including computer companies such as DEC, food companies such as Coca Cola Foods and producers of electrical equipment such as Westinghouse.

Technological developments in informatics cover an enormous range. On the one hand, major developments continue to take place in computers, semiconductors and telecommunications systems, the latter extending to mobile satellite communication services and to cellular services, which have extended to most major urban centres. On the other hand, computerized functions such

as graphics and electronics mail, together with networking facilities, have been extended rapidly and are having increasing impact on most service activities.

Considerable restructuring is taking place in the information-processing and telecommunications industry at the global level, in the form of mergers, acquisitions and joint ventures. Fujitsu (Japan) has acquired control of ICL (UK). AT&T has taken over Paradyne and GTE's office switch business in the United States and has acquired most of the telecommunications business of Philips (Netherlands), besides entering in a joint venture with Italtel (Italy) to make switching and other communications equipment in Europe. In cellular services, Britisch Telecom acquired 22 per cent of Mccaw Cellular Company (USA), while AT&T has expanded its international and national operations to hold 20 per cent of the world market. Siemens (Germany) and GEC (UK) acquired Plessey (UK) and Siemens also acquired Bendix Electronics (USA), besides entering joint ventures with Westinghouse, Intel and Asea Brown Boveri. Groupe Bull (France) has joint operations with Olivetti (Italy) and Siemens. CGE (Fr.) has acquired ITT's telecommunications business in Europe. Closer links have also been developed between IBM and Siemens in telecommunication operations. The trend has also been towards production of far more powerful micro-computers with companies concentrating on increased networking and workstations. Mainframes will nevertheless continue to be used for major and complex operations and IBM continues to be dominant, though increasingly less so for the computer industry taken as a whole. In the fast-expanding personal-computer market, which was estimated at $68 billion in 1990, 31/ competition has become very intense, with companies such as Compaq and Apple increasing their market share, particularly in Europe, and Japanese manufacturers competing in most ranges. In semiconductors, there has been a growing shift from United States to Japanese companies. While, in 1972, most of the top ten producers of 1 K DRAM chips were United States companies, led by Texas Instruments and Motorola, by 1981 four of the 10 major producers of 64K DRAM chips were Japanese, and by 1987, eight out of the nine principal producers of 1 million DRAM chips were Japanese. In 1988, Japanese companies acquired 85 per cent of the global market for one megabit memory chips, with the share of United States companies, excluding IBM's large-captive production, falling to 8 per cent. The growing dominance of Japanese companies, with the exception of Intel and Motorola corporations, is likely to be further extended in the field of "quantum" chips in the near future. The demand for new 64-magabit chips, most of which will be met by Japanese companies, is expected to increase to $50 billion in 1994-1995, with sales of products such as printers, telefax equipment etc. using such chips increasing to $2 billion. Apart from dominance of the semiconductor industry, the diversified Japanese computer companies, particularly Toshiba, Hitachi, NEC, Fujitsu and Mitsubishi Electric, are posing a growing challenge to United States companies in most ranges of computers and major components. While Toshiba has occupied a dominant position in laptop computers, NEC has concentrated on personal computers, while Fujitsu and Hitachi are producing mainframes and supercomputers. The latter segment was, till recently, a preserve of United States companies, particularly Cray Research Inc., but during 1989-1990 stiff competition was being offered by Nippon Electric (NEC), Fujitsu and Hitachi, all of which are producing supercomputers of at least comparable capability. With growing use of supercomputers in several service

branches, such as banking and financial services, the market for this range of computers may increasingly be held by Japanese companies. NEC is also emerging as a major corporation both in communications and computers and is now not only the largest maker of chips but is fourth largest in computers and fifth largest in telecommunications.

As compared to United States and Japanese companies, IBM continues to be dominant in Europe with Japanese companies increasingly expanding their operations, including through acquisitions. Major European companies, such as Siemens with 1990 sales of computers and chips of $7.8 and $1.2 billion respectively; Olivetti with computer sales of $7.5 billion; Groupe Bull with computer sales of $6.2 billion; Philips with sales of computers and chips of $1.6 billion and $1.9 billion respectively, and SGS Thomson with sales of chips of $1.5 billion, 32/, are considerably behind United States and Japanese companies in these fields. Consequently, research expenditure by these companies has also been much lower than that of companies such as Hitachi, which spends over $3 billion annually on R&D. Possibilities of merger and joint ventures or of joint research are under consideration. A joint programme for development of software, Eureka Software, has been undertaken by 14 companies and institutions from five countries. Technology cooperation programmes in West Europe include Eureka, which extends to research projects; Jessi, for development of new semiconductors, and Esprit, which concentrates on microelectronics technology.

Technological developments in informatics still largely emanate from United States corporations. The U.S. Department of Defence has provided substantial support to high-tech research involving military applications and the Defence Advanced Research Projects Agency (DARPA) has an annual budget of $1.4 billion. There is considerable spillover of such R&D to commercial applications. With sales of $55-60 billion, and R&D expenditure of over $6 billion in 1990, IBM continues to be the industry leader, with a dominating global role in mainframes and a continuing major presence in personal computers and principal components. Other major computer companies such as DEC, Unisys, Hewlett Packard, Amdahl, and Apple have, however, faced falling sales during 1989-1991, particularly in minicomputers, because of slow demand. Some companies such as Compaq have, on the other hand, improved foreign sales significantly. Software companies such as Microsoft, Lotus and Ashton-Tate continue to play a commanding role in global software sales and development. Companies such as Sun Microsystems (workstations), Intel (microprocessors), Motorola (cellular phones), and Bell Laboratories have been pioneering innovative developments in various fields of informatics. Together with the extraordinary pace of continuing technological developments, however, competition in the information processing industry remains very intense and has become increasingly globalized.

J. Software

With the enormous growth of informatics applications and usage, particularly in the services sector, there has been explosive expansion in the demand for software, extending from systems software for operation of computers and networks to applications software for a wide range of specific uses and databases and systems in various fields and sectors. Computer software comprises the collection of machine-readable instructions which control computer operations, and includes all computer programmes and

descriptions, and supporting materials. A computer programme is a set of instructions by which a computer performs specific tasks while programme descriptions include complete procedural details relating to a computer programme. Supporting materials include any additional material and instructions for assisting the application and usage of a computer programme. 33/ The software sector provides a very wide range of packaged software for customer usage in various fields, together with customized software for specific uses, and plays a critical role in all computer operations.

Estimates of the worldwide software market range from $65 billion to well over $100 billion. A recent estimate places the world market for software and computing services at $163 billion in 1991 and at $340 billion by 1996. 34/ The major fields of software development in industrialized countries in the early 1980s may be seen from Table 32.

With the rapid growth of usage of personal computers (PCs), the demand for packaged PC software is also projected to increase at a very fast pace. This may be seen in Table 33.

The supply of systems software was initially provided by computer manufacturers, together with applications software for certain functions such as payroll systems, accounts and inventories. A large proportion of software was also supplied through in-house development by various organizations and, up to the mid-1970s, such development covered about 85 per cent of requirements of governments and large business organizations. 35/ During the 1980s, however, there was major expansion of the software market and rapid increase in software packages supplied by outside firms. By the early 1980s, a survey in the United States indicated that only 19 per cent of software run on micro-computers was produced by data-processing departments, and 28 per cent was developed by users, against 53 per cent by outside vendors. The trend towards outside supply of software increased considerably during the 1980s. It is estimated that, in the United States alone, there were up to 25 000 software companies, 36/ in a global software market of about $30 billion by 1987. The revenues from information services in the United States alone may be seen from the Table 34. The demand for software and data-processing services in industrialized countries may be seen from Table 35. It is expected that, as against the annual growth of 44 per cent during the 1970s of firms dealing with software and computer services, growth of software and related services during the 1990s will continue at around 30-35 per cent annually, with 40-45 per cent with respect to microcomputer software. The demand for packaged software in industrialized countries is, however, getting obsolete and there is a growing need for user-friendly systems for multiple applications and a variety of new features.

The three principal categories of software may be described as systems software, application software and integrated systems. 37/ The growth of systems software is largely linked to the market for computer hardware. In recent years, there has been considerable increase in independent software houses dealing with special systems, programmes and database functions, though hardware manufacturers continue to play a major role. The most rapid and varied growth has been with respect to applications software, which extends to a very wide range of usage. The International Software Directory classifies 107 groups under several broad categories. By far, the majority of applications software has been developed through software companies, with the number of companies and range of usage and decision-aid systems, continuing to

expand rapidly. Such software is particularly applicable to the services sector, including hospital management, transport systems, finance and banking and merchandizing of various products. Integrated software systems, on the other hand, aim at combining different systems and sharing data and results among various programmes and different locations. The range of software products in this field is growing rapidly, including Wordstar, Windows, Perfectwriter, Topview, Symphony and others. With increasing use of microcomputers, there is growing need for integration both between microcomputers and between mainframes and microcomputers. The growth of artificial intelligence technologies would also necessitate a growing range of new and specialized software.

A major problem in software is the lack of standardization and the existence of several competing standards. At the same time, certain software packages are playing a dominating role at present in their areas of application. These include Microsoft's MS/DOS system, which is used on IBM and IBM-compatible machines; Lotus 1-2-3 which covers 60 per cent of spreadsheets; Ashton Tate's dBase system, which concentrates on the database market, and Apple's software system. The UNIX system, developed by AT&T, is also highly efficient with a wide range of applications but is often considered more difficult to use. Mainframe software vendors tend to concentrate on management information functions and database management. While mainframe vendors are relatively few, the number of microcomputer software companies has increased considerably, creating an enormous variety of programmes. At the same time, demand for new software programmes continues to increase rapidly.

The United States continues to be dominant with respect to computer software. United States companies have 57 per cent ($62.7 billion) of the global market for software and related services (estimated to be $110 million by International Data Corporation). 38/ With sales exceeding $1 billion in 1990, the PC software sector is dominated by Microsoft, with its MS/DOS and OS-2 operating systems supplied to IBM PCs and its clones, besides its Excel spreadsheet and its Windows and Microsoft word text processing programmes. The market for PC spreadsheets is dominated by Lotus, with 65 per cent of the $600 million market in 1988. Ashton-Tate's dBase programme for PC databases continues to have a market share of 45 per cent, in this $444 million market segment. ATT&T's Unix operating system is increasingly used as comparable to OS/2 in scope and functions. Computer Associates had sales of over $600 million in 1987. Several other software firms, such as Adobe (Postscript for desktop publishing), are expanding rapidly in specialized market segments of software. The subsector employs 1.2 million programmers and software engineers in the United States, besides 200,000 others in related jobs. In comparison, the share of other countries comes to 13 per cent ($14.3 billion) for Japan; 8 per cent ($8.8 billion) for France; 7 per cent ($7.7 billion) for Germany; 6 per cent ($6.6 billion) for Britain; 3 per cent ($3.3 billion) for Canada and 6 per cent for other countries. The United States lead has been partly due to the country being the major informatics market in recent decades but also largely due to the innovative capability of its software developers and support of venture capital. At the same time, there is likely to be growing competition, mainly from other industrialized countries. In Japan, the emphasis on quality manufacture by integrated companies such as Fujitsu and Hitachi, and as reflected in the high quality software for Japanese electronics export products, may increasingly pose a major challenge to United

States software companies. European software companies, such as SAP in Walldorf, Germany; Logica and MicroFocus in the United Kingdom, and CAP Gemini Segeti from France, are also expanding, with growing sales in the United States market.

There has also been considerable growth in software programming in certain developing countries, such as Brazil, India and Singapore. While software and computer services in Brazil were the highest among developing countries ($4.2 billion in 1987), but largely geared to the internal market, software exports from India and Singapore increased considerably during the 1980s. India has about 100,000 software professionals, available at much lower cost than in industrialized countries. India's market for software and related services rose from $11 million in 1984 to $337 million by 1987 and substantial exports are taking place (about $70 million annually), including through contract programming through United States banks and companies such as Digital Equipment, Texas Instruments and Hewlett Packard. In Singapore, special efforts are being made by the National Computer Board to encourage software exports through research grants and other assistance. China and Taiwan Province have also undertaken major programmes to develop software.

Software programming and packaging presents considerable potential for developing countries which have, or can develop, pools of talent in this field. The development of software is basically different from hardware in that it does not require any major investment and is primarily labour-intensive. The demand for software is growing rapidly both in industrialized and developing countries where computer usage is being extended, particularly in several Asian and Latin American countries. Apart from meeting internal software demand in these countries, including adaptations necessary to well-developed programmes of Microsoft, Lotus and other major software packages in industrialized countries, there is considerable potential for software exports from developing countries. Joint ventures have been set up with some computer manufacturers, as in the case of Tata-Burroughs (now Tata-Unisys), and also with software producers.

The development of relatively low-priced micro-computers and the fall in the price of highly-efficient semiconductors provide considerable potential for a number of developing countries to undertake software programming. This can not only meet internal software requirements in these countries, with possibilities of exports because of much-cheaper labour, but could provide significant employment opportunities for trained personnel in these fields. It is estimated that over 300,000 persons are employed in computer services and software at present. This number can be expected to increase to well over 600,000 by the mid-1990s. Much of this additional workforce could be located in developing countries, provided adequate human resource development and training in computer programming can be ensured.

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Table 13.

World production of information technology systems growth estimates, 1986-1995

	1986	1990	1995	Average annual growth (Percentage)
	(Billion dollars) a/			
Hardware	224	353	621	12
Software	84	174	433	20
Telecommunications b/ and computing services	85	107	143	6
Total	393	634	1 197	13

Source: OECD.

a/ At 1985 exchange rates.
b/ Telecommunications equipment solely for the public network.

Table 14.

International financial market activity, 1982-1988
(Billions of dollars)

Activity	Year	United States	Japan	Other developed	Other	Total
International bond issues						
	1982	15.3	5.9	38.4	14.7	74.3
	1983	7.9	11.3	37.9	16.7	73.8
	1984	24.8	15.8	51.5	16.3	108.4
	1985	40.6	20.0	77.2	26.7	164.5
	1986	41.6	31.8	124.9	23.2	221.5
	1987	22.6	42.3	88.6	22.1	175.6
	1988	17.4	50.6	124.9	33.4	226.3
Euronote facilities						
	1982	0.4	0.0	1.3	0.7	2.4
	1983	0.4	0.6	2.0	0.3	3.3
	1984	3.0	0.2	14.2	1.4	18.8
	1985	16.5	0.5	30.8	2.5	50.3
	1986	19.0	10.4	38.6	3.1	71.1
	1987	15.0	10.0	43.4	1.8	70.2
	1988	9.8	5.9	54.7	6.7	77.1
Total securities						
	1982	15.7	5.9	39.7	15.4	76.7
	1983	8.3	11.9	39.9	17.0	77.1
	1984	27.8	16.0	65.7	17.7	127.2
	1985	57.1	20.5	108.0	29.2	214.8
	1986	60.6	42.2	163.5	26.3	292.6
	1987	37.6	52.3	132.0	23.9	245.8
	1988	27.2	56.5	179.6	40.1	303.4
Syndicated bank loans						
	1982	7.0	0.1	35.4	56.9	99.4
	1983	3.4	0.1	19.2	29.1	51.8
	1984	3.6	0.3	12.5	20.2	36.6
	1985	2.1	..	7.5	11.5	21.1
	1986	3.8	0.3	14.1	19.6	37.8
	1987	15.8	0.5	59.8	11.8	87.9
	1988	..	..	..	..	101.7

Source: Bank for International Settlements, *Annual Report* (various issues); Bank of England, *Quarterly Bulletin* (February 1989).

Table 15.

Automated teller networks in the US, 1985

Network	Number of ATMs		Access-card base (millions)	
	Dec. 1984	Aug. 1985	Dec. 1984	Aug. 1985
Cirrus	6 471	8 119	27.3	30.8
Plus	4 673	5 617	26.6	48.6
Express Cash	3 200	5 294	2.1	2.9
Visa	2 240	4 500	20.0	45.0
Citishare	2 400	2 900	8.5	8.5
The Exchange	1 690	2 787	3.4	6.1
Nationet	1 434	2 400	12.0	10.0
Master Teller	1 000	2 000	3.0	6.0
TOTAL	23 110	33 617	102.9	157.9

Source: Financial Times, 21 October 1985.

Table 16. The status of consumer banking technology, 1985

Country	ATM networks	EFT/POS	In-home banking
Australia	1	3	4
Belgium	1	3	5
Brazil	1	3	4
Canada	1	3	3
France	1	2	2
Germany, Fed.Rep. of	2	3	3
Hong Kong	1	2	2
Indonesia	5	5	5
Ireland	1	3	3
Italy	2	3	4
Japan	1	3	3
Luxembourg	1	3	5
Malaysia	2	4	4
Mexico	2	5	3
Netherlands	2	3	5
New Zealand	1	3	3
Norway	1	2	4
Panama	1	4	5
Philippines	1	4	4
Singapore	1	4	3
South Africa	2	3	3
Spain	1	2	3
Sweden	1	3	2
Switzerland	1	3	3
United Kingdom	1	3	3
United States	1	3	3

Source: Touche Ross International, "The impact of technology on banking" (New York, Touche Ross, 1985), p. 9.

1 - Widespread penetration of technology among large.small banks. Growth rate slowed.
2 - Limited penetration primarily among large banks. Acceptance on widescale basis expected within 3 to 5 years.
3 - Current experience limited to testing mode. Broader acceptance possible over the next 5 years.
4 - Not operational even on test basis-conceptual phase. Acceptance 5+ years away.
5 - No plans or discussion among major banks. Acceptance not likely before mid-1990s.

Table 17.

Foreign Commercial Banks in Developing Country Markets

Country and date	*Number of foreign banks*	*Percentage share in total bank assets*
Argentina, 1987	32	20
Bangladesh, 1986	7	6
Bolivia, 1987	3	3
Botswana, 1986–87	3	100
Brazil, 1987	17	6
Chile, 1987	21	17
Colombia	8	6
Indonesia, 1986–87	10	6
Kenya, 1986–87	11	37
Malaysia, 1988	16	25
Nepal, 1988*	3	6
Nigeria, 1987–88*	15	74
Pakistan, 1987–88	20	12
Peru, 1987	5	2
Philippines, 1986–87	4	19
Senegal, 1986–87	2	4
Thailand, 1988	14	4
Tunisia, 1985	7	1
Turkey, 1986–87	18	4
Uruguay, 1987	8	10
Venezuela, 1987	3	1
Median	8	6

*Joint venture foreign banks

Source: World Bank reports.

Table 18.

Insurance density and penetration: premiums in selected economies, 1980 and 1987

Country/territory	1980		1987		
	Premiums in dollars per capita	Premiums as percentage of GDP	Premiums in dollars per capita	Premiums as percentage of GDP	GDP per capita
Developed market economies					
Australia	481.8	4.96	677.9	5.31	11 992
Austria	377.2	3.96	830.4	4.75	15 522
Belgium	445.4	4.00	673.7	4.17	14 373
Canada	520.4	5.11	1 668.2	5.41	16 161
Denmark	502.5	4.25	953.2	4.3	19 751
Finland	509.4	5.11	1 074.6	5.31	18 163
France	419.2	3.69	898.8	5.06	15 854
Germany, Federal Republic of	653.9	5.29	1 329.9	6.4	18 273
Greece	43.5	1.1	63.1	1.24	4 723
Israel	126.3	3.69	444.6	5.4	7 941
Italy	127.1	2.00	344.3	2.35	13 219
Japan	506.9	5.12	1 974.5	8.69	19 437
Luxembourg	355.6	..	705.4	3.35	..
Netherlands	603.1	5.47	1 041.7	6.291	4 541
Norway	513.2	3.97	1 083.8	5.08	19 941
Portugal	61.6	2.76	101.7	2.69	..
South Africa	121.1	4.46	258.0	10.0	2 507
Spain	90.1	1.77	279.6	3.31	7 449
Sweden	578.9	4.05	920.9	4.49	18 874
Switzerland	960.6	6.08	2 447.2	8.02	26 158
Turkey	3.7	0.34	6.0	..	..
United Kingdom	554.7	5.78	1 121.8	8.35	11 923
United States	833.7	7.23	892.3	5.41	18 436
Developing economies					
Algeria	24.5	..	37.3	1.36	..
Argentina	123.2	2.23	26.4	1.8	..
Brazil	14.3	0.91	10.8	0.86	2 142
Chile	22.5	..	30.6	2.2	..
China	..	..	0.7	1.9	276
Colombia	13.8	..	17.1	1.53	1 217
India	2.7	1.13	4.2	1.29	326
Indonesia	2.2	0.5	3.8	0.92	409
Iran (Islamic Republic of)	10.1	..	13.5	0.28	..
Iraq	14.3	..	32.1	1.9	..
Kenya	11.3	..	8.4	2.42	350
Korea, Republic of	39.4	2.89	264.8	8.86	2 925
Kuwait	178.1	..	136.9	1.27	10 450
Mexico	21.0	0.84	11.1	1.02	1 725
Morocco	15.8	1.92	14.6	1.88	..
Nigeria	8.9	..	2.3	0.88	271
Pakistan	2.0	..	2.2	0.66	332
Peru	8.4	1.05	9.3	1.08	..
Philippines	10.0	..	10.6	1.78	600
Singapore	118.8	2.66	223.3	2.98	7 623
Taiwan Province of China	44.2	..	164.8	3.33	..
Thailand	6.1	0.89	12.2	1.35	887
Tunisia	17.6	1.38	21.2	1.57	1 265
Uruguay	49.9	..	35.0	1.78	2 545
Venezuela	79.8	1.84	61.2	2.26	2 699
Zimbabwe	..	..	32.6	4.75	..

Table 19.

Total world insurance business by region, 1980 and 1987
(Premiums in billions of dollars and percentage)

Region	1980		1987	
	Premiums	Percentage	Premiums	Percentage
North America	202.3	46.9	429.5	40.1
Europe	140.6	32.6	338.6	31.6
Asia	67.1	15.6	270.2	25.3
Africa	5.0	1.2	12.4	1.2
Central and South America	8.6	2.0	6.4	0.6
Oceania	7.9	1.8	12.9	1.2
Total	431.5	100.0	1 070.0	100.0

Source: Swiss Reinsurance Corporation, *Sigma* (May 1982 and March 1989).

Table 20.

World Seaborne Trade, by Country Group, 1970 and 1987 (Estimated)

(percent)

Country group[a]	Share of world trade, by country groups								Share of world shipping tonnage by country group	
	Goods Loaded[b]				Goods Unloaded[b]					
	Petroleum Crude	Petroleum Products	Dry cargo	All goods	Petroleum Crude	Petroleum Products	Dry cargo	All goods	registration[c] GRT	DWT
Developed market economies										
1970	2.0	27.1	60.0	31.1	80.4	79.6	79.1	79.9	83.9	86.6
1987	16.4	27.5	65.3	45.5	72.1	82.3	62.3	67.9	65.8	68.1
Nonmarket Europe and Asia										
1970	3.4	8.0	8.1	6.1	1.7	1.1	5.8	3.5	8.9	6.6
1987	9.4	17.7	6.2	8.6	3.5	0.8	10.0	7.0	12.2	9.9
Developing economies										
1970	94.6	64.9	31.9	62.8	17.9	19.4	15.1	16.6	6.7	6.3
1987	74.2	54.8	28.5	45.9	24.4	16.9	27.7	25.1	20.9	20.9
Africa										
1970	22.5	2.3	9.1	15.2	1.7	4.7	3.6	2.9	0.4	0.3
1986	21.8	8.1	5.0	10.6	5.9	2.3	4.6	4.7	1.3	1.2
Latin America and the Caribbean										
1970	12.2	35.4	13.8	16.0	10.5	5.6	4.4	7.2	2.9	2.7
1986	11.7	12.2	13.8	13.0	5.5	4.1	4.4	4.7	4.1	3.9
Asia										
1970	56.9	27.0	8.1	31.3	5.5	8.5	6.7	6.4	3.4	3.3
1986	40.9	34.8	9.6	22.4	12.1	9.4	18.5	15.5	14.0	14.4
Europe and Oceania										
1970	n.a.	0.1	0.8	0.4	n.a.	0.6	0.4	0.2	n.a.	0.7
1986	n.a.	0.3	0.7	0.4	0.7	1.0	1.0	0.9	1.4	1.4

n.a. Not available.

Note: DWT, deadweight tons; GRT, gross registered tonnage.

a. For 1970, Developing market economies includes Yugoslavia; for 1987, Yugoslavia is under Developing economies, Europe and Oceania.

Table 21.

World tourism arrivals and receipts, 1950-1988

Years	Arrivals		Receipts	
	(Millions)	Annual change a/ (Percentage)	Billions of dollars	Annual change a/ (Percentage)
1950 - 1960	25.3-69.3	10.6	2.1-6.9	12.6
1960 - 1970	69.3-159.7	8.7	6.9-17.9	10.1
1970 - 1980	159.7-284.8	5.6	17.9-102.4	18.1
1981	288.8	1.4	104.3	1.9
1982	286.8	-0.7	98.6	-5.5
1983	284.4	-0.8	98.5	-0.1
1984	311.2	9.4	102.5	4.1
1985	325.7	4.7	108.1	5.4
1986	332.9	2.2	130.1	20.4
1987	358.7	7.7	158.7	22.0
1988 b/	390.0	8.7	195.0	22.9

Source: World Tourism Organization, *Compendium of Tourism Statistics: 1983-1987* (Madrid, 1988).

a/ Average annual change over previous year.
b/ Preliminary data.

Table 22.

Projected real world tourism growth, 1987-1997 (excluding inflation and exchange rate fluctuations)

Item	Billions of dollars 1987	1997	Average annual increase (percentage)
World receipts from international tourism (including transportation)	205	334	5.0
World receipts from international tourism (excluding transportation)	158	257	5.0
Total world airline-passenger revenues (including scheduled, non-scheduled and regional carriers)	108	193	6.0
World-wide accommodation revenue	155	229	4.0
Memorandum			
World gross product (trillions of dollars)	14.7	21.9	4.1
World tourism receipts as percentage of world gross product (percentage)	11.5	12.5	

Source: Somerset R. Waters, *The Travel Industry World Yearbook, Vol. 33, The Big Picture* (New York, Child and Waters Inc., 1989).

Table 23.

Shares of regions and leading exporters in world exports of travel, 1970 and 1987

Region/Country	1970	1987
Developed countries	82.7	79.1
Developing countries	17.0	19.0
Eastern trading area a/	0.3	1.9
Western Europe	61.4	63.0
North America	19.2	13.0
Middle East	1.9	2.0
Asia	4.5	11.0
Africa	2.3	3.0
Latin America	10.5	7.0
Selected Eastern European b/	0.3	1.0
Leading exporters:		
Spain	9.2	10.3
United States	12.8	10.3
Italy	9.0	8.5
France	7.3	8.3
United Kingdom	5.7	7.2
Austria	5.5	6.2
Germany, Federal Republic of	7.3	5.4
Switzerland	5.0	3.8
Canada	6.4	3.3
Mexico	6.4	2.4
Belgium and Luxembourg	1.9	2.1
Netherlands	2.4	1.9
Greece	1.1	1.6
Singapore	0.5	1.5
Korea, Republic of	0.1	1.5

Source: IMF balance-of-payments statistics.

a/ Poland, Hungary, Romania and China.
b/ Poland, Hungary and Romania.

Table 24.

Health-care markets in the United States, Japan and some European countries in 1983 (estimated values) (including all devices, diagnostics, equipment and supplies and excluding services)

Country	Population (millions)	Health-care expenditures			
		US dollars per capita	Products (million US dollars)	Imported (percentage)	Growth rate (percentage) a/
United States	236	1,500	14,500	20	6-8
Japan	120	500	3,050	20	2-3
Fed. Rep. of Germany	62	950	1,750	55	4-5
France	55	800	1,050	60	4-5
United Kingdom	56	450	950	40	2-3
Italy	58	340	800	45	2-3
Spain	39	300	300	60	2-3
Other selected	80	400	1,600	60	4-5
Total	706	858	24,000	.	.

Source: Biomedical Business International, vol. VII, 1984, p.192.

a/ Estimated average annual rate of growth for medical product imports 1983-1987.

Extrapolating from that, the total world market is shared geographically approximately as follows: United States: 50 per cent; Japan: 10 per cent; western Europe: 25 per cent; and other: 15 per cent.

Table 25.

Value of shipments of medical and dental instruments in the United States, 1983-1986

(Millions of US dollars)

SIC group	1983	1984 a/	1985 b/	1986 c/
X-ray apparatus and tubes	4 565	4 661	4 926	5 621
Surgical and medical instruments	4 343	4 495	4 617	4 857
Surgical appliances and supplies	6 044	6 473	6 615	6 847
Dental equipment and supplies	1 117	1 147	1 178	1 213
Total shipments	16 069	16 776	17 336	18 538

Source: 1986 U.S. Industrial Outlook; U.S. Department of Commerce, International Trade Administration (ITA), Washington 1986.

a/ Estimates except for exports and imports.

b/ Estimates.

c/ Forecast.

Table 26.

The ten largest advertising groups, 1988

(Millions of dollars)

	Firm	World-wide billings	World-wide gross income	Country
1.	Saatchi & Saatchi Plc Saatchi & Saatchi Advertising Worldwide Baker Spielvogel Bates Worldwide	13 529	1 990	United Kingdom
2.	Dentsu Inc.	9 450	1 229	Japan
3.	The Interpublic Group of Companies McCann-Erickson Worldwide Lintas Worldwide Inc.	8 042	1 260	United States
4.	WPP Group Plc. J. Walter Thompson	7 825	1 173	United Kingdom
5.	Omnicom Group BBDO Worldwide DDB Needham Worldwide	7 072	986	United States
6.	Ogilvy Ogilvy & Mather Worldwide	5 703	865	United States
7.	Young & Rubicam Inc. Young & Rubicam	5 390	758	United States
8.	Foote Cone/Publicis International Foote Cone & Bielding Publicis International	4 358	653	United States, France
9.	Hakuhodo International	3 939	522	Japan
10.	D'Arcy Masius Benton & Bowles	3 361	429	United States
	Total	68 669	9 865	

Source: Advertising Age, (29 March 1989).

Note: Indents indicate principal agency networks that belong to the group.

Table 27.

The ten largest advertising agencies and their foreign affiliates, 1986

Rank	Name	Home country	Year	Revenue (millions of dollars)		Gross billings (millions of dollars)		Foreign affiliates (number)										
								Developed countries						Developing countries				
				Total	Percentage foreign	Total	Percentage foreign	United States	Canada	Japan	Western Europe	Others	Subtotal	Latin America	Africa	Asia	Subtotal	Total
1	Saatchi & Saatchi	United Kingdom	1986	1 210	78	8 260	..	33	3	1	32	21	90	4	-	9	13	103
2	Interpublic Group	United States	1986	822	55	5 550	54		3	1	90	10	104	19	4	11	33	138
3	OMNICOM	United States	1986	820	25	5 820	28	1	2	4	57	6	70	4	-	9	13	83
4	Dentsu	Japan	1986	706	..	5 484	6	4	-		1	1	6	-	-	5	5	11
5	J. Walter Thompson	United States	1986	645	33	4 200	33	4	6	1	84	12	107	18	-	17	35	142
6	Young & Rubicam	United States	1986	628	43	4 190	43		3	2	64	2	71	6	-	7	13	84
7	Ogilvy Group	United States	1986	549	41	3 800	42		7	1	93	16	117	12	1	20	33	130
8	D'Arcy, Masius, Benton & Bowles	United States	1986	336	43	2 260	42		2	-	51	2	55	4	2	2	8	63
9	Foote Cone & Belding Communications	United States	1986	323	25	2 150	25	2	1	1	33	5	42	13	-	6	19	61
10	Hakuhodo	Japan	1986	310	..	2 270	..	1	-		1	-	2	1	-	3	4	6

Source: UNCTC, *Foreign Direct Investment and Transnational Corporations in Services* (United Nations publication, Sales No. E.89.II.A.1), annex table B.8, p.197.

Table 28. The ten largest accounting firms and their foreign affiliates, 1986

Rank	Name	Home country	Fee income (Million dollars)		Number of partners (Million dollars)		Number of staff		Foreign affiliates (Number)										
									Developed countries						Developing countries				
			Total	Percentage foreign	Total	Percentage foreign	Total	Percentage foreign	United States	Canada	Japan	Western Europe	Other	Sub-total	Latin America	Africa	Asia	Sub-total	Total
1	Arthur Andersen & Co. a/	United States	1 924	30	1 847	37	36 117	44		7	3	64	8	82	17	3	39	59	141 b/
2	Coopers & Lybrand c/	United States	1 695	50	3 075	66	38 500	65		10	8	166	65	249	44	35	69	148	397 b/
3	Peat Marwick f/	United States	1 672 e/	35	2 726	49	32 183	55		27	5	87	49	168	40	32	57	129	297 f
4	Ernst & Whinney d/	United States	1 492 a/	39	2 640	57	28 800	56		76	9	78	48	211	44	8	69	121	332 h/
5	Price Waterhouse a/	United States	1 488 e/	50	2 291	69	32 725	67		23	7	122	41	193	66	29	49	144	337 i/
6	Arthur & Young d/	United States	1 427	57	2 572	70	29 000	69		24	16	119	39	198	37	14	39	90	288 j/
7	Deloitte Haskins & Sells International d/	United States	1 188	50	2 192	65	26 774	65		31	7	165	49	152	31	29	90	150	302 j/
8	Touche Ross International d/	United States	1 151	51	2 600	68	27 500	10		42	15	169	51	277	41	19	77	137	414 i/
9	Klynveld Main Goerdeler f/	Netherlands	1 137 e/	89	3 263	..	30 894	..	98	50	5	180	63	396	28	19	55	102	498 k/
10	Binder Dijke Otte l/	Netherlands	531	..	1 344	..	13 027	..	46	66	3	116	27	258	11	6	19	36	294 i/

Source: UNCTC, Foreign Direct Investment and Transnational Corporations in Services (United Nations publication, Sales No. E.89.II.A.1), annex table B.7, pp. 194-196.

a/ Without correspondents that do work for other firms, unless otherwise indicated.
b/ Includes correspondents.
c/ Data are for all member firms plus referred work by associated firms; correspondents excluded.
d/ Member firms only.
e/ Member and representative firms.
f/ KMG merged with Peat-Marwick in 1987. The new firm is known as Klynveld Peat Marwick Goerdeler (KPMG) internationally, and Peat Marwick Main in the United States.
g/ E&W merged with Thorne Riddell, April 1986. Figures include Thorne Riddell, but locations with more than one office are counted only once.
h/ Member, representative and correspondent firms included.
i/ Member, correspondent and affiliated firms included.
j/ Member and correspondent firms included.
k/ Member, representative and affiliated firms included.
l/ The two United Kingdom firms of this international group merged 1 May 1987. Dearden Farrow (United Kingdom) now internationally linked to BDO. The other member firms of Derder Farrow International have formed a new association called Summit International; their fee income is about $200 million.

Table 29.

The 20 largest accounting firms world-wide, 1988

(Millions of dollars)

	Firm	Country	World-wide revenues	United States revenues	World-wide employees	Fee split: audit/tax/other/ insolvency (percentage)
1	KPMG	United States	3 900	1 640	62 500	65/20/15/0/0
2	Arthur Andersen	United States	2 820	1 700	45 900	40/20/40/0/0
3	Coopers &Lybrand	United States	2 500	..	45 000	..
4	Price Waterhouse	United States	2 218	960	38 500	55/22/18/5/0
5	Ernst & Whinney	United States	2 191	1 174	35 600	58/20/22/0/0
6	Arthur Young	United States	2 053	843	33 000	59/21/20/0/0
7	Deloitte Haskins & Sells	United States	1 921	820	31 000	61/20/14/5/0
8	Touche Ross	United States	1 840	800	33 000	56/17/18/9/8
9	BDO Binder	Netherlands	783	155	12 421	58/27/10/3/2
10	Grant Thornton	United States	721	198	11 692	..
11	Norwath & Horwath	United States	556	315	11 200	60/15/20/5/0
12	Moores Rowland	United Kingdom	477	36	9 744	..
13	Dunwoody Robson	United States	402	292	8 049	..
14	Spicer & Oppenheim	United Kingdom	372	70	9 355	..
15	Summit Int. Asc	..	366	114	6 368	55/30/20/5/0
16	Pannell Kerr Forster	United Kingdom	317	94	7 287	59.4/21/12.4/4.2/3
17	Clark Kenneth Leventhal	United States	292	120	3 840	54/26/17/1/2
18	DFK International	United States	265	..	1 106	65/20/15/0/0
19	Moore Stephens	United Kingdom	263	64	4 525	46/26/20/6/2
20	Hodgson Landau Brands	..	199	..	4 043	61/17/22/0/0
	"Big Eight" firms		19 443	9 400	325 000	
	Top 20 firms		24 456	10 964	415 000	

Source: *International Accounting Bulletin*, December 1988.

Table 30.

The 20 largest management-consulting firms, 1987

(Millions of dollars)

	Firm	Country	World-wide revenues a/	United States revenues a/	Number of professionals world-wide a/ b/
1	Arthur Andersen	United States	838	522	9 600
2.	Marsh & McLennan	United States	530	393	6 400
3.	McKinsey	United States	510	255	1 600
4.	Towers Perrin	United States	465	380	3 085
5.	Peat Marwick	United States	438	253	4 700
6.	Booz Allen	United States	412	345	2 100
7.	Coopers & Lybrand	United States	381	199	4 700
8.	Ernst & Whinney	United States	374	230	3 255
9.	Price Waterhouse	United States	345	160	4 300
10	Saatchi & Saatchi	United Kingdom	267	176	1 500
11	Touche Ross	United States	248	157	2 100
12	Wyatt	United States	237	207	1 600
13	Arthur D. Little	United States	218	151	1 500
14	Deloitte Haskins	United States	209	91	2 300
15	Arthur Young	United States	204	133	2 400
16	Bain	United States	200	140	800
17	PA Management Consult.	United Kingdom	175 c/	..	..
18	Alexander Proudfoot	United States	170	60	1 100
19	Hewitt Associates	United States	161	152	1 400
20	American Management Systems	United States	145	145	1 600
	Total		6 527	4 149	

Source: "A Survey of Management Consulting", *The Economist*, 13 February 1988; Consultant News, *Directory of the Largest U.S. Management Consulting Firms* (1988).

a/ Management advisory service revenues only.
b/ As defined by company; does not include support staff.
c/ 1986 revenues.

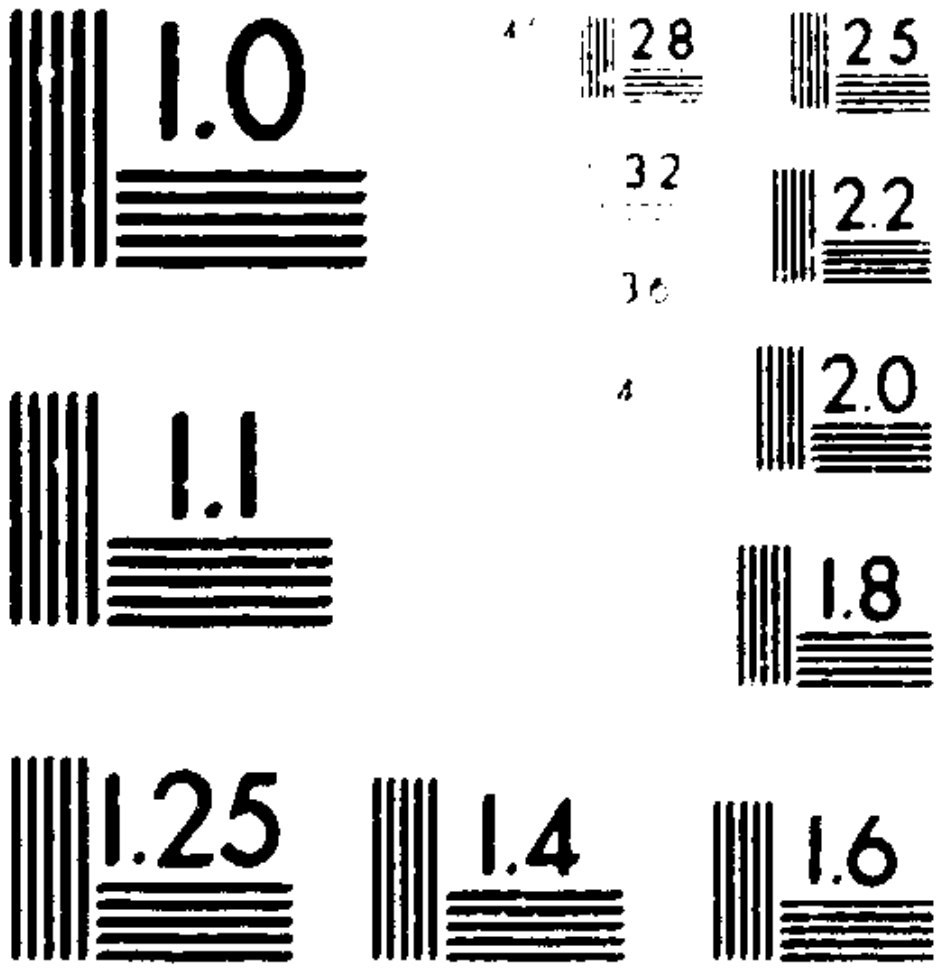

Table 31.

The top 15 firms in computer services

(Millions of dollars)

	Firm	Services revenues 1988	1987	Percentage change a/	Market share b/	Home country
1	Electronic Data Systems	1 907.6	1 440.5	32.43	9.7	United States
2	TRW Inc.	1 805.0	1 780.0	1.40	9.1	United States
3	Automatic Data Processing	1 617.0	1 467.0	1 0.22	8.2	United States
4	Computer Sciences	1 253.4	1 133.8	10.55	6.3	United States
5	Arthur Andersen	1 158.5	705.9	64.12	5.9	United States
6	Control Data	1 114.2	896.4	24.30	5.6	United States
7	Cap Gemini Sogeti	976.5	682.3	43.12	4.9	France
8	IBM	935.0	850.0	10.00	4.7	United States
9	NTT	847.0	565.6	49.75	4.3	Japan
10	Unisys	825.0	800.0	3.13	4.2	United States
11	McDonnell Douglas	791.0	825.4	(4.17)	4.0	United States
12	Martin Marietta	743.4	685.7	8.41	3.8	United States
13	Emhart	508.9	404.8	25.72	2.6	United States
14	General Electric	495.0	450.0	10.00	2.5	United States
15	American Express	446.9	383.0	16.68	2.3	United States

Source: *Datamation* (15 June 1989), p. 61.

a/ In local currency, Cap Gemini's services revenues were up 41.9 per cent to 5.8 billion francs and NTT's were up 32.7 per cent to 108.5 billion yen.

b/ Percentage share of Datamation 100 services revenues.

Table 32. Major areas of software development in advanced countries, 1982

(Billion dollars)

	Sales revenue	Major area	Global market share (%)
USA	10.3	Packaged s/w (56)	70
France	1.3	Customs s/w (70)	5 - 7
Japan	1.2	Customs s/w (95)	5 - 7
UK	0.7	Integrated s/w (54)	2 - 3

Source: EIAK/Information Industry Yearbook, 1986, Korea.

Note: Numbers in parentheses are percentages.

Table 33. Packaged PC software market, 1984-1990)

(In billion dollars)

Year	Total	US	Outside US
1984	11.1	8.4	2.7
1985	13.2	9.7	3.5
1986	16.2	11.6	4.6
1987	20.5	14.3	6.2
1988	26.3	17.9	8.4
1989	34.2	22.7	11.5
1990	45.0	29.2	15.8

Source: ADB, 1987.

Table 34. Revenue of United States information services industry

(In U.S. dollars billions)

	1978	1982	1986	1992
Processing services	5.58 (2089)	12.48 (2130)	21.32 (2110)	38.2
Software products	0.94 (7 ,2)	5.30 (1879)	14.78 (2705)	52.2
Professional maintenance services	1.23 (550)	5.33 (1348)	11.08 (1555)	33.9
Integrated turnkey systems	-	3.32 (1113)	6.85 (1162)	13.3
Total	7.75 (3391)	26.43 (6470)	54.08 (7532)	137.6

Sources: OECD, 1985: IPA, Informatization White Paper, Computer Edge, Japan, 1988.

Note: Numbers in parentheses are the number of companies concentrating on the corresponding category.

Table 35. Data processing expenditures for software and services, 1985-1990

(In billions of U.S. dollars)

	1985	1990	Growth rate
Australia	1,040	2,310	19 %
France	3,493	9,111	21 %
Germany	2,769	9,034	27 %
Italy	1,591	4,277	22 %
Japan	3,950	15,239	31 %
Norway	458	1,085	19 %
Sweden	692	1,781	21 %
Switzerland	519	1,560	20 %
United Kingdom	2,600	7,000	22 %

Source: ADB/Computerworld, CW Communication, 1987.

Note: Here, software and services include packaged and customs software purchase and consultancy, training, processing services (batch and remote). About 57 per cent of the total was software in Europe in 1983.

SECTION IV

NATIONAL AND INTERNATIONAL POLICY ISSUES FOR DEVELOPING COUNTRIES REGARDING INFORMATICS IN THE SERVICE SECTOR

National policies in developing countries on informatics and the service sector must be viewed, firstly, in relation to overall development and usage of informatics and, secondly, on the role envisaged for particular service subsectors. Increased usage of computers and telecommunications, including local manufacture of hardware and peripherals and software development, may not necessarily be directly related to the service sector, though these may well have earlier application in subsectors such as international and local banking transactions and in airlines, transport and hotel operations than in other fields. While there is obvious interaction between informatics and the needs of various service subsectors, the extension of informatics facilities and systems involves substantial resource outlays, high levels of skills and other major constraints for most developing countries and such extension would, in most country situations, be a gradual process. The role of particular service subsectors in the development process of particular countries may also be an important determinant for informatics development. In countries aiming to develop as global or regional centres for financial transactions, the latest facilities for international transfer of funds and information is an essential prerequisite. Similarly, in island economies with major tourism prospects, the use of informatics for tourism developments may be of vital significance.

It is increasingly recognized by policy-makers and decision-makers in developing countries that informatics and information-handling technologies have an important role to play not only in the manufacturing sector but also in the development of services, such as banking and financial services and insurance, tourism and travel, air and maritime transport, consulting and professional services and healthcare and social services.

Developments and applications in informatics and services in any modern economy are mutually intertwined. Effective information technology facilities and products are important for the growth of service activities. Similarly, services actually create new markets for manufactured goods, result in lower costs for manufacturers and are central to increasing the value-added by manufactured products. The same policy approach that stimulates or retards one sector will generally affect the other in similar ways. An appropriate policy framework must include development of the service sector as an essential element for overall national economic growth.

The development of the informatics sector and its extension to service activities is of vital interest to developing countries as this constitutes a critical phase of industrial and technological development. Such development is essential, both from the viewpoint of creating new employment opportunities and of developing competitive skills and capability in a period of rapid technological change. It needs to be emphasized that informatics often involves less capital investment than many other sectors. The number of jobs

created through an investment of, say, $1 million, tends to be higher in informatics than for several production sectors. The increased use and development of informatics in developing countries is also essential for overall technological development and capability to participate effectively in international markets. Usage of computers and modern communications equipment and systems needs to be gradually extended to various service sectors for greater efficiency and competitive capability in these fields. While the nature of application and usage may not be as extensive as in industrilized countries, informatics applications in services cover a wide range and have considerable potential for usage in all countries. At the same time, capability has also to be developed with respect to both hardware and software. It is essential, therefore, to develop a concerted strategy for production of software and such elements of hardware as may be feasible from a techno-economic point of view.

There is considerable scope for blending informatics applications in traditional service functions and activities, though this needs to be carefully assessed. Such blending is much more practicable than extending new informatics applications to industry and manufacture. While use of CAD/CAM needs to be made in various production sectors, a wide range of informatics applications can be extended to service functions fairly easily. Similarly, while numerically- controlled machine tools may need to be increasingly utilized, and also produced in certain developing countries, there must also be recognition of the growing pressure for increasing employment opportunities in many of these countries. It would be necessary to determine both the appropriate usage of computers and automated equipment and the extent to which human labour should be replaced in particular sectors and provided with retraining and other facilities, besides alternative sources of employment.

The development of local software constitutes both an essential prerequisite and a major opportunity for several developing countries. With relatively cheap availability of technical personnel in several of these countries, there is considerable potential for development of applications software, both for local services and for export markets in industrialized countries. Software development may require, apart from basic training in computer programming at local institutions, foreign linkages in the form of joint ventures or subcontracting arrangements with foreign software companies. With the enormous growth of new software applications during the 1990s, several developing countries can develop a niche for specific fields of software development, with training and incentives oriented towards such development and with linkages and joint ventures with foreign software companies.

The development of informatics hardware, apart from consumer electronics, also presents significant potential for several developing countries. It should be possible to undertake local production of a wide range of industrial electronics products in these countries. These could include desk-top computers; disk drives; flexible magnetic disks; component boards; keyboard assembly; display assembly; scanners; printers; plotters and memory storage devices. Besides, a wide range of discrete components can be locally produced, such as diodes, ranging from small, signal diodes to diodes for special applications; transistors, including bipolar power and microwave transistors and thyristors; ferrites; condensers; relays; tubes; hybrid circuits, including photo-receiver or transmitter packages; and integrated and printed circuits, ranging from linear, monolitic integrated circuits to

interface, and custom-integrated circuits. Audio components could include microphones, loudspeakers and amplifiers. In the communications subsector, local manufacture could be undertaken of telephone handsets, two-way communication sytems and manual and automatic exchanges, in progressive stages. Various instruments can also be locally manufactured, ranging from simple multi-meters to complex control instruments used in industry, power systems and the like.

For many of these products, the initial investment is not unduly high in relation to overall investments in the informatics sector. Production processes tend to be similar, so that initial techrological absorption could be rapidly extended to technological adaptation except, perhaps, at the higher ends of the technology spectrum. The acquisition of foreign technology should be possible as there are several alternative foreign sources from which simpler informatics technologies can be secured. At the same time, developing-country enterprises will need to assess information on alternative technology suppliers and negotiate suitable arrangements for technology acquisition and transfer. National laws and regulations will be an important factor in this regard, including laws on intellectual property rights and institutional norms and measures relating to foreign investments and inflow of foreign technology.

State intervention has been prominent, in particular, in the industrial strategies in informatics and semiconductors in India and Brazil. In addition to providing general policy framework and support, State-owned enterprises undertook production activities in these countries. In most other developing countries, foreign direct investments have been actively promoted and play a major role in the production of informatics products and semiconductors. In Malaysia, foreign-owned subsidiaries, mostly from the United States, account for the largest share of production, particularly in semiconductors. Singapore and Hong Kong are particularly open to foreign industrial investments and the majority of major producers in the field of components and industrial electronics are of foreign origin.

In a third group of countries, the situation is not as well-defined. In Argentina, the informatics policy established in 1984 promoted the establishment of joint ventures with foreign firms. Although no formal norms were adopted, wholly-owned foreign subsidiaries were not considered suitable for local absorption and development of technology. In Mexico, the policy announced in 1981 was also based on the establishment of joint ventures. However, after substantial changes in the overall foreign investment policy, 100 per cent holdings by IBM for microcomputer manufacture was accepted. In Venezuela, amendments to the foreign investments regulation have relaxed authorization procedures in the informatics field. In the Republic of Korea, the Government has significantly intervened to regulate foreign direct investment and to set conditions for the participation of foreign firms.

The various approaches reflect different perceptions of the advantages and disadvantages regarding the participation of TNCs. Countries concerned with building up indigenous industrial and technological capability have viewed such participation and control as a major limitation. The marketing power and technological superiority of TNCs may, in fact, create barriers to setting up new national enterprises, if these are forced to compete in an open market with the former.

At the same time, the development of informatics in developing countries has been, and will continue to be, based largely on the transfer of foreign technology through licences and alternative arrangements. In semiconductors, assembly operations by TNCs in the Republic of Korea, Malaysia and other South-East Asian countries did not involve any significant transfer of know-how, but considerable backward linkages have since been achieved in some of these countries. When Brazil, the Republic of Korea and India initiated manufacturing activities in computers and integrated circuits, they were able to obtain technology and know-how from foreign sources.

Together with a well-defined policy on informatics development, it is necessary for developing countries to review trends in the growth of their service subsectors. Where such service branches lag behind in technological usage, as may be the case in financial services or tourism where international transactions are involved, the technological gap should be covered. In some cases, this may involve foreign participation, as in the case of international hotel management or in offshore banking operations. In others, the informatics techniques that are used in industrialized countries can be acquired and adapted to local use. As indicated in previous sections, the technological nature and content of such techniques is not such that they cannot be extended or absorbed, once basic computer skills have been developed and the necessary informatics hardware is in position in particular developing countries.

At the international level, the recent debate on services and the liberalization of regulatory controls in the service sector has tended to focus on trade issues only. Many services and the role of informatics in services in many developing countries are regarded as essential infrastructure to be regulated and developed as part of the overall industrial development. However, the trends and developments in informatics in services in the industrialized developed countries requires policy-makers in developing countries to consider and examine the issue of liberalization of trade in services, as also the development of informatics in services. Because of multi-faceted informatics applications in the production, distribution and consumption of goods and services in any country, the role of informatics in services should be subject to carefully designed and balanced national policies, which may also lead to liberalization of trade in certain services, such as financial services, transportation and tourism and the like.

In several developing countries, as also in certain industrialized countries, regulations and limitations on foreign involvement either through trade or through investments in informatics and services are distinctive features of the government policies pursued in the past 40 years. Of course, in some developing countries there are different patterns of regulations of various services. State-owned enterprises are predominant in key service branches in most developing countries. Regulations on foreign investments in these fields often tend to be fairly sweeping, sometimes closing the whole range of activities to foreign involvement or ensuring a high degree of local ownership. At the same time, there is also a recent trend in several developing countries towards deregulation and privatization. The technological revolution brought about by developments and applications of informatics in services in recent years has raised several policy issues which need to be tackled, including facilitating the growth in international trade in services.

International organizations have an important role to play in promoting the development of informatics in services and varying degrees of liberalization of trade in particular services. It will be essential for UNIDO and other international organizations that are concerned with informatics in services (such as UNCTAD, UNCTC, the World Bank, ITU, IBI, ILO, FAO etc.) to assist developing countries to design and implement appropriate policies and strategies for the development of informatics and their application in various service subsectors.

In several developing countries many service industries, particularly business services, are developed only to a limited extent. Such facilities, including computer usage and advanced telecommunications and data services, are increasingly becoming the infrastructure for trading services internationally. To ensure that the developing countries benefit fully from the opportunities offered by increased international transactions in services, it would be necessary to ensure increased technical assistance to developing countries for strengthening informatics in services in these countries. Multilateral agreements on international transactions in services could, therefore, conceivably contain provisions concerning technical co-operation to be provided, including by international organizations.

The principle of economic development of developing countries finds expression today in most major international framework agreements. It is, therefore, relevant to all negotiations, including those on services. It is generally recognized that informatics technology is likely to play an increasingly important role in economic development. The nature and pattern of growth of the informatics sector in developing countries is a major and critical issue for the 1990s and greater attention needs to be devoted in international negotiations to ensure that the technology gap in this sector does not increase further.

The growth pattern of the service sector, on the other hand, is a complex issue and the objective of development of local technological capability must be taken into account, together with utilization of national skills in services in particular countries. In the Special Session of the Contracting Parties at Punta del Este in September 1986, it was decided to launch negotiations on trade in services with the aim "to establish a multilateral framework of principles and rules for trade in services, including elaboration of possible disciplines for individual sectors, with a view to expansion of such trade under conditions of transparency and progressive liberalization and as means of promoting economic growth of all trading partners and the development of developing countries. Such framework shall respect the policy objectives of national laws and regulations applying to service and shall take into account the work of relevant international organizations". It was also decided that GATT procedures and practices shall apply to these negotiations and a Group of Negotiations on Services was established to deal with these matters.

In view of these negotiations, the role of services has assumed special importance in the international context. Since interests of industrialized and developing countries are very widely divergent, it is difficult to anticipate the outcome of the negotiations. It is, however, clear that the role of the service sector has been recognized as being critical for both industrialized and developing countries and the latter must ensure, during the 1990s, that they do not lag behind technologically in the growth and development of their respective service branches and subsectors.

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ACRONYMS

ASEAN	Association of South-East Nations
ATM	Automated teller machine
CAD/CAM	Computer-aided design/manufacture
CAPRE	Co-ordinating Commission for Data Processing Activities (Brazil)
CAT	Computer-aided tomography
CATV	Community Antenna (Cable) Television
CD	Certificate of deposit
CDC	Control Data Corporation
CGE	Compagnie Générale d'Electricité
CII	Compagnie Internationale de l'Informatique
CIM	Computer-integrated manufacture
CMC	Computer Maintenance Corporation (India)
CNC	Computer numerically-controlled
CPU	Central processing unit
CRS	Computerized reservation system
DARPA	Defence Advanced Research Projects Agency (USA)
DEC	Digital Electronics Corporation
DRAM	Dynamic random access memory
EC	European Community
ECE	Economic Commission for Europe
ECIL	Electronics Corporation of India
ECR	Electronic cash register
ECU	European Currency Unit
EDI	Electronic data intercharge
EDP	Electronic data processing
EFT	Electronic funds transfer
EIAK	Electronic Industries Association of Korea
EPLD	Erasable/programmable logic device
ESPRIT	European Strategic Programme for Research and Development in Information Technologies
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign direct investment
FEACO	European Federation of Management Consultants
FMC	Flexible manufacturing cell
FMM	Flexible manufacturing modules
FMS	Flexible manufacturing systems
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GNP	Gross national product
IBI	Intergovernmental Bureau for Informatics
IBM	International Business Machines
ICL	International Computers Limited
ILO	International Labour Organisation
IMF	International Monetary Fund
IPA	Information and Technology Promotion Agency
ITT	International Telephone and Telegraph Corporation
ITU	International Telecommunication Union
JIT	Just-in-time
LAN	Local area network
LOTIS	Liberalization of Trade in Services Committee
LSI	Large-scale integration (of circuits)
MCA	Management Consultancies Association (U.K.)

MITI	Ministry of International Trade and Industry
MPT	Ministry of Posts and Telecommunications
MRI	Magnetic resonance imaging
NC	Numerical control
NCMT	Numerically-controlled machine tool
NCR	National Cash Register
NCSDCT	National Centre for Software Development and Computing Techniques
NEC	Nippon Electronics Corporation
NIC	National Informatics Centre (India)
NTT	Nippon Telegraph and Telephone Corporation
OECD	Organisation for Economic Co-operation and Development
PABX	Private Automatic Branch Exchange
PAL	Programmable array logic
PC	Personal computer
PCM	Pulse code modulation
PET	Position emission tomography
PGA	Programmable gate array
POS	Point(s) of sale
PTT	Post, Telephone and Telegraph
RACE	Research and Development in Advanced Communication Technologies for Europe
RISC	Reduced instruction-set computing
SCRAM	Static random access memory
SEI	Secretaria Especial de Informatica (Brazil)
SITA	Société Internationale des Telecommunications Aeronautiques
SWIFT	Society for Worldwide Interbank Financial Telecommunications
TDM	Time division multiplexing
TNC	Transnational corporation
TQC	Total quality control
UHF	Ultra high frequency
UNCTC	United Nations Centre on Transnational Corporations
VCR	Video cassette recorder
VHF	Very high frequency
VLSI	Very large-scale integration (of circuits)
WTO	World Tourism Organization

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