An Outline for Policy Analysis

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ISSN 1564-8370

International Workshop on
The Information Revolution and Economic
and Social Exclusion in Developing Countries
Maastricht, 23-25 October 1996

A Workshop funded by the
Ministry of Development Cooperation of the Netherlands
Editor's Note

With pleasure we present to our readers the special series of UNU/INTECH Discussion Papers: Information Revolution and Policy Implications for Developing Countries. Papers of the Series were originally developed for the International Workshop on The Information Revolution and Economic and Social Exclusion in Developing Countries, held in Maastricht on 23 -25 October 1996. The Workshop was an important event organized by UNU/INTECH and financed by the Dutch Government. Insights developed from the Workshop have not only been benefiting UNU/INTECH research work, but also contributing to many other initiatives in the area of innovation policy for information technology in developing countries.

There are six papers in the special series. The first five papers have been widely circulated and are provided here in the latest modified versions. These are outcomes from the two major themes set for the Workshop: ‘The Developments of Access and Effective Use of Information Technology and Exclusion’, and ‘The Gender Dimension in Exclusion’. The sixth paper, by Ludovico Alcorta, is a summary of the three country cases on Burkina Faso, South Africa and Tanzania organized for the Workshop.


#2002-2* Constantine Vaitsos, “Policy Agenda for the Information Revolution and Exclusion Phenomena in Developing Countries”


#2002-4* Carlos M. Correa, “Implications of Intellectual Property Rights for the Access to and Use of Information Technologies in Developing Countries”

#2002-5* Cecilia Ng Choon Sim, “Making Women’s Voices Heard: Technological Change and Women’s Employment with Special Reference to Malaysia”

#2002-6* Ludovico Alcorta, “The Information Revolution and Economic and Social Exclusion: The Experiences of Burkina Faso, South Africa and Tanzania”

A particular notification:

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AN OUTLINE FOR POLICY ANALYSIS

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1 In preparing this paper, I have drawn liberally on the ideas developed in the national papers on Burkina Faso, South Africa, and Tanzania presented to the UNU/INTECH Workshop on the Information Revolution and Social and Economic Exclusion. I also benefited from discussion over two days in the University of Cape Town with Dr David Kaplan, Director of the Science and Technology Policy Research Centre, Mr James Hodge of the Centre, Dr Jonathon Miller of the Graduate School of Business at the University of Cape Town, and Dr Haji Semboja of the Economic and Social Research Foundation of Tanzania. I must also acknowledge the invaluable support and inspiration I have drawn from my research colleagues at UNU/INTECH, who share responsibility for any good things in this paper. Professor Swasti Mitter took time from her overcrowded schedule to give detailed and invaluable comments and, as so often before, I am very grateful to her.
CONTENTS

1. INTRODUCTION 7

2. INDUSTRIES AND FIELDS OF APPLICATION: SOME DEFINITIONS 11
   THE INFORMATION INDUSTRIES 12
   SOCIAL, ECONOMIC, AND TECHNOLOGICAL INFRASTRUCTURES FOR EFFECTIVE APPLICATIONS 13
   AREAS OF APPLICATION OF INFORMATION TECHNOLOGY 15

3. PROBLEMS OF ACCESS AND ITS IMPROVEMENT 17
   ACCESS AND THE PRODUCTION OF INFORMATION TECHNOLOGIES 17
   ACCESS AND THE SOCIAL, ECONOMIC, AND TECHNOLOGICAL INFRASTRUCTURE 21

4. NOTES ON TECHNOLOGICAL CHANGE, INFORMATION TECHNOLOGIES, AND LEARNING PROCESS 27

5. FINAL POINTS 33
1. INTRODUCTION

The concept of an “information revolution” has been interpreted in various ways. At an early stage it referred pre-eminently to rapid changes and advances in the capacity to process information in a digitised form in both production and service sectors (informatics). More recently, the term has been used somewhat more narrowly to describe the striking technological developments that have emerged from the interaction of information processing capabilities with telecommunications systems (telematics). The emergence of a set of new service functions associated with the Internet is an example. In this paper, it is intended to use the terms information technology and information revolution in a somewhat broad sense, designating the information processing/telecommunications interaction, but also the development and application of information processing systems that may not be seen as part of the development of telematics per se.

As in the case of other major technological changes, it is to be expected that the information revolution will have a basically progressive impact in the world economy, opening the way to increased efficiency in production and improvements in the welfare of populations. These positive effects will flow partly from effects on production methods (e.g., the development of new manufacturing methods and systems such as CAD/CAM); partly from the efficiency effects working through major improvements in service operations linked to production (e.g., improvements in the responsiveness of production systems to consumer needs because of improved access to market information); and partly through direct impacts of the information revolution on many service operations which are directly used by consumers (e.g., banking and finance, household information activities, and the delivery of social services of various kinds, including education). In other words, IT may be expected to increase production capacities, enhance the quality of life, and open new employment opportunities.

At the same time, it is to be expected that the information revolution, like most other technological transformations, will have some consequences which are less obviously desirable. These will be particularly relevant from the point of view of global and national equity.

2 In some definitions broadcasting, publishing, and other media are included in the convergence.
For example, rapid advances in information technology affect the terms of competitiveness between countries even in sectors such as garments, which a decade or so ago were regarded as relatively stagnant technologically, and therefore well adapted to conditions in countries which had a weak “technology base” and an abundance of unskilled labour. These countries may be excluded from the benefits of information technologies. Rapid technological change internationally may well pose major problems of transition for them especially under modern conditions of liberalisation. The information revolution likewise will have differential impacts on specific groups within countries. Even in a country that is successfully linked to the global informational economy, some groups women assembly workers, for example may be excluded because of their insufficient access to learning processes and thus to new skills. At the same time, the application of information technology will create new opportunities for some: there will in short be inclusions as well as exclusions.

This paper is especially concerned with the possibilities of exclusion and inclusion from applications of information technology for countries and regions and for social groups. It will doubtless be felt that the emphasis in the paper is predominantly on potential and actual exclusions, and that the paper is to that extent unbalanced. That may indeed be the case, but the prospect of exclusion and its economic and social implications are major concerns in a number of poorer countries with limited technological skills many, but not all, in the sub-Saharan region, for example and it is legitimate that these concerns should be specifically addressed. The bias, if there is one, results from this focus, not from a conviction that the impacts of information technology are bound to damage the poor and weak. And the orientation of the paper is toward understanding the mechanisms that might lead to exclusion in order, if possible, to correct them. There is also a certain emphasis in the paper on definitional questions, in the interest of establishing some degree of agreement about categories and concepts.

The discussion will proceed from the near-truism that the conditions of access to information technology will determine whether or not individuals, social groups or whole countries are excluded from its benefits. We will think of restrictions on access as arising in two broadly defined ways. First, access may be restricted if, for one reason or another, those seeking to use the technology simply cannot get hold of it. This might happen, for example, if a potential producer of information technology is excluded from key components because of patent protection (though more commonly patents do not make for absolute exclusions, they simply make access more expensive). Second, access may be restricted because the potential user does not have the capability to choose sensibly what is needed or to use the technology even if it is
easily available. This second dimension will play a major part in the discussion which follows. Access, on this broad definition, determines importantly the welfare effects of information technology, especially through the influence it has on who gains and who loses from an application of such technology, or, in a widely used jargon, on the distributional effects.

The paper will proceed as follows:

- In the second section there is a description of the range of industries and fields of application that are involved in the supply and use of information technology. This is not exhaustive or even particularly informative; its purpose is to give some precision to the field of interest involved in policy research on information technology. It is, therefore, more definitional in purpose than analytic.

- In the third section there is a discussion of the different problems of access to information technology that may arise. This uses the framework set up in the second part. It distinguishes problems of access associated with the “supply side” that is to say, with the industries supplying the different components of information technology, from problems encountered by users of information technology the “user side”.

- The fourth section underlines the importance of learning processes in determining access, especially where users of information technology applications are concerned. It argues that the accumulation of technological capability is a critical requirement for successful access to information technology.
2. INDUSTRIES AND FIELDS OF APPLICATION: SOME DEFINITIONS

The development and application of information technologies involves numerous industries and social institutions. These are well known, but it is nevertheless helpful to give a short description. We will distinguish three main categories:

- the manufacturing and service industries involved in supplying various components of information technology;
- the social and economic infrastructures needed for the effective application of information technology;
- the institutions and social groups involved in applications.

The fact that these different categories are involved in the development and application of information technologies does not really distinguish them from other types of technological innovation. Most innovations pose new requirements for producing industries. Most pose new infrastructural requirements, involving plant and equipment for application of the technology, human skills to exploit it properly, and investments in public utilities of various kinds. And most innovations impose new divisions of labour in society, and so involve a range of institutions and social groups in their application.

Thus we could discuss the development and application of many technological innovations in the same categories as we have proposed for the analysis of information technologies. But development and application of information technologies nevertheless pose new challenges and problems, which may not be different in kind, but certainly seem so in magnitude. For one thing, the speed of innovation both major and incremental seems exceptionally high. And for another, the number of sectors of social and economic activity that may be involved in any single innovation is typically much greater than for other technologies which are more sector-specific.

It is indeed these differences in magnitude of impact which lead to a concern about the implications of information technologies in developing countries. Once again, the impacts of
technological changes in general in developing countries, have long been a matter of interest in policy-oriented research. This is reflected in a large body of empirical research on output and employment effects, on implications for trade and competitiveness, on the changes in international and intranational distribution of welfare which might result from technological changes. All these questions are raised about the impacts of information technologies: but they are raised a fortiori, because of the speed of innovation in information technology and the widespread pattern of impacts of these technologies.

The Information Industries

It is helpful to think of the information industries which supply the equipment and systems required for the application of information technology as comprising the following three categories:

- The manufacturing sectors producing computers and ancillary equipment, including network equipment, and the sectors producing telecommunications capital goods.
- The service sectors producing software for IT applications across a wide range of user sectors
- The service sectors providing supporting services for applications in the form of consultancy and advisory activities.

Since manufacturing and services enterprises may be engaged across several of these activities, this is not a completely satisfactory framework for classifying firms. But it is a reasonable (if simple-minded) way of grouping key activities. The extent to which each of these activities is present in different countries varies considerably even in countries where information technology applications are well advanced. There are countries without any significant hardware manufacturing capability where applications are nevertheless well advanced. In fact, the supply of all the goods and services in the categories set out above is highly internationalised. Even countries which are highly advanced in the manufacture of computer systems or telecommunications equipment rely heavily on licensing and joint venture arrangements for part of their hardware requirements. There are different reasons for this, depending on the goods and services in question. In the computer sector, for example, innovative leads change quite rapidly, and no firm is likely to hold a world market hegemony for long. In a liberalised world market, users in most countries will accordingly switch suppliers quite frequently.
In telecommunications, there are important scale economies in the production of standard equipment, and most countries import their requirements from a relatively small group of firms in a few highly industrialised countries. In software production, more traditional sources of comparative advantage are starting to determine the international location of production, and so induce new patterns of international specialisation: India, for example, has a relative abundance of software programmers at relatively low wage levels, and is a major world exporter. Advisory and consultancy firms are also internationalised, though here there are probably more important locational requirements: to be effective, consultants probably have to be close to the user enterprises.

It is useful to keep in mind that the information industries are capital goods sectors. Many of the questions which were raised in the past about the desirability of developing countries having a capability in the production of capital goods (such as machinery and equipment in general) have been raised in relation to the information industry. The central question, which has precise parallels in older debates about capital goods, is to what extent various parts of the information industries may have to be present in a country to facilitate effective application by users. In practice, the question has been answered differently by policy makers in different countries. In Brazil and some other larger Latin American countries, as well as in India about a decade ago, policy has been importantly based on the idea that nationally based and nationally owned information industries are important for the successful use of information technologies elsewhere in the society. Probably this is a much less widely held view today, partly because liberalisation has largely brushed away the apparatus of trade protection that was central to the pursuit of such policies. However, there is still a good deal of debate about these matters in relation to information technologies, and we will return to them later.

**Social, Economic, and Technological Infrastructures for Effective Applications**

If it makes sense to think of the information industries described in the preceding section as a modern emanation of the capital goods sector, then it is also sensible to think of what has become known as the national infrastructure for application of information technology as essentially composed of key items of capital stock needed to make proper use of information applications. These elements of national infrastructure or national capital stock in information systems are essential for effective use of applications. They fall into four main groups:
• The stock of computers in the country. This includes mainframe and mid-range computers as well as the institutional and household stock of personal computers. The available stock of computers is most likely a function of the level of wealth (and so also of income levels).

• The stock of software in the society. This includes for example, the computer operating systems in use, and software for operating networks.

• The stock of telecommunications equipment. This is a critical part of the infrastructure for information technology. Issues include the effectiveness and reliability of the existing system (which is usually a function of the age of the capital stock comprising it, and of the level of national wealth), the reliability and competence with which it is managed, and its geographic coverage, as well as such matters as bandwidth availability. Given the difficulties which poor countries often experience with telecommunications systems, it is hard to overestimate the importance of their role in information technology applications. In these countries, the question of how far limited network systems might be developed with minimum reliance on national telecommunications may be important, as will the possibility of by-passing archaic national systems, for example by using satellite communications.

• The stock of human skills in the development and use of information technology and information technology applications including all those skills acquired through experience in operating information systems such as local and wide area networks, and including also the skills needed in the management and operation of telecommunications networks.

In line with the idea that it is useful to think of the national infrastructure for information technology as constituted by capital stocks, one can divide the list of elements of infrastructure into items of physical capital e.g., computers, computer networks, software, and telecommunications equipment in operation and items of human capital e.g., the skills needed in running information technology systems and the telecommunications system. The value of thinking about infrastructure in terms of capital stocks is that it provides an ordered approach to analysing the infrastructure, e.g., in terms of such things as the obsolescence or otherwise of equipment, or the knowledge and skills available; it also emphasises the fact that the construction or reconstitution of the infrastructure requires major investment, which will have various gestation periods, and so require careful attention to timing.

However, while it may be useful to look at the question of infrastructures in this broad way, in terms of stocks of capital, it is important not to overlook the institutional structures in which
these capital stocks are so to say embedded. And it is also important to understand the economic and social histories that have made these stocks of physical and human capital what they are, and have distributed them in certain ways within and between national economies. For example, if computer capacity is available only to a small group of high-income people, this may be the result of the dynamics of income distribution in general in the society; or if women are disadvantaged by having lower levels of technological knowledge, this will most likely be the outcome of a gender bias in the education system and in employment patterns.

Access to information technology applications will depend in general on the successful operation of all parts of the national infrastructure as defined here. And differential access to the various components of the infrastructure will be an important factor in the distributional effects of information technology applications in other words, in the inclusions and exclusions which may result from it. We will therefore return to the concept of the national infrastructure as a set of important capital stocks, in the discussion of access in Section III.

Areas of Application of Information Technology

At this point let us note that the range of applications of information technology which are of immediate or potential interest in developing countries is wider than is sometimes recognised. Some tend to discuss the problems of the information revolution in developing countries simply in terms of communications connecting to the Internet and related matters but in fact, as most will agree, there is a much wider range of concerns. A sketch of the main fields of IT application follows.

First, IT investments are found in the provision of a wide range of services which are normally the business of the private service sector. Typical of these are retailing (whether on the Internet or in its more conventional forms), banking, insurance, financial and stock market services, and more general informational activities for the general public. IT is also increasingly used in the provision of public services and in public administration for example, in health services, education, tax collection, or the distribution of public welfare. In some countries it has a considerable field of application in policing. Within the production sectors IT is widely used in ancillary activities such as inventory control (where it has had a critical role in the development of “just in time” manufacturing systems as well as in more run-of-the-mill inventory systems),

3 Some writers define national infrastructure in more limited ways, including mainly the telecommunications system and closely related components.
or in support of enterprise administration and secretarial functions. IT is also importantly used in the *control of production* within enterprises for example, in CAD/CAM systems, or in the dedicated computer systems used in process control in sectors like the chemical, oil, and gas industries.

In addition, of course, specific applications in informational activities proper and in networking activities have become very important. Internet applications, e-mail, and related forms of communications have grown extraordinarily rapidly. So have database services. The networking of computer systems has become a key activity, not only in obvious areas like the Internet, but at the level of firms (where it may be used to integrate marketing, design, and production information), in other intra-institutional applications across a very wide range of sectors, in national information systems like the French Minitel, and in similar systems under consideration or in application at the national level in some European and Asian countries.
3. PROBLEMS OF ACCESS AND ITS IMPROVEMENT

We started with the assertion that exclusions and inclusions of the application of information technologies are determined in the first instance by the conditions of access. It is now time to return to that idea, perilously close as it is to tautology, and to indicate how it might be given empirical content.

The description just given in Section II deals with the organisational and institutional forms that mediate and determine the role of the production and application of information technology in societies. We can use this description to show some of the main determinants of access.

These fall under two main headings:

- problems associated with the terms on which information technologies are produced and sold in the world market;
- problems associated with the human and physical capital stocks available to support the application of information technology in other words, with the national infrastructure as defined in Section II.

Access and the Production of Information Technologies

We identified three main agencies involved in the production and application of information technologies: the manufacturing sectors which make telecommunications and information hardware (including, of course, the computer industry); firms involved in the production of software; and the advisory and support services needed to aid applications in society. A first question is: to what extent do these different agents have to be present in a national economy in order to assure effective application of information technologies i.e., to avoid exclusions of the country or of elements of the national society from the application of information technologies?

Behind this, as we have already suggested, there is a rather old-fashioned question, which harks back to venerable debates on the necessity or otherwise of having the production of capital goods in developing countries as a basis for industrialisation. The key argument of those who believed that the physical presence of capital goods production was necessary to national
projects of industrialisation was that the “deep” sectors of the economy were likely to generate important external economies in the form of technological capabilities, which would not be present without them. Let us note in passing that, whatever its ultimate empirical merits, this is an argument more likely to hold in the context of countries living in a high degree of economic isolation, behind trade protective barriers, than in the context of a liberalised world economy. It is not surprising, therefore, that the underlying model was drawn in the first instance from the early development experience of the Soviet Union and in the post-war years from the Indian Second and Third Five Year Plans, inspired by Mahalanobis. It is probably not useful to reiterate the terms of the earlier debates, but it may aid discussion to make three (probably contestable) points, which help to squeeze out some questions which are relevant to the question of information technology in particular. The first is that in actual practice, the capital goods strategy was only really implemented in a very few economies in India and some of the larger Latin American countries. Whatever its merits in generating technological capabilities (and there are certainly people who argue that it did so say in India or Brazil), it also resulted in a supply of high-cost producer goods to local user industries, which caused considerable problems of competitiveness in subsequent shifts to more open economy systems. Precisely similar arguments are made nowadays about attempts to set up nationally-based information technology production in developing countries, notably in Brazil and, to some extent, in India. This is argued by some to have been counter-productive because of the resulting high cost of informatics equipment to local users. Others defend the policy, if only in part, on the grounds that it created technological capabilities which were subsequently very important in the diffusion of information technology applications.

In short, the earlier debate continues, albeit in a somewhat disguised form, and about a very different type of industry from the classical capital goods industries of the Soviet and post-war Indian models. It is, however, much attenuated by the dominant (and indeed, after the Uruguay Round, legal) requirements for more open economic systems.

The second point which may be drawn from the earlier debate is that although a number of countries did eventually establish economically successful production of capital goods, they did so largely to meet international demand, rather than on the lines required by the closed economy model. Some of the Southeast Asian NICs established vigorous export production of mechanical and electrical machinery by interventionist policies often described as technological upgrading. Interestingly, technological upgrading postulates a process which runs in precisely the opposite direction to the idea that capital goods production is needed to generate technological
capabilities that then spread through other sectors. In upgrading, technological capabilities generated in the lighter industries, based on consumer goods production, eventually provided the skill basis for the export-oriented and highly successful machinery industries which followed them temporally. And, as is directly to the point here, the South Korean and Taiwanese information technology industries, now entering chip production in a major way, also followed this line of development: arguably, the skills built up in consumer electronics as well as in large-scale information technology applications created a basis for the subsequent growth of the production sector.

Third, it remains true that the older argument about the role of the capital goods sector in the industrial economy was right in focusing on the importance of technological externalities in the economy: at the most general level, on the fact that production processes themselves are important in creating technological capabilities. Unfortunately, there is still a good deal of vagueness about which processes are needed for any particular set of skills, and also about where the skill returns to production, if one may call them that, are significant. And there is also an unresolved debate, likely to be important in relation to information technology systems, about whether the older “deep sector first” strategies such as followed in the eighties in Brazilian informatics policies are more or less effective in generating the capabilities needed for countries to get access to information technology systems than the more recent “technology upgrading” strategies of the older (and newer) NICs.

However, aside from the question of which of these types of strategy might be more effective in creating information technology skills, it is pretty safe to conclude from the available evidence that effective application of information technology systems does not depend on countries being able to produce hardware. Production of information hardware and telecommunications capital goods is highly concentrated in a very few countries, yet those countries in Europe and Asia which do not produce these goods have been able to achieve very high rates of diffusion of information technology systems in the national economies. Furthermore, if South Korea and Taiwan have made rather successful applications of information technology systems, it is not because they are increasingly good at making computers, but because they have built up a relevant skill base in other ways. The timing of events in these countries bears this out: they were good at using information technology systems before they got good at making silicon chips. The same must by definition be true in countries like Singapore, and others in Southeast Asia, which are not yet engaged in the technologically higher levels of hardware production.
Software production and services to support application which we earlier identified as the other important activities of the information industry may be a somewhat different matter, although it is still not clear that a definitive argument can be made that countries need to produce software in order to use it well. There are, however, some important differences from the arguments about information technology hardware.

First, application support services are needed to support and further virtually all applications, and at early stages these are usually provided by specialised firms and agencies. This is nowadays true even of applications specifically designed to be user friendly to non-technical people, such as word processors; it is even more true of custom-made industrial applications or systems to deliver consumer services through networks. To an important extent, these support services need to be immediately and quickly available, and therefore to be locally present. This does not preclude that at the higher levels of technological complexity there may be trade in user services; it is simply that there are day-to-day service needs (which anyone who has tried to get a network to function will appreciate) that probably have to be available in immediate proximity. So the presence of application support services is very likely essential if countries and populations within them are to have effective access to information technologies. Those who struggle with e-mail access in out-of-the-way places (in industrialised Europe just as much as in the so-called Southern countries) will attest to this, and also to the cost of breakdowns.

Second, the boundary between application support services and software development skills is not very clearly defined. Some support operations require the service provider to programme and develop customised solutions, even in simple applications and once programming capabilities are mobilised, the development of software for new applications is never far away. There are probably important externalities here, through learning by doing in application support activities, though there seems to have been little research on the matter. The implication is that where the support for applications is present and operating successfully, software development is quite likely to follow, at least for local adaptations.

Third, there is clear evidence that some developing countries have shown comparative advantages in software production, because it is an activity intensive in the use of human skills and capabilities, which they have available, yet not too intensive in the need for investments and advanced manufacturing capabilities, which are less abundant. India, which has become a major world exporter of software and programming services, is a case in point. Fragmentary evidence from India, suggests in addition that initially export-oriented software and programming
activities have also had an influence on new applications (and software markets) in India itself, and that there may be important learning externalities because of the presence of the software industry itself.

There is not much doubt that the software end of the information industry is, in principle, more appropriate to conditions in developing countries than the hardware side, but the extent to which software capabilities are necessary to successful applications of information technology systems is not clear.

There is a more convincing and obvious argument that various other support services must indeed be present, and, as we have suggested, these may naturally develop in the direction of software production under ordinary market pressures. But, from a policy point of view, that is a somewhat different matter.

So far we have dealt with the information industry itself in terms of whether countries need to establish production of information technology outputs hardware, software, and supporting services in order to facilitate successful applications in other words, in order to avoid being “excluded”. The underlying, and arguably defensible, assumption is that, for most developing countries, the first requirement to avoid exclusion is to be sure of the capacity to use information technology applications. It is, however, legitimate to raise a further question, relevant especially to those countries which are developing some parts of the information industry itself: whether there are dangers of these countries being excluded from entering production of hardware and software. It is essentially about the impact of intellectual property protection, in the form of patents and copyrights, on information technology production in developing countries. It is, of course, an important part of the framework for policy analysis in many countries in the first instance those which are able to establish software industries. It is, however, too large a question in its own right to be tackled in this paper.

**Access and the Social, Economic, and Technological Infrastructure**

The social, economic, and technological infrastructure for information technology was defined in Section II as consisting of a number of important capital stocks, viz., the stock of telecommunications equipment, the stock of computers and ancillary software (operating systems and applications), and the stock of human skills in the development and use of information technology applications. It is natural for economists to think of these as a set of
capital stocks which reflect the initial conditions for application of information technologies. But the infrastructure cannot be described adequately in a purely quantitative way, and the institutional environment in which the capital stocks are set is also important.

As explained in Section II, access to information technology depends upon these capital stocks: telecommunications is essential for a wide range of applications; access to computer capacities is also essential; and the stock of human skills similarly so. Evidently then, increasing the availabilities of these capital stocks, improving the efficiency with which they are used, and making them available to parts of the population which are presently deprived of them, are all likely to be important objectives of a national policy designed to diminish exclusion from information technology. However, these purposes are not always as easy to achieve as may appear. The problem is that the present state and dispositions of the stocks are path-dependent, to use a currently fashionable term: they are the outcome of past social and economic histories. And the social and economic forces that were at work in forming those histories have to be understood in order to devise policies to improve the situation (assuming that such policies actually exist). A few hypothetical but recognisable examples illustrate the problems.

Take the case of the telecommunications infrastructure: a common problem in poor countries is that this is technologically out of date and under capacity. It may also be run down through lack of repair and maintenance, and it may cover a quite small part of the geographic area of the country. In many countries for example, in the sub-Saharan region the telecommunications infrastructure has deteriorated markedly in recent years, largely because of a failure of state investment. This is a deep problem which is unlikely to be solved by exhortation. Underinvestment by the state in most of the poorer sub-Saharan countries is a result of macroeconomic policies designed to achieve fiscal balance. State capital budgets are always easier to cut for clear political reasons than current budgets. Maintenance of the telecommunications system may have much less immediate appeal than, say, a set of subsidies for current consumption. This type of underlying conflict is part of the context in which information technology policies must operate. In many African countries even relatively rich ones like South Africa the only solution for the creation of a modernised telecommunications structure is seen to be privatisation of the telecommunications network, along with the setting of rates more in line with commercial exigencies, though even this option usually depends on attracting foreign investment into the local telecommunications sector. This is one example of the difficulties that may flow from patterns of path-dependency.
Similarly, the size and distribution of the computer stock and the stock of software are the outcome of prior economic histories. This is most clearly seen, perhaps, in the case of private ownership of computers, which is nearly always closely related to the distribution of wealth and income in the population at large. Policies to redistribute access to computer capacity, which are likely to figure in most information policies in poor countries, will have to address this underlying problem. It is a severe one; the social and economic forces determining the distribution of income and wealth are strong, and they are customarily held together by equally strong political forces. While income levels remain generally low and income growth limited, policy makers will need to find ways of extending access to computer capacity to the population at large, that are not dependent on individual incomes and wealth. Education may have a direct role to play in this process. Again, the issue of path dependence is present: the social and economic structures which have produced the present state of affairs are in most countries still in the ascendant. And they have to be addressed, and perhaps by-passed, if the situation is to be changed.

Finally, and perhaps most difficult of all, there is the supply of human skills needed in the development and use of information technology. One difficulty here is a technical one: we are simply to a degree ignorant of where these skills come from. In part, of course, the formal education system is a source for some particular technical skills programming skills or system maintenance skills but even here it seems that in technologically fast-moving fields a good number of skills are acquired by various types of individualised learning process on-the-job learning of one form or another. The situation is even less clear in relation to user skills. The processes by which new users of information technology applications for example, computer banking services either come to terms with them and learn to use them effectively or fail to do so are hardly understood, and we do not really know whether formal education plays a part in people having the ability to acquire them (though we do know that at present many probably most user skills are acquired outside the formal education system).

To the extent that formal education plays a role in providing the skills needed to use information technology applications, it will inevitably impart to the acquisition of those skills the biases that may already be built into it. For example, the massive racial biases built into the South African education system by the apartheid regime will continue for a long time to prejudice educationally disadvantaged groups in their ability to come to terms with the skills needed to use applications. In this they are reinforced by the biases which income disparities and consequent lack of access to computer capacities have already created. And there are other
important sources of bias in most educational systems certainly not just Third World ones. There are, for example, some well-known self-reinforcing biases against the poor in most education systems. In the case of education related to the application of information technologies, these are likely to be strengthened by the fact that most poor people in developing countries leave formal education at the primary level, whereas the skills needed to cope with applications of the new technologies are probably not really accessible until the secondary level.

And there are other examples. The widespread bias against women in technical education is still a major problem in European countries, and it appears to be entrenched in the sub-Sahara. It is an outcome of strongly held prejudices about women’s role in society and in the household. It does not bode well for women’s participation in the benefits of the information society. In the next section, the issue of learning and skill acquisition is discussed in further detail.

This discussion of the role of social and economic infrastructures in the applications of information technology has emphasised their importance in determining who is likely to be included and who excluded from such benefits as the applications of information technologies are likely to generate. It has also hopefully opened the way for another conclusion, which though it may seem obvious, is so important that it needs to be drawn out of the analysis. Aside from the major macroeconomic issues which arise in regard to the development of the telecommunications sector, the other infrastructural factors give rise to the possibilities of exclusion from information technology benefits because of the operation of the same social forces which have always underlain distributional inequalities in developing countries. These are maldistributions of income and wealth, on the one hand, and (often closely related) inequities arising from the way the education system works, on the other. The risk is therefore quite clear: if the introduction of information technology in fact leads to important economic and social advantages if information technologies are in that sense a “good thing” they may nevertheless reinforce an already existing system of inequalities. Indeed, if they are applied without attention to the potential exclusions which existing income distribution and educational bias may introduce, we could face an outcome where the more successfully the new technologies can contribute to human welfare at the individual level, the more decisive they may be in deteriorating the distribution of welfare and generating socially damaging exclusions. The only recourse in this case is to policies which tackle the tendencies to exclusion directly if not at root (which in the case of income and educational biases is very difficult) then at least through the pursuit of ways round the structural difficulties.
There are some possible outcomes which are a bit brighter than these rather sombre reflections. For example, it may be that information technologies will change employment patterns for women in ways which are advantageous, as well as in some of the less happy ways which we have anticipated here.

But we cannot rely on the overwhelming force of such positive developments to offset the problems we have discussed here. Markets have never been good at solving *distributional* problems, and we would be ill-advised to suppose that they might do so in the case of applications of information technology.
4. NOTES ON TECHNOLOGICAL CHANGE, INFORMATION TECHNOLOGIES, AND LEARNING PROCESS

To complete the discussion, we will include a set of observations on the implications of information technologies for learning processes. This is a central matter: it is at least a necessary condition for avoiding exclusion from the new technologies that people are able to acquire the skills needed to produce with them and to use them as consumers. Indeed, some find this also a sufficient condition, since it can be argued that, provided society is able to ensure that people can participate in such learning processes, market forces are likely to provide an adequate basis for ensuring inclusion. The following are notes on the kind of learning process that is needed; “notes” because this seems a properly modest title for what are unavoidably speculations at this stage. The speculations are presented in five steps.

First, it is easy to see that technological changes quite generally result in changes in the organisation of social and economic activities and in the skills required to carry them out. This has been recognised for a long time, certainly since Adam Smith, and probably before. Information technology is no exception to this, though it has the characteristic, already noted, of influencing many sectors and therefore imposing changes in the skills needed in production in many parts of the economy simultaneously.

An aspect of changing skill requirements imposed by information technologies is the fact that consumers of new technology products, such as personal computers, or household devices like audio and television systems, or automated banking and social welfare services, need new skills in order to make effective use of them. As electronic communication systems become more and more prevalently used for shopping, or for personal banking, or for entering bets on horses, or for having one’s horoscope read, the range of skills which customers will need will probably increase. Against this, it is obviously in the interests of the producers of such things to keep the need for customer skills to a minimum and to contribute to the education of customers; hence the hunt for user-friendliness. Where customer skills are concerned, the market may therefore work rather well.
To sum up: technological changes are associated with transitions, and a socially important dimension of these transitions is the change in the skills needed to participate in production, or to provide services, or to access newly automated services, or generally to use new technology.

The second point follows directly: it is that exclusion/inclusion in such transition is importantly influenced by the success of societies and individuals in responding to the changes in skills required. That there are very considerable differences in response is, I think, clear from casual observation. An important part of the discussion in this paper has dealt with the various reasons for these differences.

It is because the issue of skills and the readiness with which individuals can acquire them the human capital question is apparently so dominant in relation to information technologies that we choose to focus specially on it in this last section.

The third point is that, with the advent of information technology systems, we seem to have entered a distinctive period in which technological change is not only accelerating but is also much more continuous in its social impact than with other technologies. In turn, the problem of exclusion/inclusion needs to be seen increasingly as a continuous dynamic problem. The problem arises at all levels: even as I struggle to master the range of things a new 486 computer can do, others are investing in Pentiums which have a whole range of software possibilities which are beyond my present capacities and would involve difficult investments of my time in skill acquisition. I am thus excluded from the newest technology, albeit in a relatively modest and socially non-crucial way. Indeed, if we think about the matter in fully dynamic terms, most of us are nearly always excluded in these relatively benign ways from the newest things.

With the fourth point we come to the heart of the matter: what mechanisms exist to meet the need for changes in skills, capabilities, and organisation which the processes of technological change generate? The effectiveness of these mechanisms, and biases in the ways they operate, will affect who gets included and who excluded from the social activities or advantages associated with new technologies. And here “who” refers to “which societies” and “which social groups” as well as “which individuals”. It is immediately obvious that in reasonably differentiated social systems

\[4\] There are those who would argue that the rate and continuity of innovation in information technologies is in this respect an outcome of an advanced form of Schumpeterian competition—competition based on innovative advantage between the innovator firms, rather than on the classical price competition of economic textbooks.
there is usually a range of ways in which changing skill requirements are met, ranging from the educational institutions at all levels to a whole variety of less formalised learning processes. The latter may include, for example, the individual sitting in front of her computer and learning from a succession of mistakes.

How do we tackle this wide range of mechanisms in an analytically sensible way? If their effectiveness is as important to the exclusion/inclusion question as I have tried to suggest, we need some way of discussing them which is more useful analytically (and less boring) than a long list of institutional descriptions. One rather obvious approach is to distinguish between the formally constituted elements of educational systems—schools, universities, vocational training organisations, specialised diploma systems to acquire knowledge of new software systems, and the like, on the one hand; and, on the other, all those less formal methods of acquiring skills in the use and application of new technologies, such as learning by doing in production or in services, or the kind of learning which consumers of such things as PCs have to go through to become proficient in their use. It is clear that this distinction needs to be sharpened. Very likely one requires more than a two-way categorisation. But as a first approximation we might distinguish these two broad classes as formal and informal learning processes. And we note that a feature of some informal systems, though not all, is that they are intra-firm or internal to the institutions in which the new technologies are being used which might of course be households.

A plausible hypothesis is that the higher the rate of technological change, the greater will be the role of informal learning processes in the acquisition of the relevant skills. The reasoning is simple perhaps simple-minded. In the first place, formal systems of education and training are usually quite slow to adapt to changing demands, and so are bound to be out of date if the technology is changing fast. Second, formal systems as they exist at present are best at providing codifiable and more general skills, whereas the skills needed to encompass rapidly changing new technologies are usually hard to codify for example, to set down in training manuals and are usually rather specific. The underlying assumption here is that the proportion of knowledge about the use of a technology which is likely to remain “tacit” is probably higher when the rate of technological change is higher. Tacitness, in short, is a characteristic of a technology which, in part at least, is a consequence of rapid technological change. When a technology has been in use long enough, most of the skills needed to use it effectively become codified, and in this area at least, tacitness may reduce. If we look at matters in this way, the “tacitness” of technological knowledge, which has come to be an important preoccupation among economists dealing with the transfer of technology
between firms, appears less a property inherent in a technology and more a contingent outcome of the fact that the skills needed to use it are not yet fully analysed and codified.

Fifth and finally, it follows that exclusion is more likely to happen when informal systems of learning, “learning by doing”, for example are predominant because of a high rate of technological change. These are also situations in which tacitness is likely to be higher. The reason is simply that in this case the possibilities of getting access to the knowledge needed to use the technology are limited because the formal training system cannot supply it and acquisition depends more heavily on being incorporated in the production or service systems in which the technology is being applied.

An important characteristic of the rapidly changing new information technology in a great many of its applications is that the skills required to master its use are unlikely to be obtainable directly from the formal education and training systems. Learning to use these technologies, which is an essential element in participating in whatever advantages they confer, is likely then to depend on access to the production and service activities in which these technologies are applied. The possibilities of exclusion are thereby increased. It is harder for people to access tacit knowledge, especially if its acquisition depends on learning by doing. This is a specially important reason why we should expect particular problems of exclusion with new information technologies.

But where does this set of assertions lead? At one level it might be seen as rather gloomy: populations of producers and users will be excluded from the benefits which technological changes may offer because society cannot offer ways of helping them deal with the tacit and codified and very rapidly changing knowledge they need to do so. But there is another important argument to be made here. It runs as follows: As the rate of obsolescence of any given set of skills increases, so does the relative importance of people’s capacity to learn new techniques. The technology diminishes the usefulness of already acquired skills in comparison to the usefulness of having a capacity for ongoing learning. But the response to this is not to take the formal systems of education and training as they are, but to raise new questions about them. The systems we have may not be adapted to teaching tacit skills; indeed, nor formal system, by definition, is ever likely to be.
But this doesn’t mean that formal systems of education and training thereby become irrelevant. The problem is to redesign them so that they are better adapted than at present to producing people who are more easily able to learn in the course of their working lives.

It is not clear that education systems anywhere are yet able to address this issue. For example, we do not seem to understand why some people coming out of formal education have a strong inclination to continue learning, while others hope to rely on what they have already acquired in the education they have experienced, and seem to have little incentive to increase their knowledge. Are these differences in attitude a consequence of pedagogy? If they are, there are some grounds for optimism. It may well be that the most important requirement to avoid people being excluded from the gains of the new technologies lies in an education system less concerned with producing people of specific skills though that must obviously remain an important part of education and more focused on inculcating the assumption that learning is of necessity a continuing process in an economy and society where the basis of production and consumption is in continuous change. How to do this is a hard question for education policy makers.
5. FINAL POINTS

It is not appropriate to draw conclusions from the discussion in this paper, since it is in the nature of a proposal for policy analysis. This form seemed appropriate as a device for introducing the Workshop on Information Revolution and Economic and Social Exclusion in Developing Countries. It is hopefully useful too as a basis for further analysis and research. For the present it should provide a setting for the material presented in Theme I of the Workshop Access and Exclusion.