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SOCIALIST REPUBLIC OF VIETNAM

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

A SCIENCE TECHNOLOGY AND INDUSTRY STRATEGY FOR VIETNAM

by

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CHAPTER 1 INTRODUCTION: FRAMEWORK AND SCOPE OF THE REPORT

Vietnam's intends that S&T should be one of the components of the nation's socio-economic strategy. Against that larger framework, the vision of the long-term aspirations of the Vietnamese people has been articulated by the government. It states that Vietnam:

- Aspires to be a just and stable society with a high quality of life for all of its people.
- Wishes to maintain the best of Vietnamese culture and traditions.
- Aims to become a market economy, to be competitive internationally, and to remove most trade barriers by 2006 when it joints AFTA.
- Intends to have the characteristics of an industrialized or knowledge society within twenty years.

This vision and the broad means of achieving it provide the boundary conditions for the proposed technology and industry strategy. The broad means (i.e. achieving international competitiveness and acceding to full AFTA membership by 2006 and the characteristics of a knowledge society by 2020) are time specific. These boundary conditions establish:

- A deep sense of urgency; and
- Place the competitiveness of firms or enterprises at the center of strategy.

This report focuses on the contributions that science and technology might make to the government of Vietnam's stated vision of creating an 'industrial and modernized society' during the first quarter of this century. It is one of several components to the formulation of a national socio-economic strategy for Vietnam to 2010. More specifically, the terms of reference that have guided out work have set out the following:

> "….to review available research documentation, collect additional data, analyze the findings, make appropriate recommendations and prepare a draft report focussing on specific issues such as
>
> - Current science and technology capacities in Viet Nam. and assessment of domestic ability to acquire, adapt and master new technology with particular emphasis on the role of technology transfer in the development of the Vietnamese industry.
> - Lessons learned in Viet Nam and elsewhere on effective technology development and transfer, and policy implications.
> - Environmental sustainability of existing and new technology.
> - Global science and technology issues, trends and factors with relevance for the long-term development of Viet Nam's industry and services.
> - Analysis of major policy and institutional issues such as market-based incentives for science and technology development, science and technology development financing, human resources and quality of education and research systems and programmes, foreign technology acquisition policies, innovation and international collaboration, high technology development priorities with particular emphasis on information technology."

In addition, the Government of Vietnam requested that this report attempt to cast light on a number of specific questions and issues, as follows:

- What is the role of large multinational firms in technological transfer? Both Vietnamese Government officials and multinational firms are expressing disappointment on the experience to date.
- Do export zones, high tech parks, processing zones work? Much emphasis has been assigned to these in recent years, but again the results are far from universally encouraging.

What should/might be done? To what extent are these instruments valuable in further national strategy?

- Are there any real prospects for leapfrogging technologically (at least in principle) or is a patient step by step approach up the technological ladder the way forward? If the answer to the first question is affirmative, then can areas be identified where fast movement is possible?
- Are there certain 'breakthrough' areas (perhaps in high value-added agricultural products for the international market)? What might be the process for determining whether such areas can be identified?
- Is there an appropriate sequencing and targeting of protectionism for the domestic market (i.e. infant industry approaches)?
- Is a 'technological road map' possible?
- Is there any guidance that can be offered on the balance between FDI and national investment? To what extent should Vietnam's path to the future be modelled on the experience of Singapore (i.e. FDI-based and with foreign ownership)?
- Where should science fit into Vietnam's socio-economic strategy? Are there particular areas of applied science that might be emphasized (e.g. the software industry, biotechnology applied to rural transformation, agriculture, and tropical products)?
- Should Government target a fixed, higher percentage of GDP to support R&D? One part of Government has recommended an increase from the current level of about 1 percent of GDP to 3 percent - 4 percent. Should this be included in a national socio-economic strategy and, if so, are there special arrangements, circumstances and changes that this would require? To what extent should Government pursue its current intention of converting national research centers from 'stand alone' public entities to integral components of firms (i.e. SOEs)?
- What can be done quickly to create a pool of human resources equipped with the skills needed or the management of enterprises and of the technological process?
- To what extent can/should 'clustering' (sectoral and geographic associations) be encouraged as a means to increasing Vietnamese competitiveness, especially with regard to export-led growth?
- Should Vietnamese public investment involve/emphasize 'technology incubators'?

Our terms of reference and the specific questions asked of us set out an exceedingly ambitious task, all the more so as only a very short period of time has been allocated to the many activities required. The core work has been conducted by two international consultants and two Vietnamese specialists, one from the industrial branch of government and the other from the national science and technology institute. Two factors have increased in clarity as we have conducted this exercise. First, a growing sense of urgency has become a defining characteristic of Vietnam's national debate on its future direction and the policy choices to be made. The second factor is closely related to this. It involves a strong desire on the part of Vietnamese policy-makers for a high degree of specificity and of certainty. This desire is entirely natural. As a poor country, the costs of errors and of unwise development choices are especially high and, as history elsewhere shows, can indeed produce tragic consequences.

This, however, poses a dilemma. The choices that Vietnam will make will occur in technological, economic and institutional contexts whose main characteristic is unprecedented speed and intensity of change. The shared conclusion of distinguished historians like Paul Kennedy and Conor Cruise O'Brien (Kennedy 1993; O'Brien 1995) is that societies have never before confronted such complexity and never before have there been more reasons to be uncertain about the future. Recognizing this, leading international business schools are now counselling businesses, industries and also governments to abandon both the instruments and thought processes that produce 'plans' or precisely sequenced actions over several years. Instead, they are increasingly convinced that the institutions that will thrive in today's climate of rapid change will be those whose management processes and whose choices are defined by the elements of agility, flexibility, innovation and a willingness to experiment. One leading scholar of international business and technological change (see Mintzberg 1998) even concludes that the management system most likely to succeed in today's climate will be '*ad hoc*' in character.

This does not mean that strategy is unimportant. Scholars like Mintzberg also conclude that strategy – properly understood as a broad, enabling framework for sequential and rapid choices – is even more important in the context of rapid change and high uncertainty.

With this context very much in mind, we have tried in what follows to offer helpful guidance on elements of a national strategy for Vietnam. Where possible and where sufficiently supported by strong evidence, we have gone to considerable lengths to 'tease out' specific actions that can be taken in support of a broad strategy. In all cases, however, we have attempted to draw attention not only to what is known or suspected, but also to the limitations of much of today's conventional wisdom which, although it may turn out to be right, remains hypothetical and essentially untested.

This approach may not meet entirely the preferences of those whose hope is to receive proposals for specific, sequenced and timed reforms (for a road map), including a catalogue of obstacles likely to appear over time. To this we can only repeat that we have gone as far as prudence and current evidence allow us to go. We are only too conscious of the frequency of previous policy advice given confidently to developing countries by international consultants and international development organizations that either turned out to be misguided or was quickly rendered inappropriate by changed circumstance. This has indeed been a defining feature of much of the history of the modern international development effort. In the 1950s and 1960s, for example, based on the early success of a few Latin American countries, the international counsel to most developing countries centered on what proved to be an excess of optimism for policies of import substitution and infant industry protection. A further feature of the 1960s involved a wave of confidence about agriculture-based export led growth through the conversion of arable land from 'subsistence cropping' to commodities. Negative terms of trade followed for many countries that had adopted this strategy, especially when commodity prices collapsed in the 1970s. In the 1970s, country after country followed international advice and adopted integrated rural development programs as the main target of public investment. A decade later, most of these had been abandoned as expensive failures. These are but a few examples. There are many others that are well substantiated in the literature.

With the above terms of reference and general considerations in view, our report is set out in the five chapters (chapters 2-6) that follow. Chapter 2 provides a brief reminder that the means to progress or development over the next decade will be determined less by capabilities in manufacturing and more in the ability of individuals and nations to obtain, apply, adapt and produce knowledge. In this context, the strategies and policies that applied and worked in the past will need to be modified because the change holds major implications for the organization of production, for employment, for skill requirements and for technology strategy.

Chapter 3 provides a critical assessment of Vietnam's systems of science and technology. Some principal strengths and weaknesses in these systems are identified, particularly in relation to the productive or 'industrial' sector. The announced priorities of Vietnam's government are presented and examined and some initial suggestions are made.

Chapter 4 turns to the experiences of other countries, especially the late industrializers. Some lessons and conclusions are derived from the research that is available. We attempt to present a balanced picture of key factors that contributed to previous successes and failures and we also outline a disturbing paradox in the technological upgrading of Latin America.

Chapter 5 examines the main instruments for technology acquisition, upgrading and industrialization that are currently being recommended to development and transitional countries. The evidence that is available for each instrument is summarized and we attempt to extract the main strategic principles that can be justified by the evidence.

Chapter 6 builds on the preceding and sets out conclusions and recommendations for the science, technology and industrialization component of the proposed socio-economic strategy.

CHAPTER 2 INDUSTRIAL SOCIETY OR KNOWLEDGE SOCIETY?

From the beginning of time, technology has been a key element in the growth and development of societies. Entire eras are named for the levels of their technological sophistication: the stone age; the bronze age; the iron age; the age of sail; the age of steam; the jet age; the computer age. But technology is much more than jets and computers. It is a combination of knowledge, techniques and concepts; it is tools and machines, farms and factories. It is organization, processes and people. The cultural, historical and organizational context in which technology is developed and applied is the key to its success or failure. In short, technology is the science and the art of getting things done through the application of skills and knowledge.

Yet the history of technological advance is far more one of surprises and of unpredicted shifts than one where planners and strategists predicted and prepared societies well for the futures brought about by technology. In the early years of the 20th century, the *Annual Report of Western Union* (the large American telegraph company) announced to its shareholders that the newly-invented telephone was an 'interesting but limited' piece of equipment that would prove of 'little consequence to the economy'. Some thirty years later, Thomas Watson, founder of IBM, wrote that the computer would have only very few commercial applications.

It is obvious, therefore, that attempts to craft and apply longer-term science and technology strategies are complicated and fraught with dangers. This would appear to be more so today than ever before. Ours is a hybrid era, one caught somewhere between bronze and computers, between sail and jet engines; one in which quality has become confused with quantity, and means with ends. For poorer countries like Vietnam, it is a time of immense technological opportunity and optimism. It is also a period of unimaginable poverty and hopelessness. It is a time of unprecedented flows of information and of speed of technological change. And it is unlike any other period in history; for today, in addition to artisans and artists, farmers, machinists and dreamers, the direction of technology is influenced and fashioned by politicians, bureaucrats, economists, far-away corporate planners, aid agencies and charities. Never before in history have so many non-technical people exerted so much influence on the advancement, retardation and movement of technology.

A strategy for science and technology needs to be very conscious of these facts. Longer-term strategies of ten years or beyond need to be especially cautious about assuming past as prologue or of current trends as continuing. The past forty years have demonstrated in many developing countries that the consequences of inappropriate technological choice and erroneous projections can be very damaging.

This is not to suggest that strategy is either undesirable or not required. In modern times at least, a characteristic of successful societies has been the ability to anticipate, manage, direct and profit from change. It indicates for policy-makers, however, that a technological strategy should be viewed in and interpreted in light of the above and that the probability of new and unforeseen factors increases over time. It also underscores that a strategy should strive to provide a broad enabling framework and to serve as a reasonably accurate compass rather than a road map. The aim of Vietnam’s S&T compass has been set by the Government of Vietnam: to become an industrialized society by 2020.

The Meaning of 'Industrialized Society' is Changing

This raises an immediate challenge, for our understanding of what it means and will mean to be an industrialized society is changing. Knowledge in all its forms if fast becoming so central to the prospects of all countries that the very words ‘industrialized society’ are in the process of being supplanted by references to the 'knowledge society'. This distinction between what we usually understand by an industrialized society and what we are coming to understand as a knowledge society is not just a matter of words. It has profound implications for the determinants of growth, for the organization of production, for employment, for skill requirements and for the directions of technology strategy. Furthermore, the distinction is not a matter of the attributes of a knowledge society applying to richer countries only. The growing centrality of knowledge driven economies affects economies at all levels of development.

"….the balance between knowledge and resources has become perhaps the most important factor determining the standard of living…" (World Bank 1998.)

There is much debate and discussion on the emerging global knowledge societies. It has certainly become one of the major preoccupations of the governments of the advanced economies. For example, the 1998 UK White Paper *Our Competitive Future: Building the Knowledge Driven Economy* provides an excellent overview of the evidence for the emerging Knowledge Economy. It addresses clearly the relative role of the State and Business in the new changed environment that characterizes the Knowledge Economy and goes on to propose some specific initiatives for the UK Government. Although the White Paper is based on the specifics of UK society, it provides an analysis that has broader relevance. The emergence of global knowledge societies from the perspective of developing countries is specifically analyzed in two recent books (Mansell and Wehn, 1998, and World Bank, 1998). These three studies reflect and provide a basis for the thinking of the authors of this report about the significance of the concept for Vietnam.

The basic facts are that knowledge is becoming one of the essential ingredients of both wealth creation and improvements in the quality of life in most countries of the world. Each country needs to enhance its capabilities to perform five tasks with regard to knowledge. These are the ability to create knowledge; acquire knowledge; assimilate knowledge; use knowledge; and to diffuse knowledge. Not all countries will have the same mix of capabilities for all tasks. Some countries, for example, may devote more effort to acquiring knowledge than in creating knowledge. But their ability to assimilate, use and diffuse knowledge will determine their ability to succeed in the global economy.

Underlying this global transformation are the new ICT technologies. Some countries have established a capability to manufacture the hardware (chips, computers and telecommunication equipment) which is central to this revolution, and to compete with this hardware on world markets. Others, (such as India) are succeeding at developing necessary software. But the production of hardware and software represent only a small proportion of the total impact of these new technologies. It is their use in almost all sectors of society which is causing the transformation of societies. The way companies do business and operate on a global basis is radically different today than ten years ago. The exploration for and development of natural resources has been greatly facilitated. The delivery of government services, and the way government departments interact to solve problems, education, health, and of course entertainment, are all affected by these new technologies.

> "There is a consensus that the transition to the 21st Century will witness a quantum leap in the development and exploitation of information technologies, with corresponding ramifications for social and economic organization, the environment, culture and the development of a global information infrastructure. The key issues of concern to policy-makers and international organizations are the extent to which this major transformation has benefited all aspects of society and the ways and means of achieving a truly global information infrastructure." (Roffe, *et* al, 1995)

The internet is but one of the latest manifestations which demonstrate the speed of diffusion of the new technologies and its contribution to globalization of commercial activities and the possibilities of electronic commerce. The latter is estimated by OECD to reach $1 trillion annually by 2003. The reports referred to above describe in detail the actual and potential developments regarding the expansion of the knowledge economy and the likely part played by ICTs.

The three reports also highlight the key role that governments must play even in market economies. For example, the UK Government identified three areas where it regards its contribution as key to the competitiveness of British industry in this domain. These are:

- **Capabilities** – measures to improve British scientific and technical capabilities, to exploit the potentials of science and technology, to facilitate enterprise, innovation, and access to capital markets.

- **Collaboration** – measures to stimulate and support interaction between firms in networks and in clusters.
- **Competition** –measures to ensure that competition and pressures for innovation are maintained in order to increase consumer choice.

Included in the wide sweep of proposed measures in each of these domains are incentives to collaboration between universities and industry, improvements in Intellectual Property legislation, and providing the infrastructure and incentives for electronic commerce. The latter is viewed as especially critical to low entry costs for small and medium enterprises entering global markets.

But it is not only the industrialized societies which can benefit from the opportunities provided by ICTs. The report based on the work of the UN Commission for Science and Technology for Development (*Knowledge Societies* Ed. Mansell and Wehn, O.U.P. 1998) has documented the potential, even for the least developed countries, of these new technologies. It is important to stress the word potential. The benefits to most developing countries have so far been relatively modest. The UN Commission considered this point carefully. It specifically examined whether the least developed countries should postpone making decisions and investments regarding Information Technology until the benefits are more certain? The view of the Commission was that although the cost to a society of joining the information age was high, the cost of not doing so in terms of their longer term development prospects would be much higher. The governments of South Africa, Thailand, Malaysia, and Chile have all developed ICT strategies and have begun to invest heavily in building the ICT infrastructure necessary to transform their countries into knowledge societies.

In this report we argue that Vietnam should embrace the global trend toward knowledge societies, or knowledge driven economies. Within fifteen years Vietnam should aim to be able to compete globally on the basis of its ability to create, acquire, assimilate, use and diffuse knowledge. This does not mean that Vietnam should not develop its manufacturing and service industries. It does mean, however, that the type and ways in which those industries are developed will be different from the old traditional path to industrialization.

The 1998 World Development Report of the World Bank describes the current situation in the following way:

> "For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far towards the former that knowledge has become perhaps the most important factor determining the standard of living…. . Today's most technologically advanced economies are truly knowledge based."

What is Meant by the Term 'Knowledge Society'?

If this is true of the more industrially advanced societies today, given the commitment to open markets we believe that it will be essential for developing countries to follow suite tomorrow. The strategy proposed in this report is dedicated to this objective. First, however, it is necessary to describe what is meant by the term 'knowledge society' or 'knowledge driven' economies.

Simply put, a knowledge driven economy is one in which the generation and exploitation of knowledge comes to play the predominant part in the creation of wealth. This is not only about the creation of knowledge, but also about acquiring it, and about the more effective use and exploitation of all types of knowledge in all manner of economic activity. Thus a knowledge driven economy is not only about high technology, but is also about how knowledge pervades all economic activity.

Some people equate knowledge with information. This is a mistake. To become knowledge information must be read and understood. This different knowledge may result from the same information depending on the different experience, expertise and intended use of different individuals. It is also important to make the distinction between codified knowledge which is relatively easy to transfer and tacit knowledge which is not easy to transfer. Tacit knowledge is the knowledge acquired by individuals on the basis of experience. (It is like being able to swim or ride a bike – easy to do when you know how). This knowledge is often a source of competitive advantage for the firm that employs the holders of tacit knowledge.

Knowledge has become the key ingredient in the economies of the industrially advanced societies today, and will have to become a key ingredient in developing countries tomorrow because of a number of driving forces. The most important of these driving forces are: the widespread availability and use of information and communication technologies; the speed of scientific and technological advances; global competition, itself made possible by the first two driving forces; and changing consumer demands, including concerns about the environment.

These driving forces are transforming the way businesses operate in the economically advanced societies. To survive in the global market place enterprises in developing countries, in general and Vietnam in particular, will have to follow suite.

The UK White Paper on Competitiveness (1998) has described some of the implications of the knowledge driven economy for businesses in the UK:

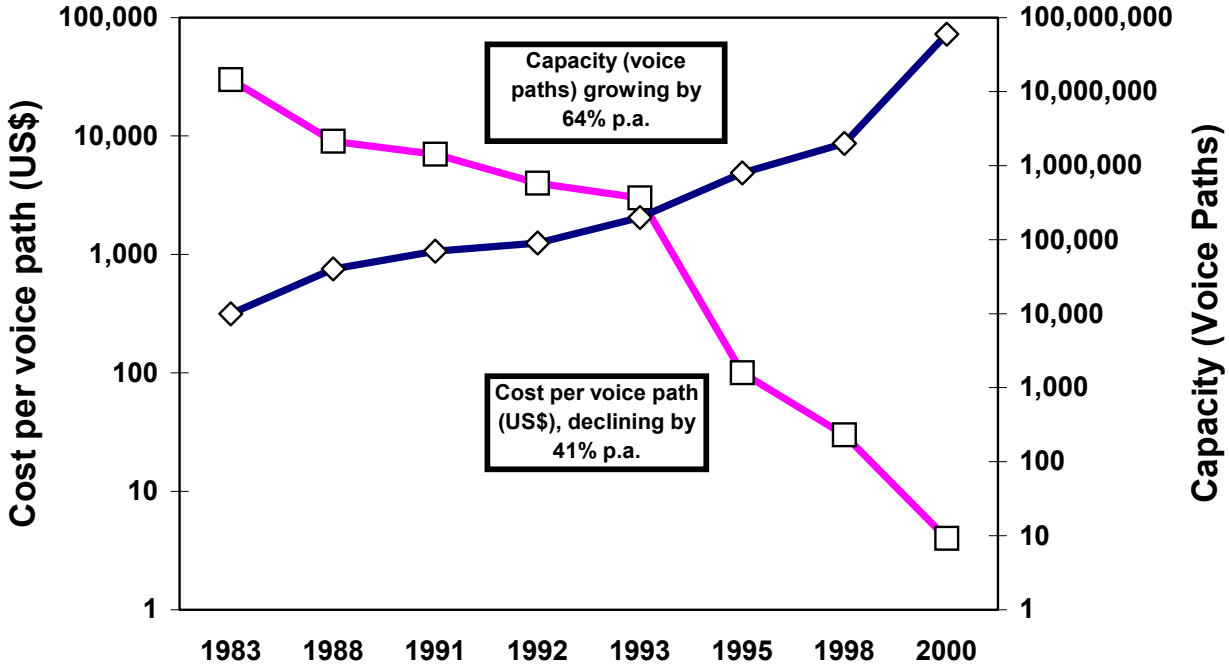
- The way in which businesses compete has been radically changed. It is now easier to access global markets using ICTs.
- Innovation has become much more rapid. If a business is to succeed it will have to embrace innovation and outperform its competitors.
- Technological developments and changing demands have led to the creation of new products.
- Each company must give greater emphasis not only to innovation but also to scientific developments, knowledge management and the development of human capital.
- Shorter product lives and increased competition mean that firms have to continuously increase efficiency and devote more resources to innovation.
- To succeed in the new environment requires organizational change and increasing workforce skills.
- The need for specialized skills means that firms increasingly collaborate with one another and develop complementary labor skills. It is one of the reasons why SMEs cluster together in specific locations.

This description of the trends in the more industrialized countries is useful for indicating the characteristics that will be required of firms operating in Vietnam.

ICT and the Knowledge Society

The emergence of the term knowledge society has coincided with and been made possible by a pace of change in ICT over the past few years that has been extraordinary. Not only has it led to the emergence of a whole new range of products and services (e.g. mobile telephones, global positioning systems), the change itself continues to be driven by a decline in costs that is nothing short of breathtaking. Nowhere is this more apparent than in international telecommunications. As the following graph from the International Telecommunications Union (ITU) shows, voice capacity across the North Atlantic has been growing annually by 64 percent while costs per voice path have been declining by 41 percent.

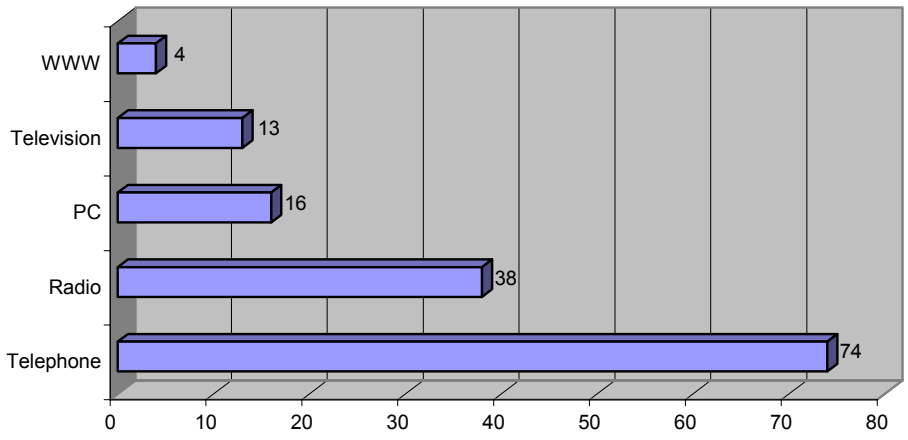
Infrastructure capacity and costs, TransAtlantic cables, 1983 - 2000



Source: ITU, TeleGeography Inc, FCC

This combination of a technological explosion together with a dramatic fall in unit costs has produced what may be the fastest penetration of a consumer technology in history. As the following table demonstrates, it has taken only 4 years for the world wide web to reach 50 million users, compared with 13 years for television and 38 years for radio.

Years it took to reach 50 Million Users



Source: adapted from ITU, Geneva.

It is this same combination of technology and cost factors associated with ICT that has also been transforming the international marketplace and introducing sweeping changes in the way business is conducted. It seems certain that this will continue as microelectronics addresses a process that is implicit in all human activities, and thus in all economic production and distribution processes – information processing. In this respect, ICT should be regarded as a uniquely pervasive technology. Since IT can apply itself to the further design and production of IT, among other reasons, the rate of progress continues to be fast and every reason exists to believe that this will continue.

Because of these factors, ICT is now necessarily a central factor (if not the central factor) to the industrial and technological strategies of all countries and to all firms wishing to compete in the transformed marketplace. But can poorer developing countries hope to gain from the changed environment? On this there is considerable debate. For some analysts, the global division of labor is largely asymmetrical, forcing developing countries to compete with one another in offering low wage assembly while denying them access to the design and process know-how (Ernst and O'Connor, 1992). Other observers reach different conclusions. For example, it has been argued that rapid diffusion provides opportunities for newly industrializing countries to achieve 'world class' production of some ICT-related products and knowledge based services (Soete, 1985). The opportunities and prospects for the least developed countries are much less certain. There are many, however, who have adopted as an article of faith that ICT makes 'leapfrogging' a viable strategy where the absence of a scientific and technical education system consistent with innovation in ICT is not a major bottleneck.

Whatever the nature of the continuing debate on the contribution ICT can make to the industrialization aspirations of less developing counties, it would seem totally ill-advised for any country to delay action until the outcome of the debate is clearly determined on the basis of convincing evidence. Moreover, we believe that the senior citizen of American business schools, Peter Drucker, is probably correct in his observation that it is precisely because of the revolutionary nature of ICT that developing countries will not in future be able to rely upon lower cost labor for their comparative advantage. Rather, as Drucker asserts, they will need to excel in the application of knowledge.

> "Developing countries can no longer expect to base their development on their comparative labor advantage – that is, on cheap industrial labor. The comparative advantage that now counts is the application of knowledge." (Drucker, 1994, 62).

What this suggests is that Vietnam's socio-economic strategy should place an especially heavy emphasis on the assimilation of ICT as a catalyst to comparative advantage. We return to this issue later in this report. At this point, however, it is important to underscore the general point that it is important to avoid the pitfall in reasoning called technological determinism. Growth in the use of ICT is often thought of as a *cause* of economic growth, but it may also be a *result* of economic growth. It is reasonably certain, if not self-evident, that ICT is a cause of economic growth where it is being used in the construction of larger human and physical systems that are capable of generating economic value. Adding equipment without adding both other physical capital and human capital, is "likely to increase electricity usage rather than economic growth". (Mansell and Wein, 1998, pg. 21). The challenge in mobilizing the complementary investments in physical and human capital is far more complex and far more uncertain than that of raising the funds to invest in the technology.

To achieve all of this and to make ICT a *cause* of economic growth will require a strong shared vision between government and entrepreneurs. It will also depend on an appropriate division of labor between the state and the private sector. Strategic efforts will be required to build the infrastructure, including the ICT infrastructure, to educate and train the workforce, inculcating the skills to manage knowledge, to develop excellence in science and technology, to encourage competition and help provide a culture that encourages and rewards innovations, and to protect the environment.

Our report is primarily concerned with technology and industry strategy for Vietnam. We recognize that the impact of ICTs goes well beyond their impact on industry. But the strategy that Vietnam is now preparing is aimed at the next 15 years, not the next 50. Its emphasis, therefore, will necessarily be on policies and measures that can increase national productivity and

competitiveness, for without this Vietnam's base for future and further modernization will be compromised. This said, we also endorse the recommendation of the UN Commission. Vietnam should prepare its own ICT strategy which encompasses industry, but goes beyond it to cover the full spectrum of development issues.

Experience in developing countries over the past three decades has demonstrated that a strong technological base is a prerequisite for industrial growth. Today's technologies, however, are changing the frontiers of industrial growth by expanding knowledge systems into all aspects of production, market-access, comparative advantage and socio-economic well-being. These dramatic shifts in the frontiers should be central to the shaping of science and technology strategy. We try, therefore, in what follows to take this into account and to draw out some of the major ingredients for building technological capacity and competitiveness. Among these major ingredients are:

- Stable domestic economy with sound macro-economic performance and openness to competition.
- A knowledge-receptive population with well-developed aptitudes in problem-solving.
- Unrestricted access to a low-cost technical infrastructure of information and communications technologies.
- Adequate and timely supply of technical, management and maintenance, quality assurance and consultancy skills, together with the systems to develop and update them.
- Institutional capacity for constant strategic assessments and for making changes and adjustments with speed and agility.
- Micro-economic policy instruments to stimulate the innovation system.
- Adequate financing mechanisms.
- Support for R&D on an essentially demand-driven basis.

CHAPTER 3 ASPECTS OF VIETNAM'S S&T SYSTEM IN RELATION TO ECONOMIC AND INDUSTRIAL GROWTH

This chapter provides an overview and critical assessment of Vietnam's S&T system, with special attention to its strengths and weaknesses in relation to economic growth. It is estimated that Vietnam has nearly 30,000 persons involved in various forms of research and experimental development (R&D), including librarians, technicians and other supporting staff. More than 22,000 of these are employed in the national centers for R&D and by ministries and government agencies. The rest are working mainly in the universities and other institutions of tertiary education that perform research. Only a small fraction of the country's R&D scientists and engineers are working in industrial enterprises. (All figures above are total numbers of staff, not full-time equivalents.)

Although official documents of the Government reveal small but consistent discrepancies in terms of the number of R&D institutions in the country, the numbers all converge at around 300. The following table derived from a 1997 database divides these by subject area and by geographic location.

Location and Subject Area Of R&D Institutions In Vietnam		
Natural sciences	55	18.6%
Medicine, Social and Cultural Research, Education	76	25.8%
Agriculture, Fisheries, Forestry	52	17.6%
Engineering	84	28.5%
Economics, Finance, Trade	28	9.5%
TOTAL	**295**	**100%**
Hanoi	226	76.6%
Ho Chi Minh City	34	11.5%
Other	35	11.9%
TOTAL	**295**	**100%**

Source: NISTPASS

The general institutional setup in Vietnam for research and experimental development (R&D) can be divided into three main components:

- Laboratories and other R&D units within the government ministries or under the control of government agencies. There are about 180 such R&D units, located in various parts of the country, although most are in the two metropolitan areas. In western industrial countries, many of these highly specialized R&D units would be located within industrial/business enterprises, a practice that Vietnamese policy has been encouraging over the past two years. In Vietnam, however, industrial firms rarely build their own facilities for development work and have very little experience with R&D. In the planned economy of Vietnam of yesterday, the principle was that government took the responsibility for technical change and industrial modernization, while industry manufactured. Among the exceptions to this rule is the state-owned Vietnam Petroleum Company, which runs four of its own laboratories.

- The university and other higher education departments which perform research as part of their normal activities. Only a limited number of faculties and academic departments in Vietnam's universities and colleges truly have the personnel, equipment, libraries and other resources to perform serious research and undertake experimental development. Among them, the two national universities and the two largest polytechnic universities are the most research-intensive parts of this academic system. If a university-based research system is to be established in Vietnam, it will take considerable time.

- The national institutions for research which are not directly under an individual government ministry or agency. These are designed to act as national networks of S&T and are placed under the Government Office (i.e. the Office of the Prime Minister). The most significant of these national institutions is the National Center for Natural Science and Technology with a northern and southern branch and with facilities also in some other parts of the country. Originally modeled after an 'academy of sciences' it was restructured in 1993 to become more like a center for applied research and experimental development. It performs advanced basic research mainly in two areas: mathematics and theoretical physics. The National Center for Social Sciences and Humanities has the same basic structure, but only half the number of staff.

These three main components of Vietnam's national R&D structure are expected to have close links with each other. The functional differentiation is as follows: applied research and experimental development is assigned to the laboratories of individual ministries; the universities and colleges are the prime producers of highly specialized human resources for R&D; the National Center for Natural Science and Technology has the prime responsibility for the most advanced forms of research and for R&D.

Given the relatively small research community, R&D performed by the various institutions should be easy to connect by informal means. The existing S&T policy framework assumes a high degree of transparency for those working inside the research system. In reality, however, there is a considerable lack of communication among specialists in various R&D units under different ministries and between the three components of the system as outlined above.

A fiscal crisis is affecting the country's R&D institutions. In nominal terms, not in purchasing power parity (PPP), Vietnam's overall R&D budget (1997) is estimated to be between US$ 50 and 60 million. Since the general wage level for R&D scientists and engineers remains low, while the costs for equipment is becoming as expensive in Vietnam as in the rest of the world, it is difficult to calculate the real value of the overall budget for R&D.

What is clear, however, is that changes are occurring in Vietnamese R&D. A combination of the lack of appropriate funding and the lack of relevant research equipment are requiring R&D institutions - regardless of their main objectives and responsibility - to move increasingly into contract research, technical services and consultancy arrangements with as wide a range of customers as possible. This shift is being actively encouraged by government.

An indicator of new efforts to commercialize the results of R&D activity is provided by statistics of industrial property activity in Vietnam over the past decade:

Industrial Property Activity: 1990-1998			
YEAR	Patent Certificates	Technical Solution Certificates	Trade Marks
1990	14	23	688
1995	56	24	4,592
1998	348	17	3,111

Source: Commercialization of Research Results; HCMC, MOSTE, 1999

A further indicator of change can be found in trends in the National Center for Natural Science and Technology, which now relies extensively on contract research and consultancy, without which it would probably cease to exist. As a result, the Center's activities have become much more applied and more clearly directed to the demands of industrial firms and other potential customers. The total budget from the central government for the National Center is less than US$ 8 million, while the total staff of the Center is more than 2,000 persons. Yet, in comparison with other state-owned R&D facilities, the National Center has significantly more funds available on a per capita basis for each researcher. It is now the case that scientists at the National Center, regardless of the stage in their individual careers, are encouraged to pursue advanced basic research outside of Vietnam, not at the Center, and, for this purpose, seek fellowships and grants from overseas.

In terms of S&T infrastructure for economic development, the strategic issue for Vietnam over the next several years is how best to link that infrastructure to increased productivity and

competitiveness over the short term. This will necessarily place by far the greatest effort on technology as opposed to science, and specifically on how to acquire (import), learn and adapt technologies.

Whatever the desired short-term balance of science and technology in strategy, however, the Vietnamese situation is complicated by the fact that, at present, the national R&D system is organised, financed and managed in such a way as to make the transfer of relevant information from research into technology both difficult and expensive. This is not unique to Vietnam. The research institutions in the country tend to follow a logic mostly inherited from a Soviet (mission-oriented) approach to the conduct of research activities, in which the end-user (the scientific community, educational institutions, a public agency) did not operate in the market. Research activities were identified in advance. There has been, until very recently at least, little awareness of the need to orient research activities towards the needs of the productive system. However, a few research institutes have been rather effective in obtaining contracts to provide technical services, usually applying well-known technologies, to government departments and state-owned enterprises. These linkages to the productive sector through contracted services to government agencies and SOEs appear to involve little genuine scientific research.

An assessment of some of the structural and linkage difficulties follows. The essential point, however, is that the successful economic transformation that Vietnam is seeking will require that the deficiency in the technological infrastructure be addressed as a serious issue for the country's innovation policy.

Basic Research in Vietnam

In Vietnam, as in many other countries, there are a variety of views on the precise meaning of the term Basic Research. The draft law on Science and Technology defines Basic Research as referring to theoretical or experimental research, which aims at discovering new knowledge about the laws of nature, society and thought.

In some countries there are further subdivisions into what is sometimes called Blue Sky or Curiosity Driven research and Strategic research. Curiosity driven research has the sole objective of satisfying the curiosity of the researcher. It may at some future time have some other useful value, but the purpose is to satisfy curiosity. Strategic research on the other hand has the hope, even expectation that in the long term the research will lead to economic or social benefit. Long term in this definition is usually in excess of 10 years. We take the view that when the Vietnamese Government refers to basic research it means both curiosity driven research as well as strategic research.

In the period before Doi Moi, most basic research in Vietnam was carried out in laboratories and institutes of the National Research Centre of Science (NRCS). In the last 10 years, however, the funding for basic research, in the NRCS has declined and the organisation now carries out a mix of basic research and applied research, and provides technological services. At the same time, while the intent is that government funding for basic research will focus increasingly on the universities, they (the universities) are being encouraged at the same time to expand their research activities and to become more demand driven. This approach is consistent with trends occurring in many other countries, including China.

A question in all countries is how to set an informed and productive framework for public support to research. In many countries, the State helps facilitate the process of setting strategic research priorities, whereas priorities for Curiosity-Driven research are almost always determined by the scientific community. Quite sophisticated methodologies (called Foresight Techniques) have been developed to identify those areas of research that might bring economic and social rewards over a 10 to 15 year time. These usually involve extensive interactions between scientists and representatives from the productive sectors with the process facilitated by government. Japan was one of the first countries to develop these techniques, but they have also been embraced by the UK and other governments. South Africa has also begun a major Foresight exercise. The appropriateness of this approach to a Vietnamese S&T strategy would have to be explored further, but it would seem to offer worthwhile possibilities and to merit such further exploration.

Unless basic research is excellent by world standards it is usually not worth doing. To reach world levels of excellence requires well qualified scientists working in a good environment with advanced equipment, and access to advances in their subject with other scientists world wide. It also requires a real commitment to science and an opportunity to devote full attention to research issues. Most of these requirements are, by all accounts, in short supply in Vietnam. It is a tribute to those scientists who are still producing world class science that they are able to do so despite the limitations.

One particular feature of science in Vietnam is the ageing of the scientific community. Prior to 1980, many scientists went overseas to the Soviet Union to study and do research. Since that time, relatively few have had the opportunity to study science at the advanced graduate level. As a result there is a real shortage of young scientists who are well trained, and apparently few new entrants into the profession. Vietnam's financial realities suggest an S&T strategy that concentrates scarce resources in a few critical areas of science. The areas should be selected to bridge Vietnam's immediate need to compete internationally with considerations of long term comparative advantage. Applying these criteria would result in assigning a high priority to building a cadre of high-end biotechnological specialists with application to plant genetics, plant breeding, plant and animal pathology, etc. Within these areas, it would be essential to train the best scientists and engineers overseas.

According to the National Survey of S&T potential, about 11.2 percent of the 22,313 persons working in 233 research institutes in late 1995 had post-graduate degrees, 51.3 percent had a higher education degree (BS/BA), and 37.5 percent were technicians, workers and auxiliary staff.

Vietnam's Ageing Scientific Community

The age structure of research staff with post-graduate degrees is highly skewed, with about 60 percent of personnel with higher degrees being over 45 years of age. Moreover, the age distribution of staff engaged in research is heavily skewed, and at senior levels the average age is between 55 and 60. The average age of professors and associate professors employed in research institutes (see table below) is 59.5 and 56.4 respectively, while the average age of Directors of S&T research institutes is 55.

Average Age Of Professors And Associate Professors In Selected Research Institutions

Ministry or Agency	All	Professors	Associate Professors
National Centre for S&T	53.8	55.1	53.3
National Centre for SS and Humanities	50.9	63.1	49.1
MOSTE	55.6	57.3	55.2
Ministry of Industry	57.2	57.9	57.0
Ministry of Agriculture and Rural Development.	57.3	58.9	56.8
Ministry of Marine Resources	54.7	56.5	54.0
Ministry of Health	60.9	64.5	58.9
Ministry of Construction	56.4	-	56.4
Ministry of Transportation	56.1	56.0	56.1
MOET	59.1	61.8	58.4
Total	**57.2**	**59.5**	**56.4**

(Source: NISTPASS, 'Proposal and Terms of Reference for a Study of Research and Post-graduate Education in Vietnam (RAPOGE)', May 1997)

Aggregate figures from the 1996 National Survey of S&T Potential show that, as of late 1995, more qualified researchers were leaving research institutes than coming in. In relative terms, the loss of staff was more acute for researchers with PhD degrees.

The issue of an ageing population of Vietnamese scientists engaged in basic science may prove to be a significant issue in the long term. Again, however, in the short and medium term, Vietnam's drive for modernisation and industrialisation will likely depend far more on the availability of practitioners – those who can apply and adapt technologies -- than on the availability of pure scientists able to conduct basic research. There are two points here: first, to neglect the investments required in producing the next generation of scientists for Vietnam would be unwise, but, secondly, this should be approached with balance and perspective.

Possible Measures to Address the Problem of an Ageing Scientific Community

- The launching for the next ten years of a selective post-graduate fellowship programme in selected fields of science and engineering. This would send a significant number of outstanding young graduates to leading universities abroad for periods of 2-3 years.
- The establishment of short-term programmes, possibly on the lines of a "summer school" format, for bringing university professors up to date with new developments in selected fields of science and engineering.
- The establishment of a significant programme of small grants for young researchers returning after completing post-graduate studies abroad. This could be structured along the lines of the existing programme of the Stockholm-based International Foundation for Science (IFS).

Financing of R&D

Statistics assembled by NISTPASS indicate that total R&D expenditure per full time researcher has been falling dramatically since the introduction of reforms under doi moi. Between 1987 and 1990, for example, the per capita expenditure was placed, respectively, at US$687 and US$289. Although there may be some margin of error in these estimates, the figures are startling in relation to those for other East Asian countries (Japan at $135,000; South Korea and Singapore at over $50,000). NISTPASS reports further that the annual per full time researcher expenditure on the physical and infrastructure facilities for research stood at only about US$50 at the beginning of the 1990s and that only about 10 percent of Vietnamese researchers had access to experimental equipment on anything close to a par with those of most East Asian counterparts.

Also presented by NISTPASS and the General Statistical Office of MOSTE are figures showing that Vietnam's institutions of R&D remain almost entirely dependent on government financing for what research they are able to do. According to a quite recent MOSTE publication:

"Out of 233 research institutes and centres surveyed in the second half of 1995 only 3 percent had no funding from the government budget, 69.5 percent obtained all their funds from the central government budget, and 27.5 percent obtained only partial funding from the government budget.

About 90 percent of the 687.8 billion Vietnamese Dong (approximately US $60 million) allocated for research institutes in 1995 came from domestic sources, of which 57.6 percent were central government budget allocations and 32.4 percent were resources generated by the research institutions (research contracts and contributions from local governments and SOEs). About 10 percent of research funding came from foreign sources, mostly from foundations, bilateral co-operation agencies and multilateral institutions."

(Source: 1996 National Survey of Science and Technology Potential of S&T Institutions under Ministries and Agencies, Hanoi, General Statistical Office/Ministry of Science, Technology and Environment, October 1996).

In addition to the four national high-tech programs, there are eighteen other S&T programs of significant size and standing, funded over the State Budget. Eleven of these S&T programs are oriented towards natural S&T and supervised by the Ministry of Science, Technology and Environment (MOSTE). Seven are classified as programs for the social sciences and humanities and placed under the supervision of the Party.

On top of its S&T programs, MOSTE channels funds to smaller S&T programs and projects conducted at various R&D institutions and at some of the 103 universities and colleges throughout the country. The result, according to government calculations, is that, in 1995, 226 separate institutions received grants from state budgets in support of some 9,000 S&T activities being conducted within those institutes. What this means is that the average amount made available to each institution was roughly US$200,000 and that the average S&T activity received something in the order of US$5,000[•]. This indicates a dispersion of the very modest funding available to bring about Vietnamese development through S&T. This situation is well illustrated in, for example, the College of Social Science and Humanities at Vietnam National University of Hanoi (by most accounts the country's leading university) which is receiving for 1997 a research budget from the central government of only about 500 million VND (US$43,000). This kind of budget process does not recognize the requirements of quality research activities, and does not consider the time horizons inherent to the research project or the minimum critical mass of resources required.

Given this situation, in 1997 the government launched an initial programme of rationalisation involving two main components:

- The assigning of specific research structures to a related corporate structure (e.g. telecommunications research to fall under the National Telecommunications Industry and oil and gas research to fall under the National Oil Company). The underlying ideas are to make Vietnamese research much more demand driven and to generate new and more diversified sources of funding for national R&D.
- The phasing out of a significant number of institutions through a gradual process of reducing subsidies, equitisation, mergers or integration into larger government structures.
- The according of much increased autonomy to R&D organisations which permits -- indeed encourages -- them to generate revenues through contract research, to open their own bank accounts and to seek credit lines from banks.

These steps are clearly in the right strategic direction. The rationalisation programme represents an important first step on the part of government. In addition to the steps already taken, however, the launching of a new S&T Strategy provides a timely moment to quicken the pace of reform.

Should government seek to do more and, specifically, should it seek quickly to increase public investment in R&D to the level of 2 percent of total public expenditure. This is a proposal currently being examined in Vietnam's government and, if approved, it would more than double the current level of expenditure. The authors of this report were asked to comment on whether this is an appropriate level of commitment on the part of government. It would not at all be out of keeping with the pattern in East Asia. Even at 2 percent of public expenditure, Vietnam would lag significantly behind some of its principal competitors (notably Korea, Singapore and Taiwan) where such expenditures are now in the range of 3 percent of GDP (i.e. over 5 percent of public expenditure).

Vietnam's resources are considerably more constrained, however, than are those of the countries just mentioned. Moreover – and as outlined above – there are major structural weaknesses in the current R&D system which distance research from the productivity and competitiveness imperatives of Vietnam. If this diagnosis is correct, then a doubling of expenditure might not correlate strongly with Vietnam's larger national goals of rapid economic growth, employment generation, industrialisation and modernisation, and social stability. To accord with these larger objectives and to ensure effective integration into a national S&T strategy, it would appear desirable to link any increases in public support for R&D to structural reform of the sector and to target the increase to a few high priority areas for national research and capacity strengthening.

There has already been some diversification of R&D activities as a consequence of the granting of greater autonomy and encouragement of contract research arrangements. A comparative study across several ministries conducted by NISTPASS in 1996 revealed a significant percentage shift over the period 1982-1995 to contracted services and away from R&D funded directly from the state budget. The change, however, did not represent a fundamental reduction in the dependence

[•] The figure on the number of projects is probably a considerable underestimate as many separate projects may be grouped together by a research institution or a university department.

of Vietnam's R&D institutions on state financing, as almost all contract work was to state institutions.

Thus, according to the Ministry of Science, Technology and Environment (MOSTE), the state budget continues to represent about 85% of the total finance for R&D in Vietnam[•]. The fragmentation of the very limited funds available in Vietnam for R&D clearly remains a major problem of the government. A possible strategic mechanism might be to provide government funding on the basis of a limited number of large, multi-year grants aimed at establishing national 'Centres of Excellence'. Criteria would need to be specified and, against these, proposals would be invited. The proposals would be adjudicated by peer review, including regional and international assessors. Policy approaches along these lines were followed by Korea and Singapore in the building in those countries of strong and integrated S&T institutions.

The Draft Law on Science and Technology

With a view to providing an improved enabling environment on all aspects of science and technology, the Government has been preparing a new Law on Science and Technology. This new law would represent a continuation of a process of change in the approach to and framework for S&T that began in 1987 with a government decision removing the state monopoly on S&T. This was followed by decrees on foreign technology transfer (1988); on organisational and individual rights to enter into contracts or to co-operate in S&T activities (1992); on external grants in support of S&T (1994), by the promulgation of a Civil Law in 1995 which included protection of copyright, industrial property rights and a legal framework governing technology transfer; and by a foreign investment law which governs S&T activities in economic projects. In addition to these measures, a large number of regulations have been promulgated relating to the contracting and procurement of technologies, to domestic and non-domestic financial requirements, to ownership and to specific technological requirements of a sectoral nature.

All of this has entailed an enormous shift from the situation that pertained only a decade ago when all S&T activity was under the exclusive jurisdiction of the state. Much, therefore, has already been accomplished. By all accounts, however, the sequential process that has been followed has produced some 4,500 separate regulations (including those of equitisation and the licensing system) which pertain in one form or another to investment, technology access, technology transfer and technology application.

This new law may prove to be an important companion to a national S&T strategy if it simplifies, clarifies, and is enabling. It should remove ambiguities about, for example, intellectual property rights; facilitate ease of interpretation; and, above all, encourage investment and creativity.

Synopsis of Main Strengths, Weaknesses and Problems of Vietnam's S&T Systems

It is clear from the above that Vietnam has a quite large number of S&T personnel and institutions available to carry out R&D, although the age structure of research staff is highly skewed with averages falling between 55 and 60. More broadly, there are nearly one million graduates from approximately one hundred universities or colleges spread throughout the country and some 1.3 million have attended technical training institutes. This human resource and institutional base contrasts sharply with the situation in the vast majority of less developed countries when they sought to achieve rapid modernization. An extreme and often-cited example is that of Zambia which it is claimed had less than two dozen university graduates and a handful of trained technicians at the time of its independence. At a minimum, it seems reasonable to conclude that there is an important and promising foundation on which to build.

The outline provided above, however, points to a number of weaknesses and problems, including:

- The personnel classified as involved in R&D may be relatively numerous, but there are serious quality issues. Most received their training in a different era under a Soviet-oriented

[•] This figure includes recorded assistance from international aid agencies.

learning system with its emphasis on linearity between science and technology, on the technology of heavy industry and on state planning and control.

- Vietnam's S&T institutions tend to work in isolation, structured networks are few, and few opportunities exist for exchanges and shared learning.
- The infrastructure for research is universally assessed as falling well below international and regional standards.
- Although some progress has been made during the past 3-5 years, linkages between Vietnam's R&D institutions and the productive sector are few. Research continues for the most part to be 'supply driven' with little connection to the production needs of business and industry. Especially in the SME sector, the timely availability of essential professional advice through consulting services is largely unavailable[•].
- What very modest financing there is for R&D via the state budget is severely fragmented, resulting in such small amounts being available to individual research projects as to make any form of serious research impossible.

Integration of the S&T and the Economic Systems

With the above background and assessment of the key S&T characteristics of Vietnam, we now examine in more detail and actual and potential integration of S&T into economic systems and the contribution it might make to industrial production.

Main Effects of *doi moi* on linkages between the S&T system and economic activity

The shift in social and economic orientation brought on by doi moi increased the demand for technological support services within Vietnamese firms. A 1992 examination of national innovation (Vu Cao Dam, 1992, unpublished) revealed the extent to which that demand was not being met, especially in SOEs, due to the sharp segmentation between production, on the one hand, and state-sponsored S&T institutions, on the other. The study also highlighted the almost total absence of private input in setting national R&D priorities.

The reforms launched in the 1980s and accelerated in the 1990s, included measures aimed at closer alignment of the national S&T systems to the needs of the productive sector. Some of the main measures included:

- Granting authority to R&D institutions to enter into direct contracts with industry.
- According R&D institutions much increased flexibility to develop and provide, in addition to research, a full range of services, including technology transfer, consulting services, experimental and pilot manufacturing, etc.
- Diversifying the potential for the financing of R&D, including the retaining of profits and legal authority to seek bank credit.
- Privatisation of R&D activities (i.e. removal of the previous state monopoly) and a legal framework designed to provide enhanced protection of intellectual property rights (Vu Cao Dam, 1992: 5-10).

The results of this extensive range of changes appear to have been somewhat paradoxical. One study in 1996 (Nguyen Thanh Ha, 1996) concluded that few institution to institution arrangements had resulted from the reforms and that whatever linkages there were between the S&T sector and industry were based on the same kinds of personal contacts that had been characteristic before the reforms. Another study detected little change to the previous dominant preference for supply side management of S&T activities and, within research institutes a reluctance to adapt to the long term strategic view linking S&T intimately with the productive sector (Nguyen Si Loc, 1996).

On the other hand, evidence from relatively new firms in selected industries (textiles, garments and electronics) concluded that the technological innovation and learning efforts of these enterprises were creating more direct institutional linkages with S&T organisations (Tran Ngoc Ca, 1999).

[•] Efforts are being made to effect improvements here through technical cooperation provided by UNIDO.

The most reasonable conclusion on the basis of these paradoxical findings is that the take up by both Vietnam's S&T institutions and its productive sector has been slow and uneven. The quality of many S&T, as indicated previously, is no doubt a contributing factor.

Current technology status of Vietnam's industrial sector

There are clear dangers in generalising about the technological characteristics of economic activities as diverse as the large, capital intensive extraction of oil and natural gas to labour intensive, household based production of clothing. Nevertheless, NISTPASS has provided a helpful and informative overview based on a recent and considerable range of observations and studies (including *Survey on technology market in HoChi Minh City,* Department of S&T and Environment, 1999*; VISED Project on financial institutional reforms for S&T,* Vu Cao Dam and Nguyen Thanh Ha, 1996; *Viet Nam Industrial Competitiveness Review,* DSI and UNIDO, 1998*; Survey on level of technological capability of 6 industries*, NISTPASS, 1997 and 1998). The following is a distillation of the NISTPASS findings.

NISTPASS Evaluation of technological level of industrial firms

On equipment and machinery:

- There is a low level or backward linkage from manufacturing and industry to capital and intermediate goods.
- Beyond the fact that there are weak linkages between R&D institutions and the productive sectors, the evidence indicates that in many instances the two are often in the mutual position of lacking the capabilities to connect with one another.
- A significant percentage of the managers of industrial SOEs continue to 'think' in terms of fragmentation, of being self contained and as not requiring external linkages or support.
- The role of the state remains inefficient and relatively ineffective in supporting enterprises through the provision of information, through clear and consistent policy signals and through credit in support of 'reform'.

On labour:

- Responses to a survey of more than 1000 enterprises (including SOEs, private firms and joint ventures) indicated that there is a generalised shortage of appropriately trained and skilled technicians, engineers and labour, and that enterprises must contend with low productivity due to an excess workforce of unskilled and semi-skilled labour.

On training and management and competitiveness issues:

- The existing technical, engineering and management training institutions are not producing human resources with the skills and aptitudes required for firms needing to compete and upgrade.
- Management capabilities to manage firms in a competitive market economy are particularly lacking.

On other factors hindering technological change

- Other factors hindering technological change and upgrading that are indicated in these studies are the relative lack of financing, including access to credit on reasonable terms; an unsuitable and exceedingly complex taxation system; an unstable policy climate with regard to bureaucratic, financial and trade regulations which generates confusion, entails high costs and discourages new investment; and an inadequate legal framework.

Technological capability (TC) and learning experiences in industrial firms

An extensive literature in industrial economics demonstrates a high correlation between success in the industrial marketplace and what is referred to as technological capability (TC). Far from involving a single capacity, TC is interpreted as involving an extensive range of factors. These include capabilities from the ability to deal competently with an existing production process to the capacities to envisage, plan and direct a major technical change. Recent studies in Vietnam provide helpful indications of some key aspects of and barriers to TC and industrial learning experiences in national industrial firms (Tran Ngoc Ca & Le Dieu Anh, 1998; Tran Ngoc Ca, 1999). Those studies also suggest a range of policies and actions to increase national TC.

Principal Research Findings on TC and Industrial Learning Experiences in Vietnamese Firms (from the work of Tran Ngoc Ca and Le Dieu Anh)

The studies revealed an extreme imbalance in national TC. It was reasonably evident in areas of existing production methods and in managing minor technical change, factors associated with the early or entry end of the TC continuum. By contrast, the authors found little evidence of TC in the areas of major technical change and marketing. This may not be surprising given the long history of command and control approaches that industry in Vietnam and the recency of the transition to a more competitive economy. Indeed, the authors attribute this imbalance precisely to a lack of the learning opportunities that come from competitive pressure, and a consequent lack of a need to engage in marketing or to innovate products in terms of range and quality. The most developed technological capabilities are production, minor technical.

Among the mechanisms by which TC is acquired, the studies offer the surprising and worrying conclusion that joint ventures and other connections between Vietnamese and foreign firms have not produced extensive learning in either marketing or the management of technical change. Exactly the opposite conclusion emerged from earlier studies in Singapore and more recently in China. If the findings of the Vietnamese studies hold up under further scrutiny, there will doubtless be important strategic implications. It is, of course, possible that the difference between the experience of Vietnam and that of Singapore and China is more apparent than real and is due essentially to the relatively early stage of connections between Vietnamese and foreign firms. The authors of the Vietnamese studies noted that Vietnamese firms generally did not know how to go about utilising partnership arrangements with foreign firms in order to learn TC. Equally, they noted, foreign partner firms often showed little voluntary willingness to structure and facilitate the learning. A passive approach, they suggested, would need to be replaced with conscious and creative strategies by the individual firm to exploit the potential for TC learning. Institutional factors (e.g. the vast difference in the traditions of SOEs and foreign firms, legal and regulatory regimes or financial impediments) may also have been contributing factors to the discouraging finding in the Vietnam studies.

The studies also concluded that government was playing 'a contradictory role' and that 'It over-intervenes in industrial activity in some respects yet it simultaneously offers inadequate support for other activities. There is little evidence of selective intervention….in the form of explicit promotional policies such as tax rate reductions and exemptions, adjustable financial incentives, or flexible regulations on labour use and recruitment…' .
Finally, the studies drew attention to the relationship of ownership issues to TC accumulation in the Vietnamese context and, specifically, to the inequality within Vietnam's competitive environment. This, the authors state has made it difficult for firms - especially privately-owned ones - to see to their existing businesses and, at the same time, to seek the learning required for marketing, international competition, and technical change. Private firms have less access to R&D, training and education facilities, are subjected to stricter financial and tax regulations, and have more limits placed on their opportunities to use bank credits are just some examples of this discrimination. While both private and state-owned firms have their own problems, this factor strongly influences their learning.

Status of technology development in Small and Medium Enterprises (SMEs)

SMEs make up the vast majority of registered companies in Vietnam. According to 1996 data (Phan Van Thuan, 1996), there were 655,000 of them operating at that time, a number that has probably increased further over the past three years. Of these, 4,000 were classified as State Owned Enterprises (SOEs) and 11,000 as private companies (private, limited or share holding companies. Of the total number of companies in the country, the SME share (1996) is 96.5 percent.

Compared to both world and regional levels, The technology level across the SME sector is generally assessed as being two, three or even more generations behind comparable regional and world technologies. The assessment of the Ministry of Industry is summarised as follows:

- The coefficient of equipment use is low (about 25-30 percent). Technologies are being upgraded on average at only 7 percent per annum, at which rate it would require 12-13 years for the upgrading of existing plant. Technological upgrading is proceeding with great unevenness across different sectors. It is, for example, relatively rapid in telecommunication, fishing, electricity and garments and slow in metallurgy and plastics.
- The coefficient of fuel and material consumption per unit of product is estimated at approximately 1.5-2.0 times higher than average world levels.
- The quality of finished products is generally low and there are few indications of either product innovation or enhancement.
- Factor analysis indicates the value of technology in finished products at only about 10-20 percent.
- Quality control suffers from technological weaknesses and deficiencies in technologies, especially those required for measurement, experimentation and certification.
- The skill level of labour is currently inadequate to support technological upgrading and there is very little R&D appropriate to support such upgrading.
- There is little in the way of a market-oriented relationship between the production sector, R&D institutions and universities.
- Endogenous capacities for the management and leadership of technical change are weak.

In addition to the above factors, it is clear that SMEs experience great difficulties in obtaining credit from the banking system due to lack of collateral assets and also because of the very complicated procedures of getting credit. The result is that they have almost no resources for longer term investments, including training, technology upgrading, or the recruitment of more highly skilled labour, and most lack the experience and capability to organise R&D activity for new products or process technology.

Current Technology Priorities of the Government of Vietnam

Earlier in the history of modern Vietnam, specific technological solutions have been proposed by the Government according to the expertise and resources available, but the government previously avoided setting specific priorities within whole fields of technology. About five years ago, however, there emerged a clear ranking in the form of four national priority programs for 'high technology'. Each is viewed by government as important to modernization. High-level inter-ministerial committees monitor and coordinate the four national programs which are in (1) information technology; (2) biotechnology; (3) new materials; and (4) automation.

The procedure followed in arriving at the four technology areas is unclear. The fact is, however, that Vietnam has set the same general priorities for its technological renovation as its largest neighbors (indeed, also as most industrial countries). The Vietnamese version of high-tech programs assigns highest emphasis to the means to access and obtain high technology from overseas, and on how to apply and adapt this technology among firms and institutions throughout the economy. Much less emphasis is placed, at least initially, on the generation within Vietnam of high technology, although a degree of experimental development of technology is being encouraged.

This approach is very similar to the previous successful experiences of Singapore, Malaysia and Indonesia where the emphasis was on technical and related services rather than on scientific

research[•] (i.e. far more on the technology part of S&T than on the science part). We agree with this emphasis. It reflects the urgent need to increase Vietnam's international competitiveness via firms and institutions obtaining better access to available modern technology from within the country and from elsewhere. In addition, only very few companies in Vietnam can afford the luxury of developing by themselves products and processes with a high technological content.

As policy initiatives, the four national high-tech programs have been widely publicized. They all have steering committees involving experts from different government sectors, but they are all differently managed. The most comprehensive and advanced of the four national programs is that on information and communications technology (IT).

The obvious question is whether these four programme areas are suitable and the right ones for a Vietnamese strategy. Certainly they are popular choices for, as has been mentioned, these are the chosen programme areas of many countries, including those that are among the most scientifically and technologically advanced. There would appear to be two more precise sub-questions that may address the issue of whether these programme areas are suitable for Vietnam:

- What is the evidence that latecomer countries can successfully enter and profit from these areas?
- Do these programme areas accord with Vietnam's comparative advantage?

The problem is that there are no simple or obvious answers to these questions. To the first question, it is always possible to argue that these are essentially new areas and that it is too soon to judge evidence of latecomer success. This is a valid argument as far as it goes. The issue for national policy makers is whether it goes far enough. What we can say, based on data that are available, including surveys of intellectual patents, is that there is very little evidence to suggest that latecomers are experiencing any significant success in two of the chosen areas: biotechnology and new materials. With the possible exception of India, scientific and productivity advances in these two areas seem to be located almost exclusively in the most advanced countries. The areas of information technology and automation appear to be quite different as is made clear in the section of this report on the experience of the tigers of East Asia. There is no doubt about the technological and competitive gains in East Asia in the areas of information technology and automation. The same conclusion may be reached, although on a smaller scale, of the experience of Brazil.

The second question asks whether the four programme areas accord with the comparative advantage of Vietnam. Comparative advantage is, of course, not a static state and economists refer more accurately to dynamic comparative advantage. The major current comparative advantage of Vietnam may be said to center on three factors: an energetic population with demonstrated learning propensities; a significant supply of surplus low-cost labor; and abundant and productive agriculture. This suggests that S&T strategy should aim at:

- Education and building on the talents and propensities of the population.
- SMEs of all description as the means to employment generation and longer-term technological advance.
- Agriculture and agro-industry (including specialized tropical products) and rural industries (linking rural needs with SMEs) as a generators of wealth, long-term competitiveness and social stability.

The main weakness in the current approach to the four national programs would appear to be structural. There are only a few companies involved as partners with the dominant institutions (ministries, state agencies, R&D institutes, university departments). The four national programs connect R&D scientists and engineers mainly among public institutions and some state-owned enterprises. Nevertheless, there is limited involvement also from R&D institutions and high-tech firms from overseas who have the available technologies and who are leading in their further

[•] There is, of course, a further concern that this will raise: the concern of how to avoid longer-term scientific and technological dependency. This point is addressed by Christopher Freeman (Freeman, 1992, p. 61):

"It is conceivable that one could rely as a matter of policy entirely on imported know-how, and not attempt to do research. Although this is a possible line of argument on economic grounds, it has obviously enormous implications for cultural and political results flowing from such a policy."

development and application. The composition of those involved in the programs restricts the effective diffusion of technology and related know-how mainly to the government sector. Yet, opportunities for sub-contracting and other cross-border production networks will likely depend on how well technology-related skills and experiences have been accumulated and consolidated among Vietnamese firms and institutions. If the programs are to become national, they will need to include a variety of other partners such as business enterprises. It is in the broader economy that capabilities should be created to absorb new technology.

More broadly, the choice of technological areas within a development strategy will want to be informed by the growing recognition throughout the world that the dominant civilisation of the 21st century will require a strong foundation in TC and in problem-solving skills. The recent efforts to transform Vietnam's primary school curriculum have been aimed in precisely that direction. This, perhaps more than any other aspect of an S&T strategy, is likely to service the modernisation interests of the country in 15-20 years' time.

Furthermore, the new century is expected to be an age of integration and synthesis of basic research with technology development; multi-disciplinary synthesis is expected to be central to new technical breakthroughs. For this reason, new regional programmes of co-operation are emerging and Vietnam will be in a position to take advantage of these. For example, East Asian countries are collaborating in the establishment of the Asia-Pacific Centre for Theoretical Physics which started its operation in 1997. In addition, more than 25 Science Research Centres are now operating at Korean universities under long-term (9 years) large financial (US$ 1 million per year) support.

The pattern of support for basic research is also changing in other newly industrialising states. No longer do we observe many examples of the approach based on the Soviet-style academy model. Competitive research proposals are solicited and they are invariably peer reviewed, often internationally. Outputs of research projects are critically evaluated also by peer reviews. In order to carry out these peer reviews and to allocate scarce research funds in a fully competitive manner, a number of nations operate science and engineering foundations. In Korea, the Korea Science and Engineering Foundation (KOSEF) is responsible for processing and administering basic research projects and it relies heavily on the peer review system. KOSEF administers single-researcher projects, fellowship awards, block grants, centres of excellence awards, equipment grants and international co-operative grants to professors and universities. The centres of excellence awards are particularly popular and have been cited often as effective policy instruments for upgrading academic research potential.

The last chapter of this paper returns to the four areas of technological choice indicated by the government of Vietnam, with particular emphasis on microelectronics.

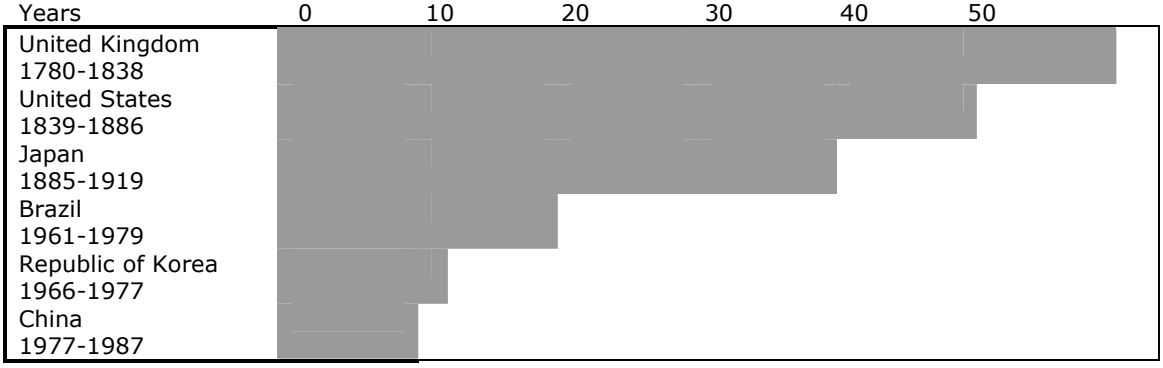
CHAPTER 4 SOME LESSONS AND CONCLUSIONS FROM THE EXPERIENCE OF LATE INDUSTRIALIZERS

The goal established by Vietnam's policy-makers is to achieve 'a modernised and industrialised society by the year 2020'. The Government envisages further that this will happen in two stages: initially through obtaining, applying and mastering imported technologies and subsequently via the generation within the country of new technologies.

This raises a host of obvious questions. Is the goal realistic? Is there evidence from the experience of other countries that suggests that it can be achieved? What are the circumstances and strategic factors in the world of today and tomorrow that need to be taken into account in trying to frame a national strategy in support of this aim? What needs to be taken into account in the evidence of successes and failures of others in the acquisition and assimilation of technology? Are there some central lessons and trends in the processes of selecting and creating comparative advantage, through technologies? This chapter looks at some possible strategic lessons from the countries that moved in recent years from a traditional to an industrial economy. It also examines major changes now occurring in the electronics manufacturing sector, as this bears directly on a matter of priority concern for Vietnam and, as it also implies, shifts of such a magnitude that lessons from the past will require especially careful interpretation.

Transformation over 25-30 years from an essentially rural and traditional economy to one generally characterised as 'industrialised and modernised' would not be unprecedented. Technological changes have provided the key both to the rapid economic expansion of many countries and to dramatic reductions in the time dimension for industrial development. The following table shows the time taken for the doubling of per person output for selected countries.

Periods During Which Output Per Person Doubled



Source: adapted from World Bank tables.

What the above shows is that, during the industrial revolution, it took Great Britain 58 years to double *per capita* output. This same doubling was achieved in 47 years in the United States during the middle years of the last century. During the early years of this century, Japan achieved the same in 39 years. More recently, Brazil's *per capita* output doubled in 18 years, Korea's in 11 and China's in 10. The reasons for the dramatic gains in the output of Brazil, Korea and China over only a very few years are complex and have been the subject of extensive scholarship and considerable dispute and there is great danger in any oversimplified explanation. There is, however, a strong consensus that technological advances have been the most critical factor in collapsing the time frame for industrialisation.

There is, then, solid evidence that rapid transformation, industrialisation and economic growth are possible. The next obvious question is whether a latecomer to industrialisation like Vietnam can achieve the same rapid modernisation over the next twenty years that some of its neighbours and near-neighbours achieved over the previous twenty? This is a far more difficult question which raises, in turn, a number of key further questions. Are there lessons that can be extracted from the experiences of Taiwan, South Korea, Malaysia, Singapore, Thailand and China that can help to

inform a Vietnamese strategy? Can we identify patterns that facilitate the acquisition and mastery of technology? What were the indispensable functions of the state? How important was the role of Trans National Corporations (TNCs)? How did the Asian tigers avoid the trap of stagnation at the low-cost labour, entry-level levels of industrialisation?

Although there are many claims to the contrary, answers to these questions are, in fact, far from clear. First of all, it is not clear that we have arrived at a fully adequate understanding of exactly what explains the dramatic successes over 25 years of Korea, Taiwan, Singapore, etc. Secondly, geopolitical and geo-economic factors have altered significantly since the "Asian tigers" launched their rapid economic growth. Thirdly, the complexity of global trends today, coupled with the speed at which changes are now occurring, should suggest extreme prudence in extrapolating the past as prologue.

These cautions notwithstanding, the examples of the Asian tigers provide important factors to take into consideration in the construction of a strategy for an industrial latecomer like Vietnam. Moreover, some quite recent study in East Asia and elsewhere has contributed to important increases in our understanding of the role technology played in rapid economic advance. It is to these that we now turn.

Early Experiences

Development theory in the 1960s held that technology transfer was the key to economic and social development. In 1963, the first major United Nations Conference on Science and Technology for Development was held. The consensus that emerged was that the world market was like a 'supermarket' filled with technology that was 'available for the taking'. The advice given to developing countries was to take advantage of this and to 'shop wisely'. In retrospect, this appears as very naive, but it was the view that prevailed during the first 'development decade' of the United Nations. Studies conducted in the early years of the 1970s revealed a number of deeper issues in technology transfer, including the following:

- Far from being easily available, especially higher-end technologies were either unavailable to developing countries or available only under restricted conditions. The most common restriction either prohibited export of goods produced with the technologies or restricted their export to a limited number of neighbouring countries.
- Technological know-how, especially the abilities to adapt and modify technologies, often remained with the original owner. Control over the application of technology and its profitability were thereby retained by the owner.
- It became clear that, from the perspective of the owner of a technology, there was a high risk associated with any transfer of a high-end technology to a developing country. This most often involved fear that proprietary (patented) title would be lost and with it the owner’s comparative advantage.
- Many developing countries in the late 1960s, especially those in Latin America, responded to these limitations by asserting government control over the transfer of technology. Special units were established to oversee the legal and contractual aspects of technology transfer whether via direct purchase, joint ventures, sub-contracting and foreign ownership. In several countries these units were assigned the further role of assessing the technologies themselves. Far from proving merely ineffective, these mechanisms served mainly to curtail the availability and transfer of all forms of technology. Because of this, most of these units had disappeared by 1980.
- Perhaps the most worrying result of these studies to developing countries related to technology and productivity gains. Productivity from new technologies introduced into developing countries did rise initially to levels similar to those experienced with the same technology in industrial countries. After a short period, however, they diverged sharply, with gains continuing in industrial countries but not in developing countries. The studies concluded that most of the divergence was due to continuous technological innovations and incremental small gains occurring to a much greater extent in industrial countries.

Circumstances have, of course, changed since the 1960s, but three broad observations deriving from these early experiences of developing countries seem relevant to considerations of future strategy:

- Proprietorship over technology is no less strong today than it was three decades ago. Indeed, it is arguably stronger and better protected under the intellectual property rights provisions of the WTO. S&T strategy needs to include actions that take this fully into account through national legal structures that provide protection to intellectual property.
- The role of government should be heavily weighted in the direction of facilitation and the removal of barriers, rather than in the direction of regulation and control.
- The factors that support and encourage a continuous process of innovation are of critical importance - more so today than in the past. To be successful a S&T strategy should aim at establishing and strengthening the factors of innovation.

Infant Industry Strategies for Technological Acquisition and Learning

Experience and research over the period 1960-1980 also showed that a developing country that wished to establish new export-oriented industries and new areas of R&D usually began from a position of disadvantage relative to established industrial countries and leading firms. This gave rise to 'infant industry' policies involving a range of measures (mainly tariff and non-tariff arrangements) to protect industries in early years in order to give them a chance to become established in world competition. Although the approaches varied somewhat, infant industry practices were key components of the strategies of Singapore, Taiwan, South Korea and Brazil.

The theory behind infant industry approaches assumes that over time there will be increasing returns to scale in the supported industry. The argument begins with the proposition that the new industry is small, inefficient, inexperienced and unable to compete. It holds that the acquisition of management know how, market knowledge and technology choice can occur if temporary protection is provided. With that protection, the industry will accumulate the experience required, will improve productivity and will become competitive. The required protection is to be accorded by the government in order to expand the industrial base and to raise national income.

Infant industry approaches contain a number of serious problems. First and foremost, a considerable body of evidence has accumulated over the past 40 years which indicates that the learning and productivity gains that occurred under protection did not always follow a time-dependent learning curve. In many countries, the requirement for protection became a permanent feature, rather than an instrument to 'prime the pump'. A second problem is that many governments have proved not to be up to the job of managing infant industry programmes. A UNIDO-DSI report of September, 1997 makes this point in the following way:

> "Modern theory of 'market failure' also recognises the risk of 'government failure'. *i.e.* government interventions may not actually improve matters very much, either because the government's ability to design and implement good selective policies is limited, or because the government serves the interests of special, often politically influential, groups rather than the general interest of society" (UNIDO - DSI, 1997, p. 103).

In addition, it is becoming less and less possible for developing countries to exercise protection of the 'infants' as they integrate into the regional and international economy. Infant industry approaches are, however, continuing today, but the much more integrated global economy means that the instruments used must be both more subtle and flexible. Indonesia, for example, has emerged as an internationally-competitive exporter of a range of manufactured goods only in the past ten years. Its success in export-led manufacturing can be attributed to a number of factors, including 'successive packages' carefully assembled and timed over a decade to reshape and 'fine-tune' the banking and financial system, customs arrangements, tax laws, protection against imports, import monopolies, licensing of investments and production, sea communications and

state enterprises. It needs to be said, however, that even such sequenced packaging is, in today's environment, less possible than it was only a very few years ago.

Given the deficiencies in the Vietnamese market environment, however, some measures of selective industrial intervention would appear to be appropriate to national strategy. This, of course, is not a view held by most neo-classical analysts who tend to urge wholesale and quick liberalisation. They argue that comprehensive import liberalisation should be carried out before efforts are made to increase export earnings. This, they claim, is required in order to eliminate inefficiencies generated by protective barriers and enable a subsequently stronger response to export demand (see, for example, Krueger, 1978). With the exception of Hong Kong, however, the East Asian experience is far more supportive of selective industrial strategy involving sequencing gauged to the competitiveness of domestic industry (see Helleiner 1988, Krugman 1989, Wade 1990).

As indicated, however, the conditions now confronting Vietnam are very different from the conditions that confronted Japan, Korea, Singapore and Taiwan when they made major inroads into Western markets. The Asian Free Trade Area (AFTA), of which Vietnam is a member, requires of Vietnam that its tariffs on intra-regional trade not exceed 5 percent by 2006. The recent agreement between China and the United States in support of China's membership in the WTO will likely create sooner rather than later a new trade dynamic within Asia and globally. This will place further time pressures on Vietnam to reach a level of international competitiveness with China. A further factor is that over the past decade technological change has produced a dramatic fall in the demand for unskilled and low-cost labour per unit of production. Studies show that when labour cost fall to 5 percent or less of total production costs, the price of labour becomes marginal to decisions on industrial location.

These changes mean that the choices available to Vietnam in its technology strategy are fewer than those enjoyed by countries who launched their modernisation efforts in an earlier period. The changes also create greater pressures of urgency in achieving international competitiveness.

Inputs to Technology Strategy from the Asian Tigers

There are major continuing debates and differing interpretations over how exactly to explain the dramatic successes of the tiger economies of East Asia. Most of these are focussed on macro-level assessments of the contribution of state management versus the forces of the market, on policy sequencing versus full international openness, and, more recently, on the factors that explain the sharp reversals of 1997 and 1998, and the rebound that has occurred this year. What follows is an attempt to extract some conclusions that are much more specific on how technology was acquired and how technological learning actually occurred. These conclusions draw heavily on the recent and excellent comparative work of Michael Hobday (Hobday, 1995).

Each of the tigers was in the 1960s and 1970s a latecomer to industrialisation; each followed trajectories involving different time periods; and there are many important features of policy and practice that differentiate the experiences of the different countries one from the other. It is important that this fact be mentioned in order to underscore that no single blueprint to technology strategy emerges from the experience and lessons of the tigers. Each country has a distinct history, geography and natural endowment. Each has a different set of economic opportunities and problems. Some of the basic principles that can be extracted from the technological advance of the tigers may, however, be instructive and of value to the formulation of a distinctive Vietnamese strategy.

Among the key basic principles, then, are the following:

- **Science played virtually no role in the technological and industrial advance in East Asia.** The linear model of S&T has been widely criticised, especially in recent years and in the context of the emerging literature on knowledge societies. Nevertheless, the conventional 'Western' model of innovation and technology still stresses the centrality of R&D to technology learning. The linear model was even more strongly affirmed in the Soviet model. According to these models, the starting point to industrialisation and industrial gain is scientific advance through research. From this base, R&D is conducted by firms (or the state in the Soviet model). New products are then developed, refined and marketed. The product life cycle flows from the early to the mature stage. The sequence of the linear model

remains pervasive in much thinking and runs deeply in much of the literature on education and policy analysis. In the case of all of the East Asian tigers, however, the evidence shows that science played almost no role in technological transformation. The same conclusion is reached with regard to R&D.

The importance of this for a technology strategy is obvious. The linear model would assign highest initial priority in a technology strategy to investments in scientific capabilities, followed by investments in and incentives for R&D. The experience of the East Asian tigers would not support such sequencing or such emphasis.

- **Imitation was the entry point to innovation**. In contrast with Western preoccupations with invention, R&D and advanced product designs, the learning experience of the tigers was based on competition to manufacture goods for established markets. East Asia's latecomers travelled backwards along the standard Western product life cycle, reversing the normal path. The process of technology acquisition and adaptation in the tigers began by learning mature, standardised manufacturing processes, in other words learning by imitation. As Hobday notes:

> "Once manufacturing capabilities were in place, companies moved onto advanced process engineering, product-process interfacing and product design. Only recently and selectively have the leaders exploited R&D for future product developments. In this sense, they reversed the normal cycle of innovation, passing from mature to early stages of the product life cycle, from standard to experimental manufacturing processes and from incremental production changes to R&D."

This suggests for a Vietnamese technology strategy that, while low-cost labour will likely provide the main, initial comparative advantage to technological learning, the strategic challenge is to establish the means to rapid transformation from simple assembly to process adaptation and incremental improvements.

- **'Leapfrogging' did not occur**. Not surprisingly, the idea of leapfrogging is very popular. It holds that developing countries may be able to bypass earlier vintage technology and enter directly into high tech areas of electronics, information technology and biotechnology. Hobday has examined this theoretical question with regard to Singapore. Singapore is an excellent case study given that it has benefited more than others from its information infrastructure and had the pre-conditions in education and absorptive capacity for leapfrogging to occur. The conclusion is that neither Singapore nor the other tigers experienced leapfrogging from one vintage technology to another. Rather, they engaged in a painstaking and cumulative process of technological learning (from imitation to innovation). 'A hard slog rather than a leapfrog', to cite Hobday. In the electronics sector, the route to technological advantage was via a long and difficult learning process through the assembly of goods for export to software and advanced information technology.

The implications of this East Asian experience for government policy in an overall Vietnamese strategy are essentially in the area of human resource development. To gain a foothold in the global electronics industry, for example, the key initial requirement will be an adequate supply of human resources trained in a range of basic craft, technical, engineering and industrial skills. In other words, a basic pre-requisite is a cadre that can manage the process of technological transformation and technological gain. Like the tigers, Vietnam's strategy should include taking very seriously the low-technology side of the so-called high-technology industries. Again, to quote Hobday: "Only by developing capabilities in fields such as plastics, mouldings, machinery, assembly and electromechanical interfacing, did East Asia emerge as the leading export region for electronics."

- **FDI contributed disproportionately to technological advance**. With the exception of Singapore, FDI represented a relatively modest proportion of investment in the tigers. In the case of South Korea and Taiwan successive governments exercised strict controls over the size and direction of foreign investments and FDI accounted for only a tiny proportion of total capital formation (2 per cent in Korea over 1976-1987 and from 1.4 percent to 4.3 percent over a twenty year period in Taiwan). The relative amount of FDI may have been quite small. Its effects, however, were exceedingly large. FDI began the production of many fast-growing export lines. Research also shows that the TNCs frequently acted as

demonstrators and role models for local companies. Some foreign operations were responsible for extensive training of engineers and managers, and for transferring skills and know-how. FDI was the most important factor in opening up export markets to the tiger economies. By the mid-1970s, it accounted for roughly 20 percent of Taiwan's manufacturing exports. There is also evidence that local engineers trained by FDI investors left the parent firm to set up their own companies (often to supply the subsidiary with components or some kind of technical services, thereby creating important backward linkages).

The implications for Vietnamese strategy would appear to underscore the importance of establishing the conditions most conducive to FDI on the grounds that it offers multiplier effects to technological learning that are disproportionate to the relative magnitude of the FDI.

- **Privately owned SMEs took the lead in economic growth, technological diffusion and employment creation.** Although larger multinational enterprise and FDI played the disproportionate role in technological learning just mentioned, it was, in general, tens of thousands of small and medium enterprises that took advantage of the learning and moved quickly up the value chain. This was especially the case in Taiwan, Hong Kong and, more recently, China. The role played by SMEs in the transformation of China is quite staggering. In 1986, only 4.2 percent of China's industrial output was accounted for by foreign and private companies. Only ten years later, these same enterprises accounted for over 31 percent of industrial output. Even more startling it the fact that by 1996 the Town and Village Enterprises (TVEs) employed some 135 million people and accounted, together with the urban non-state sector for twice as many jobs as the state sector.

  Central to the dramatic economic growth experiences of Taiwan and China was the technological learning made by SMEs. A major catalyst to this in China's case has been the technological diffusion program (SPARK) set up by the Chinese government (an explanation of that program is provided later in this report). Taiwan's success thirty years earlier was facilitated and driven by, credit guarantees and direct venture capital facilities established and managed by government. Both experiences may hold value for Vietnam's S&T strategy. A further key factor contributing to the vast economic contribution of SME's in the transformation of both Taiwan and China was the formal recognition by government of the importance of SMEs and strong public expressions of support for their establishment.

- **Buyers served as important sources of technology and of market information**. Large international buyers played a major role in the rapid transformation of the tiger economies. They enabled many firms to expand production capacity and to obtain credit by guaranteeing forward export orders. In the case of South Korea, one study shows that a very high percentage of sampled Korean firms benefited directly from buyers through visits by foreign engineers and visits by Koreans to overseas factories. Buyers provided local companies with blueprints and specifications, information on competing goods and production techniques, as well as feedback on design, quality and performance. Buyers helped the latecomers to overcome their distance from the advanced markets and foreign sources of technology.

  This suggests that Vietnam's strategy for technology acquisition and modernisation should encourage arrangements designed to facilitate maximum access to international buyers, including policies and incentives to encourage buyers to locate in Vietnam. According to a recent study (MPDF/IFC, Webster, and Taussig, 1999), SME learning in Vietnam is currently constrained because producers often know very little about how or to whom their products are distributed. The same report also mentions that producers are often dependent on a single buyer 'who has appeared at their doorstep'. Earlier experience from elsewhere in East Asia suggests that investments in establishing distribution systems via multiple and established international buyers would facilitate broader exposure to the wider world, its distribution systems and to product and process upgrading.

- **Continuous incremental innovation was a defining characteristic**. We do not know enough about the nature and extent of innovation in the tiger economies. In general, the research that has been done has focussed on the growth, expansion and diversification that has taken place without uncovering the details of the innovations that made success possible. The few studies that have been done, however, tell us that continuous incremental

innovation was key to the tigers avoiding the low wage, entry-level industry trap. Substantial innovation took place as the automation process proceeded apace. The innovation that occurred, however, was not radical or driven by R&D (a point made earlier). Rather, it was incremental and driven by the needs of competitive manufacturing. The innovation that occurred, especially in the early years of the transformation of the tiger economies, was of the continuous improvement variety. This included soft or organisational-managerial innovations and innovations of technical process. Especially as wages rose, it became clear that this process of continuous innovation was central to export success. It is in fact difficult to understand how the rapid expansion that occurred would have been possible without the local capabilities for innovation that were evidenced in the tiger economies.

This implies for a Vietnamese S&T strategy the centrality of investments and policies that build the problem-solving and innovative qualities of the nation's human resources. An educational curriculum designed to inculcate and nurture these qualities is likely to pay longer-term dividends no matter what the nature or extent of future (and unforeseeable) technological change.

Possible Worrying Features of Recent Latin American Experience

A very recent study conducted by the United Nations Economic Commission for Latin America (ECLA) summarizes the impact of trade liberalization and market deregulation on the national innovation systems of Latin America (Katz, 1999). He points out that the rapid process of diffusion of computer-based production technologies together with recent structural reforms have significantly changed the technological behaviour of individual economic agents as well as the structure and performance markets. Among the findings of the study, five are especially worrying for policy-makers:

1. The principal impact of these changes has been to reduce the costs of importing capital goods with the result that locally produced equipment is no longer able to compete against imports.
2. A similar negative impact is reported on 'in-house' engineering activities which firms used to carry out to improve the efficiency of the equipment and to extend its life cycle.
3. The privatization of public enterprises in areas such as energy production and telecommunication services has led to the closing down of local R&D and engineering departments. The study points out that the new operators, which are mainly subsidiaries of large public enterprises in the developed countries are rapidly modernising the domestic infrastructure in all these sectors, but they are doing this on the basis of imported capital equipment and know how. The technological gap between Latin American countries and the developed world in these fields has been considerably reduced, but domestic technological capabilities appear to have diminished.
4. Another impact has been the cutting back on the number of parts and components which are produced domestically and their replacement with imported intermediate inputs. 'In-house' local design capabilities have been substantially reduced
5. There has also been a change in the behaviour of local subsidiaries of transnational corporations which have reduced their domestic input and now are more in the nature of assembly plants of imported parts and components than integrated manufacturing facilities.

This recent experience in Latin America seems to be at considerable variance with that of East Asia where backward linkages into the domestic economies have been substantial, and where there is still an emphasis on developing domestic capabilities to improve imported technology.

The longer-term implications of the recent trends in Latin America are far from clear. It seems that although there are technological advantages to production by becoming more integrated into the world economy, these may be at the cost of diminished local technological capabilities. If this Latin American experience is typical, it will have considerable implications for industrialisation and the role of government strategy in Vietnam. It demonstrates the importance of closely monitoring global trends and being able to respond to these threats and opportunities. There is no point in

Vietnam designing industrial technology policies which have been tried and discarded by the rest of the world.

Changing technological frontiers

It was mentioned earlier that the recent experience of the Asian tigers is no blueprint for the strategy of a latecomer aspirant like Vietnam. The conditions that prevailed when South Korea, Taiwan and the other tigers began their transformation have been replaced by a very different set of conditions. At the core of these new conditions is a technological revolution which is altering fundamentally all aspects of business, industry and manufacturing. New technologies, based on a constellation of industries, which are the fastest growing in all the leading industrial countries (e.g. computers, electronic components and telecommunications) have already resulted in vast improvements in technical performance, as well as a dramatic fall in costs and a counter-inflationary trend in prices. Their revolutionary effects, however, lie in the fact that they are influencing, although very unevenly, all other sectors and that they are changing the very nature of industry, economy and society. The revolution in industry was succinctly outlined some time ago in a special supplement to The *Economist* (30 May 1987) entitled 'Factory of the future':

> "For the first time in three-quarters of a century the factory is being reinvented from scratch. Long, narrow production lines of men crawling all over them - a feature of manufacturing everywhere since the days of the car-making dynasties - are being ripped apart and replaced with clusters of all-purpose machines huddled in cells run by computers and served by nimble-fingered robots. The whole shape of the industrial landscape is changing in the process. In short nothing less than a whole new style of manufacturing is in the process of being defined."

The complete reorganisation of the production system is now taking place and is far more important than any particular discrete piece of equipment. This 'reinvention' of the basis of manufacturing and industry is intensifying and it is a trend that must be expected to continue.

Changes in Electronics Manufacturing and Implications for Vietnamese S&T Strategy

Our terms of reference have asked that we give special attention to the electronics sector. What follows outlines a major change now taking place in electronics manufacturing. This will likely modify significantly the options available to Vietnam and it suggests that the experience of earlier industrializers through electronics manufacturing will be difficult to replicate. A major example of the changing technological frontier is found within the manufacturing side of the electronics industry itself. This report was asked to pay particular importance to this sector and so we provide in what follows a summary of these changes as derived from the recent work of Timothy Sturgeon of the Massachusetts Institute of Technology (Sturgeon, 1998).

In choosing this sector, the Vietnam government makes reference to the comparative advantages of relatively cheap labour and on the rapid learning aptitudes of the population. Drawing on experiences elsewhere (e.g. Taiwan, Singapore), the following logical sequence is drawn: Microelectronics is conducive to industrial latecomers because entry-level assembly operations are determined on the basis of low-cost labour. Entry-level technologies are available and are furnished by large multinational corporations (FDI wholly-owned or in joint ventures with local firms). Skills are acquired and upgraded, establishing the base for higher-end technologies and greater value-added. Backward linkages to component manufacture are thereby encouraged.

This logic is entirely valid as a reflection of what occurred during the 1970s and early 1980s. During that period, offshore affiliates of brand-name electronic firms were established in places like Singapore, Hong Kong, Malaysia, Thailand and Scotland in order to take advantage of high-quality, low-wage workers. These were involved in labour-intensive assembly and the 'reverse engineering' processes on which this depended. The circuit boards and final products that were assembled were largely for high volume, price sensitive electronics sectors such as personal computers and peripheral equipment, telephone hand sets, toys, etc. Initially, most materials and

components came from the United States for assembly on a 'consignment' basis. Over time, an increasing share of inputs was sourced locally, drawing on nearby semiconductor plants that had sprung up.

The problem is that this pattern has changed and is continuing to change at a very rapid pace. This is due to recent dramatic technological changes in microelectronic manufacturing and in the organisational changes they are producing. Any Vietnamese strategy to become a player in this sector will need to take careful account of these changes.

The first part of the change is technological change itself. As recently as 1985, the prevailing technique for attaching electronic components to bare circuit boards was to place and then to solder components on the board (either by hand or by machine) using 'pin-through-hole'! (PTH), or simply 'through hole' circuit-board assembly technology. This was a highly labour-intensive and repetitive process. A generational change in circuit-board assembly began, however, in the mid-1980s and it has dramatically increased the capital intensity of the circuit board assembly process. Today's highly integrated semiconductor devices (e.g. microprocessors, application-specific integrated circuits, dynamic random access memories, etc.) have become so complex that it is no longer physically possible to use PTH assembly techniques (the pin holes simply cannot be drilled close enough together). The solution has been to forgo drilling altogether and to use an assembly process that is called 'Surface mount technology' (SMT).

The point here is not to describe the new technology but to point out that before SMT, the majority of electronic assembly was done by hand. The popular image of the 'global assembly line', with rows of workers on microscopes for chip assembly, or placing electronic components on circuit boards by hand, is well known. It has long been an ironic truth that such 'high tech' items as semiconductors and circuit-boards were assembled under extremely 'low-tech' conditions. But the shift from PTH to SMT has rapidly forced the electronics industry away from hand work and toward automated assembly. Thus, in most electronics factories, the number of workers has been substantially reduced and circuit board assembly is now done largely by programmable 'pick-and-place' robots. With automation, equipment costs for a new production line have increased from less than $200,000 in the early 1980s to more than $1,000,000 in the mid-1990's.

Labour costs will, of course, continue to be very important where price sensitivity exists. What has happened with the technological change just described, however, is that comparative advantage has shifted from low-cost, relatively unskilled labour to low-cost, high quality manufacturing engineers. This shift currently favours such locations as Singapore, Hong Kong, Scotland, Thailand, China and India.

The second aspect is organisational change in the global microelectronic industry. Particularly since the early 1990s, the large international electronics companies (e.g. IBM, Apple, NCR, Hewlett Packard, Digital, Ericsson, etc.) have been abandoning their internal manufacturing operations *en masse*. They have been turning to contract manufacturers on a complete 'turnkey' basis to build their products while they concentrate on marketing, on product design and on R&D. The result is that turnkey manufacturers have become central to the prospects for technology access, export-led industrialisation and market penetration. A further result is that aspiring late entrants into microelectronics confront a much more complex and demanding environment than that which existed previously.

Firms that provide electronic assembly services can no longer rely mainly on low labour costs to win business. Suppliers must have the financial and administrative capability to purchase all needed component and material inventories up-front. In order to control the flow of components through the factory, especially in an environment where multiple products for multiple customers are being assembled, most turnkey contract manufacturers deploy computerised 'manufacturing resources planning (MRP) systems'. These systems are expensive, difficult to master, and often must be continually adapted and upgraded to fit the contractor's specific operation. Today, policies intended to upgrade the local supply-base need to take such new requirements into account. Capital needs to be made available, not just for plant and equipment, but for turnkey components purchasing and sophisticated MRP systems as well.

The emergence of large-scale turnkey manufacturing, therefore, creates new complications and greater challenges for aspiring late-entrants like Vietnam. On the other hand, it creates major new opportunities. The previous practice of consignment contracts - where customer firms purchase components and supply contractors - are essentially labour contracts. Consignment contracting is

especially common in export processing zones (EPZs). Experience shows that such contracting provides little opportunity for industrial upgrading beyond the creation of a low-skilled industrial labour force. The advent of turnkey contracting provides new possibilities for the development of backward linkages to the local economy and thus for the upgrading of the supply-base. This is what has been happening in Singapore where several smaller component and service suppliers - each with its own specialised expertise - have recently merged to create larger firms capable of providing full-service contract manufacturing.

These shifts suggest the following to a longer-term Vietnamese strategy that includes emphasis on electronics manufacturing:

- Both Government and entrepreneurs will need to identify and to form strong linkages with the advanced foreign companies that continue to create and define the trajectory of technology in this fast moving sector.
- Turnkey contractors that supply technologically advanced customers are increasingly central to this and will likely be the main 'trend setters' over the next several years.
- Increasingly, development in electronics means strategies that aim at becoming part of an international production network. It does not mean the creation of a Korean-style export-oriented national industry from the ground up, this being a strategy unlikely to succeed in such a fast moving sector.
- Strategies aimed at providing firms with low-cost labour for manual assembly are becoming less effective.
- Government-led investments aimed at producing a cadre of 'techno-managers' who can deal with the demands of full service delivery will probably pay dividends.

The Entire Paradigm is Changing

Under the heading 'Change of techno-economic paradigm', Christopher Freeman (see Freeman 1992) has provided a helpful listing of some of the major aspects of the transformation that is occurring:

Change of techno-economic paradigm

'Fordist' **Old**	**ICT** **New**
Energy-intensive	Information-intensive
Standardised	Customised
Rather stable product mix	Rapid changes in product mix
Dedicated plant and equipment	Flexible production systems
Automation	Systemation
Single firm	Networks
Hierarchical structures	Flat horizontal structures
Departmental	Integrated
Product with service	Service with products
Centralisation	Distributed intelligence
Specialised skills	Multi-skilling
Government ownership and control and planning	Government information co-ordination and regulation; 'vision'

The strategic implications of these dramatic shifts for Vietnam, and for all countries aspiring to modernisation, are numerous. Among them are the following:

- Flexible approaches and a relatively open framework are most likely required. Industrial planning with government direction and specific targeting have been the preferred technological instruments of many countries, including Vietnam. They would appear to be ill-suited to the new environment just described. A good rule for technology strategy today is to aim for agility, for networks of problem-solvers that can assemble quickly to deal with a particular issue which self-dissolve just as quickly. This means that rules should be flexible

and enabling and that public management should be able to make rapid adjustments and changes in response to new circumstances.

- Government was a major actor and played a pivotal role in bringing about development through industrialisation in Singapore, South Korea and Taiwan. Based on the success of those experiences, there are many who advocate similar approaches for the future. The new paradigm suggests, however, that guidance and direction may now be more appropriately and effectively exercised through a 'gentler touch' based, as Christopher Freeman suggests, on mastery of an inspired vision of an industrial society and on its communication. Interestingly, one of the main authors of prior success, Lee Kwan Yew, the former Prime Minister of Singapore, has suggested that future progress will depend increasingly on participative approaches because of the complexity of modern technology and of the organisation around it. (*Economist* magazine interview, 9 June, 1991, pp. 18-19).

CHAPTER 5 CREATING AND NURTURING TECHNOLOGY-BASED ENTREPRISES: A REVIEW OF SOME STRATEGIC INSTRUMENTS

What strategic instruments are currently being recommended by donor and specialised agencies to countries such as Vietnam that are seeking rapid industrialisation? Globalisation has intensified competition throughout the world to attract and retain technology-based enterprises. It has equally accelerated the continuing search for strategies that will assist in 'growing' technology-based enterprises nationally. In this regard, conventional wisdom holds that there are a number of strategic instruments that can assist the governments and firms of developing countries. Typically, the instruments recommended include:

- The provision by governments (national, regional or municipal) of serviced industrial sites (technoparks).
- The use of 'business or technology incubators' to pick and nurture 'winners'.
- Encouragement of 'clustering', especially by SMEs, to build comparative advantage, access export markets, and facilitate innovation.
- The establishment of strong linkages to 'global buyers'.

Vietnamese policy makers are well aware of these instruments, with significant national investments and international assistance being directed to all of them, particularly to technoparks. There are some obvious questions to be considered in the context of the new strategy that is being prepared. What does the evidence suggest as the potentials, limitations and risks of these instruments? What is the appropriate role for the state in their management and what needs best to be left entirely in the hands of the market? Does the evidence suggest specific applications to the Vietnam case? Do we know enough to determine a balance of emphasis between the instruments and, if so, what is that balance? To what extent should these instruments be considered as major components of a national strategy?

What follows is a short review of each of these instruments. Complete answers to the questions just listed do not emerge from this review, because such answers simply do not exist. The review does underscore just how little is really known about the effectiveness of these instruments. This does not state that they may not prove of great value to Vietnam's industrial modernisation efforts, but rather that they should be approached pragmatically and on the basis of constant feedback as to their cost and effectiveness. The review attempts to provide an up-to-date critical assessment and to offer a synopsis on the basis of the comparative studies that have been carried out. Finally, a number of specific suggestions are also made in the hope that these will help to provide a reasonable and informed basis for policy discussion and strategic choices.

Technoparks

The idea of industrial zones is a very old one, dating back to the early years of this century. The idea really took hold, however, following the second world war. In North America and in Europe, industrial zones were established mainly with a view to attracting new investment. In the 1960s, the idea spread to Asia and Central America. The concept of industrial zones has been shifting over time in order to respond to different definitions of development need. They have come to be viewed as direct instruments of technology strategy on the assumption that, properly structured, they can facilitate technology transfer, national R&D and national technology development. In general, the industrial zone concept may now be said to embrace:

- Industrial Zones (IZs): These aim at providing attractive real estate and services (e.g. roads, water, electricity, security) at a reasonable or subsidised price to investors. The products of businesses that locate in such zones may be directed principally at either domestic or export markets.

- Export Processing Zones (EPZs): These aim more exclusively at export markets and usually provide real estate, services and significant tax concessions (duty free import of equipment and materials). Some EPZs operate entirely in offshore currency.

- Technoparks or High Tech Zones: These may function on the basis of either of the above models, but their rationale is distinct. The aim behind these is more specifically to create an environment that will attract and develop technology, that will stimulate the establishment of backward linkages (to domestic suppliers and to universities and research centres) and that will be conducive to the pooling of R&D.

Over the past few years, Vietnam has invested substantially in establishing such zones, often with encouragement and support from international organisations. According to available statistics, Vietnam currently has 66 industrial zones, of which three are classified as export processing zones (EPZs) and the remainder as industrial zones (IZs). Two major technoparks or high tech parks (in the Hanoi and Ho Chi Minh areas, respectively) are under development.

Are industrial zones (and their variants) appropriate instruments in a Vietnamese science and technology strategy? The answer is not clear. There has been very little research on the returns to investments in industrial zones and even less research that compares such returns to those from alternative approaches. Evidence from earlier experiences in Central America concluded that the manufacturing that did occur was almost entirely of the 'enclave industry' variety. It developed few, if any, linkages to the local economy; it was almost entirely of a low-cost labour variety; and no significant technological transfer or training occurred.

More seriously, the evidence from Central America showed that the countries had given too much away in order to attract investors. Ceilings were fixed for the returns to the individual country and incentives were structured in a manner that encouraged producers to keep wages low.

By contrast, there are extensive claims that industrial zones have played an important role in encouraging investment in the economies of East Asia, although there does not appear to be much in the way of systematic research that supports these claims.

There is also little systematic evidence on technoparks (high tech parks) as instruments of technology acquisition and development, a fact which is somewhat surprising as many have been around for some time. The tendency appears to be to refer to a number of technologically highly successful geographic areas (e.g. Silicon Valley in California; Phoenex, Central Florida; Raleigh, NC; Sophia-Antipolis, France; Ideon, Sweden) as proof that technoparks are sound investments that produce technological advantage. There are also numerous examples of technoparks that do not appear to be performing at all well, but here also the evidence tends to be anecdotal. Even in the examples of success, the picture is very unclear and the key questions for strategic consideration are not addressed: how did the parks form in the first place? Was there a role for Government and if so what was it? What was cause and what was effect? To what extent do the parks really facilitate the spontaneous growth of backward linkage industries? Is there any effective inter-firm co-operation in R&D? Are there some public policy instruments that are judged as catalytic in making technoparks successful?

In other words, much appears to be assumed about the value of technoparks to latecomer countries like Vietnam, but there is, in fact, very little systematic evidence in support of this. This, of course, does not mean that technoparks should not be included as instruments of technology strategy, although it should suggest the importance of a cautious and questioning approach. There is some recent evidence on 'clustering' which may bear on this issue and that is presented in a subsequent section of this report.

Whatever the historical case, we do know that competition to attract investment is greater today than in the past. Countries, and even cities and industrial zones within countries are seeking ways to gain advantages in attracting and retaining investment. Also irrespective of experiences elsewhere, a recent, draft UNIDO report (UNIDO, 1999b) makes an interesting and important point linking the potential of industrial zones to the environment. The report notes that, while the converse may be true, if properly planned, developed and supervised, industrial zones can be a force in reducing or eliminating industrial pollution. This point may bear particular examination in a Vietnamese strategy especially in light of problems China is encountering with some of its SMEs and TVEs, some of which are now being forcibly closed by the state because of the severe damage they have inflicted on the environment.

If we examine the experience to date of Vietnam’s industrial zones, the picture that emerges is very mixed. According to statistics from the Ministry of Industry, many of the existing zones are

experiencing low occupancy rates and total employment in the 66 industrial zones remains low (less than 125,000). The recent UNIDO report assesses this as follows:

> "….there is no single organisation at the national level responsible for the planning, development and supervision of industrial zones on a national scale. The result is a number of successful zones, but also a significant number of zones will poor development prospects."

A high opportunity cost to Vietnam is involved in investments in zones that do not yield expected returns.

With regard to the 66 industrial zones that have already been established in Vietnam, the UNIDO suggests a very pragmatic approach to a number of issues which are identified in its report. We agree with these as logical first steps to deal with industrial zones as part of a technology strategy. Briefly, UNIDO recommends the following:

- A single, national organisation should be mandated to deal with all aspects of public investment and management of existing industrial zones.

- Efforts need to be expanded to attract FDI into the existing zones. It follows by implication, that the future of zones that prove unsuccessful in attracting the investment would require examination.

- Institutional arrangements relating to zone development and supervision need to be examined in order to eliminate any legal or bureaucratic barriers to efficient usage (e.g. duplication, gaps, bottlenecks, restrictions and inconsistencies).

- Operating procedures of each zone must be made consistent, efficient, clearly understandable and transparent if investors are to have gain confidence.

With specific regard to Vietnam's plans for future high tech parks, the following factors are suggested as components of an overall strategy:

Strategic Elements Regarding Technoparks

- First, consider the alternatives. To be successful, export-oriented firms must create longer-term market advantage by constant innovation, distribution efficiency, targeted customer strategies, etc. How will technoparks contribute to these factors? Are alternatives likely to be equally or more effective and cost-efficient? These key questions can only be answered on a sector by sector and firm by firm basis.
- Be careful while selecting the geographic location. The criteria for selecting the most appropriate site (or sites) for a high tech park should be elaborated before any decision is taken. Decision-makers should consider carefully both advantages and disadvantages of each site. Alternative locations should also be discussed in detail. Experiences from other countries show that the choice of location is of paramount importance. Access by and to local firms would appear to be imperative to the prospects for the building of important backward linkages. Detailed site analysis may even determine at a very early stage the probability of success or failure of a high-tech park.
- Look into existing strengths of the already accessible techno-industrial infrastructure: for instance, a survey of R&D resources in the Hanoi area was completed in 1997 to provide a general overview and an analysis of available (and some potential) resources for the Hanoi high-tech park. The survey contains an analysis of available scientific and technological facilities and other resources for industrial innovation, which could be linked to a high-tech park in the greater Hanoi area. Ideally, the decision regarding the location of a high-tech park should accommodate the survey results.
- Identify short-term benefits. Success is more likely if there are both short-term and long-term benefits for the high-tech park's tenants. The final version of the conceptual design for a park should include what is to be considered achievable in the first few years of the park's operations and what will be achievable in the consecutive time periods.
- Consider carefully the implementation strategy of the high-tech park. The complexities facing high-tech park developers should not be underestimated. To succeed, a park will have to draw on a variety of financial, technical, manpower and other resources - to be combined into joint efforts. The criteria for choosing the first domestic and foreign partners to become 'anchor tenants' may influence the profile of the park for a considerable length of time.
- Develop a comprehensive policy framework to be used in clarifying problems facing the high-tech park developers. A blend of policies will influence high-tech development. The current policies (rules and regulations, government support schemes, etc.) should be discussed in detail and changes in the regulations should be introduced to make the early implementation of the park effective.

Technology/Business Incubators

The essential idea behind business or technology incubators is to provide a full range of start up services to SMEs which would otherwise be either unavailable or too costly for small, entry-level firms. The SMEs are selected for their presumed growth potential and the overall intent is to nurture small enterprises into large ones. Thus, business incubators are micro-facilities offering to start-up and existing small firms an integrated and relatively low-cost package of:

- Shared and managed work spaces (these may be integral with industrial parks, including processing and special economic zones).
- A small team of professional managers with core competencies in business and technology assessment and diagnosis and/or with knowledge of sources of excellence for referrals.
- An expected graduation of firms after no more than 2 to 3 years with about 20-25 start-up groups operating in an incubator at any one time. The careful selection of firms combined with the professional assistance is designed to increase the survival rate of new firms.

- The incubator operates as a business and is expected to become fully self-supporting within a relatively short period.
- In almost all instances, the initial establishment and support for incubators is provided by governments or aid agencies in the form of subsidised facilities and/or an operating subsidy.
- Outreach assistance is sometimes provided to firms outside as well as inside the incubator.

Incubator approaches have been introduced into many countries, especially over the past ten years. In the United States, many public sector incubators have been established by state and municipal governments with the purpose of stimulating growth in areas of high unemployment. They are now widely used in Eastern Europe and the former Soviet Union to help in the formation of enterprises in the transition from a planned economy. At least 80 incubators now operate in China where they are responsible for their own profits and losses. A November, 1997 study (Lalkaka, 1997) estimated that there were at that time about 2000 incubators world-wide of which some 500 were in developing and transition economies.

How have these incubators performed? Again, we discover that there has been very little in the way of systematic research. The idea itself seems so logical and intrinsically attractive that it has clearly attracted much support and investment by governments and aid institutions even in the absence of extensive supporting evidence. The evidence that there is, however, does provide some encouragement. A five country incubator assessment by UNDP-UNIDO-OAS conducted in Brazil, Czech Republic, China, Mexico and Nigeria provided evidence of the potential of incubators to create innovative enterprises, increase the chances of survival and success by new firms, and generate employment. The same study indicated further benefits in making research of direct value to the needs of the productive sector, in building entrepreneurial skills and in bringing about positive policy shifts in national policies regarding SMEs. In addition to this study, there are indicators from China and Eastern Europe that some three-quarters of businesses in incubators are likely to succeed as compared to only one-quarter outside the incubator.

This is encouraging, but the results must be treated with caution for four reasons. First, the selection into an incubator is designed to select 'winners'. The success rate of incubator firms may not be attributable to the contribution of the incubator. Secondly, being inside an incubator may entail a considerable public subsidy that will disappear when firms graduate (and none of the available studies have followed firms over several years). Thirdly, three-quarters of the incubators in developing countries are less than three years old and any results should be treated cautiously because of this. Fourthly, there appears to be no evidence thus far to support the view that incubators can serve as an effective instrument to international technology access.

Finally, incubators can be very expensive and can call substantially on the severely restricted resources of poor countries and international agencies. Their cost needs also to be considered as a function of the relatively small number of firms that can benefit from the approach.

This does not mean that an open-minded approach, including experimentation with incubators, should not be part of a national science and technology strategy. It does suggest, however, that initiatives in this area should not occur without very careful examination and that caution and prudence should comprise the operating strategic principles.

Business/Technology Incubators in China

Incubators in China operate as enterprises responsible for their own profits and losses. Each is owned by a public entity, thus exhibiting public-private characteristics. One assessment judged that the programme is driven by a technology commercialisation orientation, with a corollary goal of employing under-utilised technical personnel. Graduation policies are flexible, but tenants have full responsibility for income and expenses and are committed to debt funding.

Clustering and Networking[•]

In both advanced and developing countries, small and medium enterprises (SMEs) have become an increasing focus of attention over the past decade. This is due to several factors, including the growth and employment creation potential that SMEs have demonstrated in many parts of the world, perhaps especially in East Asia.

What is also clear, however, is that there is a very strong tendency for SMEs, especially in developing countries, to remain small, undercapitalised and unable to move up the value chain and technological ladders. Helping small firms to develop is not an easy task, given the constraints that SMEs face. A good deal of evidence has been gathered which shows that the limited factors to SME expansion include:

- **Raw materials and components** – owing to the absence of local suppliers, or an inability top obtain inputs from abroad;
- **Finance** due to discrimination by banks or the high costs of dealing with a large number of small firms;
- **Technology** – either because it has to be imported, or because the initial investment costs are too high for individual entrepreneurs;
- **Product markets** – due either to a lack of contact with market traders, or an inability to market effectively and advertise products;
- **Government** – due to the limited political weight and bargaining power of SMEs.

For the individual small firm operating in a highly competitive environment, these barriers are very difficult to overcome. There is, however, increasing evidence that it is the isolation of the small firm, rather than its size per se, that is the major problem. This is where networking and clustering may offer a way forward.

A **cluster** is a group of firms concentrated sectorally and spatially. There may be no active collaboration between the firms. By contrast, a **network** is a collection of firms that need not be located in the same place but that work in cooperation. Both types of grouping can give SMEs competitive advantages. Research (Schmitz and Nadvi, 1999) that has been conducted in a large number of countries indicates that there are two aspects to the 'collective efficiency' that can be achieved:

- **Local external economies** – these are benefits which occur purely from the concentration of firms in the same town or region. Such groupings attract local suppliers, giving the firms better access to inputs and raw materials, and helping to create a pool of skilled workers.
- **Joint actions** – through firms consciously cooperating, or joining forces in business associations and other groupings, joint action can bring a number of benefits. For instance, producer associations can help to open up new overseas markets and increase small firms' access to government support services.

Some of the best known examples of industrial clustering come from Italy where, in the 1960s and 1970s, there was a surge of growth in the Northeast and Central regions of the country, areas not previously known for strong industrial capacity, In a number of sectors, groups of firms clustering together managed to break into very competitive export markets for shoes, leather handbags, knitwear, ceramics, musical instruments, and food processing. The breakthrough also occurred in the industries that supplied machinery to these sectors. Moreover, these firms expanded production and exports at a time when large enterprises elsewhere in Europe were in decline. Perhaps the most important factor of all was the capacity to upgrade production continuously. The studies of what took place in Italy concluded that this phenomenal success in rapid industrialisation was driven by the close proximity of suppliers, component producers, and subcontractors, and the combination of intense rivalry between the firms and cooperation in producers' associations.

[•] The assessment that follows draws heavily on the extensive work jof the Institute of Development Studies and on a recent *Policy Brief* prepared by the Institute. See Schmitz and Nadvi (eds.) 1999.

But successful examples of clustering are not limited to Europe and industrialised countries. Numerous cases also exist in Asia and Latin America, although these are not nearly as well known as the case of Italy. Several examples come from India: for example, the metalworking and textile industries concentrated in Ludhiana, the diamond industry in Surt, and the engineering and electronics industries around Bangalore. Mexico, Peru, Indonesia and Taiwan provide other examples. Two of the best documented developing country cases are in Brazil (footwear) and Pakistan (surgical instrument-making).

Between 1970 and 1990, Brazil raised its share in world exports of leather shoes from 0.5 percent to 12.3 percent, largely on the basis of a cluster of firms in the Sinos Valley in the south of the country. By 1991, the cluster (consisting of over 500 manufacturers and over 1000 suppliers of specialised inputs and services) was exporting nearly 100 million pairs of shoes per year worth almost $900 million in foreign exchange.

Around the town of Shilkot in Pakistan, precision surgical instruments are produced by a cluster of over 300 manufacturers, who farm out work to 1,500 small enterprises specialising in particular stages of the production process. Alongside these firms, there are an estimated 200 suppliers of inputs and over 800 units providing various types of services. Working conditions in many small workshops are poor and wages are often low. But cheap labour is not enough to explain the cluster's success; it is the connections between firms that are critical. Over 90 percent of output is exported, most of it to Europe and North America. The cluster accounts for about 20 percent of world exports of surgical instruments, making Pakistan the second largest exporter after Germany.

A fundamental question that is raised by this work on clustering and networking is whether governments can help with it or whether it needs to be left to enterprises themselves. What happened in the Sinos Valley and in Pakistan was the result of 'spontaneous associations' that formed in response to opportunities and threats. It was not the result of government strategy or policy instruments. It is also clear that there were few if any restrictions to the forming of associations and that governments played almost no role whatsoever.

Does this tell us that clustering and networking arrangements can best (perhaps only) come about if left exclusively to 'market forces'? One observer who has studied SMEs and developing countries over many years comes very close to that conclusion in writing the following:

> "… in most developing countries good performance by SMEs has been achieved despite governments, not because of them. Government-sponsored support mechanisms have generally lacked the needed flexibility, motivated personnel and political leadership; comprehensive small enterprise development strategies do not exist; international technical assistance projects and development loans have been largely unsuccessful in leaving behind sustainable activities; universities, research organisations, large corporations and their associations in these countries, have, until recently, played no significant supporting role." (Lalkaka, 1994, p. 13)

Nevertheless, for policy makers wishing to promote SMEs, the impressive examples of success from clustering provides a tantalising demonstration of what can be achieved when the energy and initiative of small firms is effectively harnessed. The question for future efforts is where are there actions and measures that governments can take to assist this process – either by fostering the growth of new, embryonic clusters, or by stimulating other forms of networking and inter-firm linkages.

On this, there is some recent and encouraging evidence from a number of countries suggesting that governments can indeed play a valuable supporting role. In Northeast Brazil, for example, the development of a new cluster (furniture making) was stimulated through a public procurement scheme. The impact was startling. When the programme began 4 sawmills and 12 employees were involved. Five years later, there were 42 sawmills with over 1300 people working directly or indirectly in the woodworking industry. By helping to ensure quality control and to achieve branding, 70 percent of the output now goes to the private sector, much of it for export.

Comparing experience in different countries, three factors seem critical to the success of schemes aimed at encouraging the growth of small firms. These should serve as guides to any efforts by governments to support clustering. To be effective, interventions need to be:

- **Customer oriented** – efforts must be driven by the needs and demands of the customer. This forces firms to face up to underlying problems of competitiveness. The most successful interventions are those which have helped firms to learn about their customers, and then introduce the changes and innovations needed to meet market demand.

- **Collective** – outside assistance is most effective when it is directed at groups of enterprises, rather than individual firms. This means working with business associations, producer groups, and other industry alliances. Where they do not exist, conditions can be created for their formation and support linked specifically to the formation of such groups. This has two advantages: it is more cost effective than assisting enterprises individually, and it helps to develop constructive relationships between firms, which can improve their efficiency and increase their potential for learning from each other.

- **Cumulative** – one-off improvements are not enough; if firms are to remain competitive they need to be able to change and develop in response to new market conditions and new opportunities. The objective of governments should be to remove any constraints that stand in the way of this and to help generate these capacities with groups of firms so that public support can quickly be removed.

How to foster SMEs has become a concern for policy-makers worldwide. What has changed in the 1990s is that economies are more open than in the past, and international competition is much fiercer. This makes the task both more difficult and more urgent.

The collective approach outlined above is no 'quick fix'. But it does offer a promising alternative to traditional methods of assisting small firms, the weaknesses of which are well known. In the past, the policy has generally been to target support to individual enterprises, usually through a combination of credit schemes, grants, technical assistance and other help. The problem is that these initiatives tend to be too supply oriented, focusing on inputs to production and ignoring the crucial question of who will buy the firm’s outputs. Another drawback is that programmes are rarely sustainable, since the cost of reaching a multitude of small firms is very high, and the likelihood of significant cost recovery small. At best programmes have a one-off effect on the performance of firms that are targeted, and rarely produce the capacity for self-help and continuous improvement.

The collective clustering and networks approaches are still in their early days and proven examples are too few for firm policy guidelines to be drawn. But the signs are encouraging. Spontaneous clustering and networking should be actively encouraged and all forms of barriers to such occurrence removed as quickly as possible. Other measure of support and encouragement should be examined by government as opportunities emerge.

This chapter has demonstrated the potential value of technoparks, business incubators, and clustering and networking of SMEs for Vietnam. The role of government in fostering these activities has also been discussed. Most of what has been described has been aimed at creating both a physical and business environment conducive to the long term growth and success of individual firms. Experience elsewhere suggests that this environment is also conducive to the start up of new technology based enterprises, to the making of improvements in the technology, and to the encouragement of new higher technology investments from abroad. These new technologies may then be diffused to other members of the clusters or zones.

The Role of Global Buyers[♦]

Reviews conducted by NISTPASS and other recent studies (Webster, 1999) have drawn attention to the importance of buyers to Vietnamese manufactured exports. The current situation for larger, private manufacturers has been summarised as follows:

> "Because information problems occur in both input and output markets, Vietnamese manufacturers' reliance on trading agents can be quite comprehensive……(F)ew manufacturers selling through agents know even basic characteristics of the final consumers of their products. Trading agents tend to be all too aware of the information vacuum that creates demand for their service in Vietnam. As such, they are averse to information sharing that might reduce the scarcity value of their services, i.e. they resist giving manufacturers information about alternative, potentially competing, suppliers and buyers. The limited number of foreign traders that have set up fixed offices in Vietnam constrains manufacturers' ability to compare services among agents." (Webster and Taussig, 1999, p. 41).

According to this assessment, problems and difficulties are currently the key defining characteristics of the relationship between Vietnamese firms and global buyers.

What can be done about this? Historically, the subject of the relationship between buyers and producers appears to have been more a matter of ideological debate than of serious research. In neo-classical economics, buyers tend to be seen as passive intermediaries, just useful in linking demand and supply. It is only in new institutional economics, with its focus on transactions and monitoring costs, that the role of intermediaries is given more importance. Neo-Marxist literature continues to present buyers as surplus extracting parasites (Harvey, 1995). Much of the policy-oriented study simply stresses that buyers appropriate too much of the value-added (UNDP *et al*, 1998). A sharply contrasting perspective stresses the role of buyers as facilitators of industrial development (Glasmeier, 1990).

Clearly, then, views on the role of buyers differ a great deal, ranging from exploiters to promoters of producers. To make progress on this issue requires, we believe, that the question is not whether buyers block or promote industrial development, but under what circumstances they play a negative or positive role. Approaching the question this way is important because of one fact on which there is almost no dispute: when trade is liberalised, developing countries do not automatically gain access to international markets, because the chains which producers feed into are often governed by a limited number of buyers.

It is perhaps somewhat paradoxical that buyers have become more concentrated as a result of globalisation. The number of firms and countries involved in global marketing has increased dramatically over the past few years, but there has been a concomitant concentration amongst buyers. These buyers are global in that they source from producers all over the world, achieving thereby an unrivalled ability to compare. It would seem to follow, therefore, that a critical factor for producers and for the governments of producer countries is to gain a reasonable understanding of how buyer chains influence producer prospects.

Recent work (see G. Gereffi, 1994 and 1999) in buyer-driven global commodity chains provides a strong demonstration of two conclusions. First, the role of buyers is essential to market access. For the apparel commodity chain, the study show that in order to participate in export manufacturing to North America and Western Europe, developing country producers need access to the chains' lead firms. These firms 'undertake the functional integration and co-ordination of internationally dispersed activities'. Access to the lead firm can be direct, by becoming a supplier, or indirect, by becoming a second-tier supplier. No access to the lead firms means being excluded from the world's main export markets.

Secondly, access to lead buyers can produce good prospects for upgrading within production and subsequently into design, marketing and branding. 'Participation in global commodity chains is a necessary step for industrial upgrading because it puts firms and economies on potentially

♦ For a more complete discussion of this issue see Schmitz and Norringa, 1999.

dynamic learning curves'. Based on his garment research, Gereffi shows that East Asian producers moved from (a) mere assembly of imported inputs, to (b) taking care of the entire production process, to (c) design and sale of their own branded merchandise in internal and external markets.

Further recent work on footwear on global market penetration and industrial upgrading by Brazilian and Indian firms (Schmitz, 1997 and 1998; and Knorringa, 1996 and 1999) confirms the centrality of lead firm buyers. These studies, however, do not offer unqualified optimism. They all confirm as characteristics of the relationship between producers and global buyers the kinds of barriers, conflicts and problems that were highlighted the recent study of Vietnamese industry (See *Vietnam's Undersized Engine*).

The broad conclusion is clear: for success in international markets, Vietnamese firms will need to achieve productive relationships with international lead buyers. There are a number of more specific conclusions from these studies, however, and these are suggested as elements to be factored into Vietnamese strategy. They are:

- The upgrading contribution of buyers is especially difficult to obtain at incipient stages of export to international markets. New producers generally require much more help than well-established ones and buyers appear to be generally cautious about the implications for them at incipient stages of manufacturing. In the early 1970s, for example, Brazilian firms were at a very early stage in seeking export markets for footwear. The producing firms confirmed in later studies that the buyers played the key role in their upgrading and market access. The buyers confirmed in the same studies that their assistance was anything but an act of generosity. The producing firms convinced them that of the price advantage of Brazilian manufactured shoes, but in order to sell these in the US or Europe they simply had to assist firms to reach international quality and delivery standards. Studies of the producer-buyer relationship make very clear the entirely logical point that the buyer must be convinced that major potential benefits for him are to be derived from assisting in the technological upgrading of local producers.

- The more product quality matters, the greater the demands on the producers and their suppliers, the greater the buyers' interest in upgrading these products. The studies show that buyers in quality-driven chains have the most forthcoming policy of investing in the capabilities of producers and developing what has been termed 'obligational relationships' (Sako, 1992). This was not necessarily completely absent in price-driven chains, but the mutual commitment of buyers and producers in these appears to be much weaker. Buyers operating in quality-driven market segments with established brands indicated they had a conscious policy of building longer-term relationships. Buyers operating in these segments were very aware of the cost of changing partners for the sake of (short-term) price advantages: it raises transaction costs and increases the potential for misunderstanding quality specifications. They preferred stable relationships based on intense communication and trust in order to obtain good quality and prompt delivery.

- Although the evidence shows that buyers have contributed in major ways to upgrading within the sphere of production, it appears unlikely that they would also assist upgrading in non-production activities such as design and marketing. The problem is that marketing, and often also design, are part of the buyers' own core competence. Buyers helping their producers with this kind of upgrading risk making themselves redundant.

- The distinction between direct purchasing or sourcing through intermediaries also appears to be important to the producers' options for moving up the commodity chain. In global horticulture chains, it was found (Dolan *et al*. 1999) that, precisely because the overseas buyers operated through intermediaries, there was scope for local firms to enter higher value-added stages in the commodity chain. Intermediaries themselves stand to gain a percentage of the value-added from successful upgrading. By contrast, the evidence indicates that where there is direct purchasing by large international firms, there is little incentive to provide support for upgrading.

There are obvious implications in these comparative findings for Vietnam's strategy of industrialisation and technological upgrading. Most importantly, it seems clear that, whatever the difficulties and frustrations encountered to date in the experience of Vietnam's firms with global buyers (see again Vietnam's Undersized Engine), building and expanding relationships with buyers is of major importance. Secondly, because assistance in upgrading is likely to be more forthcoming

via arrangements with intermediary buyers over those with direct purchasers, consulting services and the general guidance to firms provided by government should take this into account. Thirdly, implicit technology acquisition and upgrading actions and policies are probably of major importance to building the kind of confidence in longer-term mutual benefit that was so important to the success of Brazil's footwear industry. Included here would be increasingly clear signals from government of the importance of the private sector, the streamlining of legal and financial systems and the removal of impediments to the movement of goods, services and people. Fourthly, the clear link between product quality (as opposed only to price) and the willingness of buyers to invest in local upgrading would seem to reinforce the potential of clustering, which has been discussed earlier. Clustering has been shown to bear importantly on product quality and should serve as a catalyst to encouraging global buyers to assist actively in industrial and technology upgrading. Finally, the evidence suggests that expectations for the upgrading role of buyers should be realistic and should take account of comparative experience which shows a far greater willingness to assist in production methods than in design and marketing.

CHAPTER 6 TOWARDS A VIETNAMESE STRATEGY ON TECHNOLOGY AND INDUSTRIALIZATION

In preceding sections of this report, we have presented the case that the prosperity of nations now depends on a new configuration of skills, abilities, and competencies. The factors behind this, we have argued, are the widespread availability and use of information and communication technologies, the speed of scientific and technological advances, accelerating global competition, and much shorter product life as a consequence of changing consumer demands. This will not be at all new to decision-makers within Vietnam; everywhere one goes the words 'knowledge-based economy' have become commonplace. The words themselves are of little importance and they may indeed serve to divert attention and energies into unproductive exercises aimed at exact descriptions and measurements of the distinctions between an industrialized economy and a knowledge-based economy. What does matter for Vietnam, we believe, is to find the means to adapt and to build comparative advantage in light of the new determinants of economic progress.

With this in view, earlier sections of this report have also attempted to provide an assessment of the main features of Vietnam's systems of science and technology, to examine recent experiences of other latecomers to industrialization, and to examine critically some of the current approaches being recommended to countries such as Vietnam. The coverage of these issues has necessarily been quite broad, but the approach does produce a number of important observations which, we believe, provide guidelines to thinking about, preparing and implementing an industrialization strategy for Vietnam.

Some Guidelines to a Strategy

1. **There is no single blueprint or roadmap**. There are successful examples provided by previous late industrializers in East Asia and elsewhere and guidance can be extracted from their experiences. There is, however, no single pattern or roadmap to technology acquisition, technology learning and industrialization. The patterns and instruments of government intervention differed greatly between Taiwan and Singapore, and also between Hong Kong and Korea. There are, however, a number of common characteristics which seem to be associated with their success and these may serve as general guides to the preparation of Vietnam's S&T strategy. These characteristics include the following:

   - Their industrialization was based primarily on export led strategies.
   - The key decisions related to technological learning were made by the managers of enterprises.
   - It took 20 to 30 years to build all the technological capabilities needed to successfully exploit the innovations derived from domestic in-house research and development. Many technical and engineering skills had to be accumulated in the process. It is possible that this time could be shortened to 10 to 15 years.
   - Government policies aimed at influencing the behavior of entrepreneurs and the managers of enterprises varied considerably between the 'tigers'. But each showed the following characteristics:

     (i) Governments generally followed a set of macro economical policies which provided stability, low interest rates, and high savings (i.e. they provided an environment conducive for long term planning and investment.)

     (ii) Government policies promoted export-oriented industrialization and facilitated the acquisition and adaptation of foreign technology.

     (iii) Governments developed an appropriate educational and technological infrastructure. This included the provision for widespread literacy, vocational education, development of a cadre of engineers and the training and support of research scientists. Vocational courses often

directed toward company needs were carried out in local universities and polytechnics.

(iv) When necessary, governments intervened to ensure that the entrepreneurial base was strong enough to lead industrialization.

2. **'Leapfrogging' did not occur in latecomers to industrialization**, but the time periods for technological learning were greatly shortened. This may appear paradoxical. What occurred in East Asia involved rapid learning by reversing the usual stages in the development and application of individual technologies. As explained previously in this document, the East Asian process did not move from science to invention to production, but the other way around. It involved a process that began with imitation and proceeded to innovation. In other terms, it began with low-tech production and assembly and proceeded over several years to high-tech through a continuous process of upgrading and innovation. The learning was difficult and lengthy, but the time frame was remarkably shorter than had previously been thought possible. There was, therefore, no leapfrog that jumped over the different components of technological capabilities. The learning took place far more quickly than in pervious generations, however, and in this sense there was a leapfrog.

3. **Even if a blueprint could be designed from the previous successes in East Asia, the international context has changed.** A good part of the reason for earlier East Asian success had to do with international factors. These factors created opportunities for relatively low-cost industrial production sites to integrate into the world economy. In the 1960s, several conditions combined to produce a special set of factors: relatively favorable access to industrial country markets, greatly increased access to international finance, and increasing relocation of production by multilateral corporations to lower-wage countries. Since then, there has been a dramatic fall in the demand for unskilled labor and raw materials per unit of industrial production. Tariff barriers may be falling, but quantitative barriers (non-tariff) have increased with special discrimination against developing countries. By the later years of the 1980s, 18 percent of manufactured imports from OECD countries were covered by quantitative restrictions, in comparison with 31 percent of those from developing countries. The requirement that Vietnam comply fully by 2006 with the terms of AFTA membership and the nation's possible membership in the WTO are other factors in the new international context.

4. **'Implicit' policies of S&T are at least as important as 'explicit' policies**. Since the 1970s, S&T policy analysts have drawn a distinction between policies that are explicitly directed to S&T instruments (e.g. patents, intellectual property rights, what type of scientific endeavors to support or the specific targeting of technologies such as microelectronics) and those that are not specifically directed to S&T but which determine its performance, success and failure (e.g. economic and financial policies, labor codes, environmental standards, etc.). One of the most consistent findings in policy studies is that the technological behavior of industrial enterprises is as much determined by the technology policies and strategies inherent or implicit in a country's fiscal, trade and education policies, as by the more explicit technology policies and strategies. It is obvious, therefore, that explicit S&T strategy is of little value on its own.

5. **To achieve competitive advantage in the new international environment will depend on knowledge of emerging trends and agility in responding to and taking advantage of them**. This is as much a requirement for government as it is for the private sector. Strategies for science and technology must be based on valid, reliable and relevant information on the performance of research and experimental development (R&D), on the access to modern technology from abroad, and on the diffusion of this technology and related know-how. For Vietnam, there is an urgent need to have better access to comprehensive, up-to-date indicators on science, technology and innovation within the

context of the overall performance indicators of the Vietnamese economy and the economies of its neighbors and elsewhere. Existing indicators do not lend themselves to comparisons over time, with various subsectors of the economy, and with other socio-economic indicators.

Among the most industrialized countries, over the past decade or more, internationally comparable statistics on science, technology and innovation have been improved considerably. General standard methods are in use throughout Europe (including Eastern and Central Europe), North America and Northeast Asia for observing and 'taking the temperature' of the national and regional R&D activities through a variety of input and performance indicators. Evaluations and policy-relevant assessments are based on relatively sophisticated combinations of R&D and innovation (R&D&I) statistics, such as various input, output and "process" indicators. Even the 'technological interaction' between branches of industry over national and regional borders is being monitored with the help of skillful statisticians depicting 'technology balance of payments' and trade performance in high-tech and other product areas.

For its national and regional planning and policy-making, Vietnam ought to modernize its science, technology and innovation indicators system in the context of the transition to a market economy. Decision-makers in Vietnamese government and industry should have the same (or better) indicators available as their colleagues in neighboring countries. They need to know details such as the flows of funds to R&D&I, human resource development, trends in the mobility of highly-skilled personnel, etc. They will also need to compare internationally the outputs from the Vietnamese R&D system in such detail as to be able take relevant action.

The first step to improve such indicators and statistics is to secure arrangements whereby standard classifications are applied. This will be the basis for any comparison. It involves also the development of reliable business and other registers and their use for science, technology and innovation statistics.

The following steps imply a close interaction between the producers of the R&D&I statistics and the several user groups throughout Vietnam. Vietnamese users may actually help define the specific needs for improvements of existing statistical series and the creation of entirely new and more relevant data such as statistics on industrial innovation; the diffusion of technology in various economic subsectors; 'technology balance-of-payments' in relation to other countries; the usage of secondary data such as patents, licenses, royalties, publications and other performer-based data; human resource development and migration. In all of these statistical areas there are internationally agreed manuals for the collection and processing of the data. Vietnam's own statisticians and policy analysts must attain at least the same qualifications and practical experience in producing and using this kind of data as their colleagues in other countries.

This implies that Vietnamese specialists need to cooperate more actively than today with statistical and other units abroad and particularly with the international organizations responsible for the standardization of R&D statistics on regional and international bases, e.g. UNESCO and the Organization for Economic Co-operation and Development (OECD) among the highly-industrialized countries. To some extent, Vietnam already complies with UNESCO standards, but - as was underlined in a recent Southeast Asian programme for developing R&D&I indicators - the standards must go beyond the elementary statistics, processed and published by UNESCO.

Creating an 'Observatory' for Science, Technology and Innovation

Vietnam should create a more advanced system for the production and distribution of indicators for science, technology and innovation, and encourage the use of these indicators for assessments and prognostics. Internationally comparable indicators should be used more frequently in performance evaluations of R&D institutions and in assessing technological services, trade in technology, human resource development, etc. In cooperation with other government bodies and other organizations, a well-staffed unit or 'observatory' of professional statisticians and policy analysts should be made accountable for providing government and other stakeholders with up-to-date data on the actual performance of the institutions (and firms) involved in R&D and related innovative activities. International training should be granted these staff to make their output and analyses fully comparable with that of other countries.

6. **SMEs can be highly effective in technology acquisition, technology upgrading and as contributors to export-led growth, but they often require assistance to do so**. The costs of initial entry to export markets is usually prohibitively expensive for SMEs. Success can depend on the availability of mechanisms that reduce entry costs for both the SME and the buyer. Research tends to confirm, however, that governments of developing countries do not generally have the capacities or agility needed to provide useful export support services and that the most effective role of government is that which facilitates services rather than providing them directly.

   There are, however, examples where government programs were critical in the successful export growth of SMEs. In Taiwan, for example, government-led credit and venture capital programs were a key factor to that country's dramatic export gains that were driven by its SMEs. One result of the credit schemes used by Taiwan in the 1960s and 1970s was to shift the balance of government financial support from SOEs to private enterprise. This produced both rapid economic growth based on new exports and technological upgrading. A similar approach might prove valuable to Vietnam. Chapter 3 of this report provides a review of several additional mechanisms that are either currently being attempted by or under examination by Vietnam. These are:

   - Industrial zones and technoparks: In Chapter 4, we draw attention to the fact that there is very little systematic evidence that lends support to technoparks as crucibles to technology acquisition and technology development. The absence of evidence of benefits, however, is not the same thing as evidence of absence of benefits. We suggest that Vietnam's strategy on industrial zones and technoparks should embrace the managerial steps outlined in the recent UNIDO report on the subject. We further outline (see Chapter 5) a number of specific strategic elements that may serve to guide further consideration and treatment of technoparks.
   - Technology/business incubators: Within international organizations, there is currently considerable enthusiasm for business/technology incubators as a mechanism to increase the early success of SMEs and as catalysts to technological learning. We have drawn attention to the fact that these are very recent innovations and that it is too soon to judge fully their benefits. We do know in general that they represent a rather high-cost mechanism, although we also draw attention to China where incubators operate as private enterprises responsible for their own profits and losses. We suggest further examination of this mechanism as part of Vietnam's S&T strategy and a cautious, experimental approach.
   - Clustering and networking: Chapter 4 also outlines a number of examples of impressive SME gains through collective approaches (e.g. clustering and networking).

The indications from research on this subject are very encouraging to the prospects for start up of new technology based and export oriented enterprises. The most important key to government facilitation of effective clustering appears to lie in the removal of obstacles to the forming and operating of associations.

- Using trade fairs to facilitate entry into international markets, and to gain access to international buyers and technology. This mechanism was not mentioned in Chapter 4. For small firms, the complexities and costs associated with becoming known to international buyers are usually prohibitive. In this regard, trade fairs may offer an excellent avenue for firms to market their products, learn about customer needs and preferences, and gain an appreciation of the competition they face. The problem is that for small firms the cost of attending and exhibiting, especially in international trade fairs, can be prohibitive. In addition, many small firms simply do not know how to exhibit their products and large fairs can be especially intimidating.

  Experience from a number of countries shows that SMEs can overcome these barriers and profit from trade fairs if they act jointly. A shared presentation at a trade fair allows small producers to put on a more impressive show and to face the world's buyers and competitors with greater confidence. For the entrepreneur/owner of a SME, the evidence also suggests that trade fairs can serve as a source of new ideas and as an impetus to innovation and newer technologies. Trade fairs were central to the development of the Sinos Valley shoe and leather cluster in Brazil. Joint action in the early 1960s led to the setting up of their own regular trade fair, which attracted buyers from all over the country and later internationally. Organized by local business associations and subsidized by government, these groups played a vital role in connecting the existing cluster with international buyers and providing a driving force for ongoing innovation and improvements. Joint participation in trade fairs was also how ceramic producers from the Philippines launched themselves internationally in the 1980s.

  It is worth noting that the United Nations Industrial Development Organization (UNIDO) and other donor agencies have begun programs to help developing country manufacturers to exhibit in trade fairs. The German agency, GTZ, for example, has launched Protrade, a program which provides financial and technical assistance to groups of firms enabling them to share a stall at European trade fairs.

  The experience of other countries suggests strongly that strategies be formulated aimed at exploiting trade fairs, both nationally and internationally, as a means to gaining access to buyers and markets and as an impetus to technology acquisition and upgrading.

- Global Buyers are likely to play a key role not only in access to markets for Vietnamese products but also in the technological upgrading of production. The indications to date of the experience of Vietnamese firms with buyers is not altogether salutary, yet, especially for SMEs, the role of buyers has been critical to success elsewhere. There are different categories of buyer and comparative experiences suggest strongly that Vietnamese firms are likely to gain more support and assistance in technological upgrading through intermediaries than via direct buyers. It would also seem to follow from comparative experiences that the streamlining of financial and legal systems and the removal of any serious impediments to the movement of goods, services and people are key factors in the extent to which intermediate buyers invest in the relationship with local firms.

Constructing a Strategy

We have already drawn attention to the important distinctions between a plan and a strategy. A further important point, given Vietnam's current stage of development, is that a strategy needs necessarily to be systemic. It is, of course, possible to approach reform on a segmented or step by step basis and such an approach may produce benefits, but this is not what we would recommend. Indeed, because of the interdependence of the factors involved in a transition to a knowledge-based economy, we conclude that the segmented approach entails unnecessarily high risks of failure. To illustrate, the technological upgrading of the information infrastructure would permit cheaper and faster information access, should improve efficiency, increase economic opportunities for Vietnam, and attract inward investment. The potential benefits, however, will be greatly restrained if the overall incentive regime to economic activity is hampered by high transaction costs. Benefits will also be reduced if the human resources produced by the educational system are incapable of responding to and creating their own opportunities via new information infrastructure. Thus, a strategy aiming at broad socio-economic progress should be approached systemically with all the elements of the system being reformed on an inter-related basis.

A systemic approach aims, therefore, to see how the pieces of a puzzle inter-relate and add up to the larger picture. This does not mean than everything must or can be done at once. The sequencing of reforms is entirely consistent with a systemic approach. Some actions and reforms must be initiated before others if systemic change is to be functional. For example, if major industrial restructuring is likely to produce widespread unemployment and human suffering, adequate social safety arrangements should be in place before the restructuring. The Asian financial crisis of 1997-98 showed the importance of establishing a well supervised and regulated banking system in advance of the full opening of capital markets.

In terms of sequencing, then, the review and assessments outlined in the earlier sections of this report suggest to us that the highest initial priority of Vietnam's strategy should be directed to the economic and incentive regime (in other words, to 'implicit S&T policies'). In the first instance, this means sending clear and consistent signals that, far from being merely legitimate, the private sector is vital to Vietnam's future and is encouraged and supported by its government. More than signals are required, however, and in what follows we outline a considerable range of actions and reforms. These are divided into a suggested sequencing of short term and longer term measures, although it needs again to be emphasized that the overall approach to strategy should be systemic and inter-related.

Short Term Measures

- Providing the environment which is conducive for foreign investment, and which encourages export led growth. This environment is primarily determined by fiscal, trade, monetary, taxation and banking policies, by legal entitlements such as IPR and other enforceable rights, and by government-imposed transaction costs of doing business. Over the past few years, Vietnam has received volumes of study on these matters and the project of which this report is a component includes separate and detailed contributions on these matters[•]. Each of these policy instruments requires careful study and precise articulation and this is well beyond the terms of reference of this report on S&T. The central point - and one that is quickly increasing in clarity and urgency - is that significant new foreign investment in Vietnam is improbable in the absence of systemic reform in these areas. The current economic and investment climate in Vietnam appears far less attractive than in the fast reforming states of East Asia and China. Moreover, all indications are that China is moving quickly to WTO membership, which will accelerate greatly its internal reform process and make it an even more attractive destination for FDI. If Vietnam is to compete for such capital, it must quickly become at least as attractive as China in the eyes of international investors.

- The technological renovation of state-owned enterprises. Unless the economic performance of SOEs reaches the levels required for successful international competition, they will distort

[•] See, for example, F. Flatters, *'Globalization and International Financial Integration'*, Center for International Economics*, 'Economic Integration and Vietnam's Development Strategy*,' J. Riedel et al., **The Role of the State and the Market in the Economy of Viet Nam***.*

economic choices and frustrate national progress. Recent experience in China (see following box) has shown that successful transition is possible for many SOEs (available data are widely divergent on estimates of success rates, but most suggest a range of 30-50 percent). Broadly speaking, the efforts to reform China's SOEs have involved three components: a) incremental change and efficiency gains to existing technologies; b) in larger SOEs the establishment of on-site R&D facilities; and c) direct purchase and assimilation of new, foreign technology. China's experience suggests that foreign investors generally avoid partnerships or new joint ventures with existing SOEs involved in manufacturing or heavy industry, imposing major limitations to the prospects for privatization (or equitization) with foreign companies. China's experience also suggests that the direct purchase of new foreign technology has been imperative to the SOEs that have been able to achieve competitiveness. Between 1978 and 1996, an estimated US$40 billion was spent by China on foreign technology upgrading for SOEs. Vietnam's efforts to transform its SOEs, therefore, would appear to confront a formidable combination of an apparent reluctance of international capital to invest in SOEs, the required new technologies being largely a matter of direct purchase, and the exceedingly high level of capital costs involved. Efforts to address this issue through the pursuit of licensing agreements and openness to joint ventures between the SOEs and foreign companies should, of course, be continued. As noted earlier in this report, however, the problem that has been discovered with infant industry approaches is that very often they do not follow a time dependent learning curve. Time-specific incentives and penalties will be needed to deal with this issue - with the ultimate penalty being the closure of persistent loss-making enterprises.

Technological Renovation of State-owned Enterprises in China

One component of the many reforms which have been enacted to improve the performance of State-owned Enterprises (SOEs) in China has been a set of measures to improve their technology. This is the so-called technological renovation programme. It consists of three components: Efforts to improve existing technology through incremental technical change; the establishment of corporate R&D laboratories within the larger SOEs; and the importation and assimilation of foreign technology. Similar measures are being attempted in Vietnam.

Each of the above channels for improving the technology has contributed to the improvement in the technological level many SOEs. However, on average the technological level of most are still well behind current international standards. If many of the SOEs are to be retained, the need for ongoing technological upgrading continues to be a pressing matter. Without such upgrading, a vast number of SOEs will simply be unable to compete and, in general, they will also not be supportable by the state following accession to the WTO.

It has been estimated that between the late 1970s and the mid 1990s China spent more than 40 billion U.S. dollars on foreign technology.

- Generating required domestic savings by assigning science and technology priority to the agricultural sector

  The matter of public financing raised above in the context of SOE technological renovation raises the larger issue of the financing of Vietnam's development effort and particularly the need for domestic savings. Vietnam’s level of domestic savings is relatively low, certainly much lower than in countries such as Singapore, South Korea and Taiwan. This is a severe limiting factor to the country’s aims technological upgrading and rapid industrial growth. We agree with the World Bank recommendation that policies are required to increase domestic savings via 'the prosperous agricultural sector' (World Bank, Vietnam: poverty assessment and strategy, 1995, pg. 12). The history of Southeast Asia provides abundant examples of agriculture as the early engine that generated the domestic savings and set in place the conditions for the unprecedented economic development that followed. Malaysia built its economic growth on the application of S&T to vitalise its exports of rubber and oil palm.

Thailand applied scientific breakthroughs to a rapid expansion of rice and maize production, and exported a considerable surplus that helped to build the financial foundations for industrialisation. Indonesia blended cash crops with timber and petroleum products to fuel its engine of progress.

Agriculture represents approximately 30 percent of GDP, 50 percent of export receipts and provides livelihood to some 70 percent of the Vietnamese population. A sequencing of a national S&T strategy that simultaneously builds each successive step on those that have gone before would begin with the evolutionary development of several of the country's basic economic sectors and then move to a stress on the modernization of the nation's industrial base. The development of a primary product strategy should be geared to providing Vietnamese agricultural, fisheries, forestry and livestock products to regional and global export markets. There is strong evidence of a large, unmet and fast-growing demand for Vietnamese agricultural products in China. The concomitant S&T strategy for the social and economic development of the nation's natural resource base should be centered on two major goals. First, it should seek to liberalize and apply the productive energies, enterprise and skills of Vietnam's primary product producers and its rural private businessmen and investors in order to meet, and fill, the needs of a modern primary products economy. Second, it should strive to establish the conditions conducive to attracting foreign investment to complement domestic efforts to create the advanced agro-business infrastructure that is required.

The market for high value Vietnamese products such as fruits and vegetables, fish and livestock has really not been assessed or tapped. For successful entry into this market, the national development strategy must be built on a post-harvest and food processing infrastructure that will prepare, package and handle these perishable products in a manner that makes them a valued item in regional or global markets. In the process of pursuing sales in these markets it may be useful to seek the help of large multi-national food and agricultural product export firms to assist or, if possible, invest in developing an international market for Vietnamese high value, food products. The technical foundation for expanding the output of Vietnam's farms to take advantage of export markets is available. A major weakness lies in the relatively undeveloped infrastructure of its food processing and farm supply sectors. The obvious requirement here is investment in obtaining and developing technologies and systems in storage facilities, processing, packaging and preservation technologies to the quality standards of the international market.

In sum, as an essential component of the sequencing that is required, there are compelling reasons to support a conjunction of S&T strategy and economic development strategy with initial priority application to the primary products sector. The implementation of such an approach holds major promise for the modernisation of the country's rural areas, the provision of a large number of new, low capital-intensive rural employment opportunities, and the generation of the domestic savings and foreign exchange necessary to support a medium-term programme of industrialisation.

- Establishing appropriate social safety nets

  As is also the case in China, Vietnam's decision makers are concerned that the magnitude, extent and speed of reforms required to attract FDI and modernize the economy will also involve high social costs of unemployment, loss of livelihoods, disruption, migration, etc. There is solid evidence from other transition countries and from developing countries in general that such concerns are well founded (UNDP 1999). Studies of the overall macroeconomic benefits and gains from major reforms seldom take account of the human misery that these same reforms create for some parts of the population. This now has widespread international acceptance as a result of the many lessons learned from programs of 'structural adjustment' over the past two decades. Accordingly, there is much talk by governments and members of the donor community about the need for strong social safety nets to protect the poorest and most vulnerable in times of shock and rapid change. It has proved difficult, however, to match the talk and the concern with policies and programs that are adequate and effective. This general difficulty is compounded in Vietnam's case, where few social safety nets exist and where existing programs are not equipped to deal with significant increases in vulnerable groups.

  There is a separate component of this project which is directed specifically to rural social development and the protection of vulnerable groups. The purpose here is not to repeat the

recommendations made in that report, but rather to draw attention to the integral nature of those recommendations to the process and sequencing of technological and industrial reform.

- Facilitating the growth of rural industry: Implications for Technology

  80 percent of the people of Vietnam and 90 percent of the poor reside in rural areas. At the moment about 20 to 25 percent of gross industrial output comes from these rural areas. Food production accounts for 36 percent of the total rural industrial output, agro processing (excluding food) accounts for 16 percent, wood processing 15 percent, textiles and garments 13 percent, and construction materials 10 percent.

  The potential for expanding rural industry is considerable and the need to create rural employment an urgent task. A recent UNIDO review of rural industry identified many shortcomings in the existing system and proposed a number of remedial measures. We concur with these measures but believe that more needs to be done regarding the design of and access to technology packages. In other Asian countries, such as China and India, there has been considerable attention paid to schemes for diffusing packages which include well proven technologies, assistance to farmers in training, help in acquiring bank loans, and with subsequent technical back up. The accompanying box describes some of the features of the SPARK programme in China. A programme for franchising well proven technologies as the basis for developing rural industries in India has also been pioneered by an NGO, 'Development Alternatives', which is now seeking to bypass expensive intermediaries by becoming a 'dot.com' operation and making the technologies directly available to rural entrepreneurs via the internet. Models such as SPARK and technology franchising cannot, of course, be imported wholesale. To apply to Vietnam, they would first require careful study and adaptation to national and local needs and realities. They appear nevertheless to be so promising as to merit such careful study and we recommend that this be done as an integral part of Vietnam's strategy.

The SPARK Program in China

The SPARK Programme is a scheme for diffusing well proven technologies to help people in rural areas in China to start (or improve) Township and Village Enterprises (TVEs). The scheme provides technical backup and training as well as advice on acquiring loans and on marketing approaches. Local research institutes help with the training, but the technologies are not released for use until they are proven.

The scheme has spread to virtually every Province in China and has helped create more than 20 million new jobs, thus improving the living standards of farmers and their families. The program's success is due to its flexible nature, farmers can select from a wide range of proven technologies to suit their particular region or district. Each project is well linked to the local agricultural and industrial market systems. In general there is an east to west increase in the number of enterprises that produce or process agricultural commodities.

Other features of the SPARK Programme that have contributed to its success are:

- The choice of a particular project within the programme lies with the participants;
- The incentive to join the programme is the prospect of a greater income;
- The technologies used in the SPARK Programme are in general already proven in practice;
- The selection of the leader of a SPARK Programme project is in the hands of the participants (subject to approval);
- Financial support is provided (from the State) for training the participants and for technical advice, usually from the local research institutes;
- The enterprises are funded almost entirely from bank loans and from capital raised by the participants and not from government grants, which tend to include more bureaucratic requirements;

A considerable effort is made to ensure that market outlets are available for the products of the enterprises.

- Public expenditure on R&D

  Earlier in this report, we looked into the strengths and weaknesses of Vietnam's national R&D systems and made a number of specific recommendations aimed at a much better alignment of these systems to the needs of the productive sector. We also suggested a number of measures to deal with the problem of an ageing scientific community and the rationalization of public funds to R&D institutions by moving to a limited number of large, multi-year grants aimed at building up national "Centers of Excellence.

  We did not specifically address the issue pending before the government of Vietnam of whether to move immediately to a doubling of public expenditures on R&D. Given the seriously inadequate state of the national R&D system shown in our earlier analysis, it is difficult not to agree with the proposal for a doubling of current levels of expenditure. We are also in strong agreement with one of the stated rationales for this proposal, which is to establish over the longer term an adequate supply of talented and creative scientists and engineers. It is, however, precisely because of the serious inadequacies that we have pointed out in the current system that we would emphasize the importance of improving the efficiency of existing government programs before proceeding with a major expansion of financial support. Although positive changes have been introduced over the past few years, supply led approaches and supply oriented decision-making systems remain the norm of the system. Inducement of an efficient and effective national R&D system will probably depend on the pressure of greater competition, including pressure from the country's SMEs for R&D products that meet their needs and priorities.

  Moreover, there is the even larger question of what R&D is best provided through public financing and what is best left to the private sector. To the extent that Vietnam succeeds in its goal of attracting FDI and joint ventures, the experience of other countries suggests that the private sector will attend increasingly to its own R&D needs. This will require a redefinition of the role and function of government supported R&D with major focus on the area of public goods, including health, environmental, agricultural and other science and technology knowledge issues not addressed by the private sector. The redefinition would also then aim more at basic and pre-competitive research.

  Finally and in the short term, there is need to bring about significant improvements in the effectiveness of Vietnam's national R&D systems to assist and respond directly to untapped potential of the agricultural sector and to strengthening the technological capabilities of SMEs, including specific applied research on the cluster approach.

Assigning R&D Priority to the Agricultural Sector: Increasing Domestic Savings

As noted previously in this report, R&D funding in Vietnam is limited and there is a proposal currently under review to increase it from about 1 percent to 2 percent of GDP. We suggest that public funding for R&D and increases in that funding should give priority to the agricultural sciences and to technologies directed to the sector. Eliminating the 'green disease' in Vietnam’s fruit crops would in itself pay handsome, short-term dividends to the economy. Resolving the technological barriers to increased post-harvest marketing will do the same. It should be noted in this regard that a significant percentage of such S&T to agriculture will likely be at the very frontiers of science in plant breeding, genetic engineering and biotechnology.

For these reasons, we suggest that reform of the current public R&D systems should be much further advanced before there are significant increases in government funding of those systems.

Longer Term Measures

The above outlines a number of immediate actions which might be taken to strengthen the national innovation system in Vietnam in the short term. We recognize there may be other actions appropriate to the specific problems of individual industries, but the constraints on our study have prevented us from going into this level of analysis. We now turn to a number of longer term actions aimed at preparing Vietnam to become a knowledge society over the next 20 years.

- Increasing priority to and emphasis on the national information infrastructure

  Earlier in this report, we placed ICTs at the center of the global technological transformation that is occurring. Vietnam has already assigned high national priority to ICT. It is one of the four identified programs of 'high technology' and has been accorded much higher priority than the other areas of biotechnology, new materials and automation. We have concluded that even much greater attention and priority are warranted. The revolution that is occurring in ICT is affecting the structure and functioning of all economic and social activities. Such technological transformation is usually referred to as a 'techno-economic paradigm shift' and compares with such earlier transformative technologies as electricity, the automobile and the telephone. There is, of course, enormous hype today about ICT and there is no shortage of inflated claims and even outright lies about its benefits. There can be no doubt, however, that ICT is improving the speed and efficiency of markets, reducing transactions costs, and making possible a range of products and services that were inconceivable only a few years ago.

  Like technologies before it that created techno-economic paradigm shifts, no nation can hope to achieve future comparative advantage without a solid foundation in this new technology. There is already growing evidence of an emerging 'digital divide', (World Bank, 1998, UNDP, 1999, Mansell and Whein, 1998) of a widening gap between the richest and the poorest, and the experience of the more developed countries suggests that the risks on a widening gap will increase with the transition to the knowledge economy. This indicates a critical role for government through proactive policies to provide access to ICT to disadvantaged and vulnerable groups.

  In general, however, this does not mean regulation by government, but rather timely actions aimed at facilitating and supporting social applications, redressing imbalances in access and in equity. The Government of Vietnam has been taking steps to liberalize the country's ICT sector (e.g. opening up to the internet and the availability of e-mail), but strong regulatory control remains. Yet the reality of this sector is that it involves a market that moves much faster than any regulator can anticipate. It follows, therefore, that regulatory controls should be removed as quickly as possible and that highest priority should be given to national public and private investments that expand access to the Internet, improve and expand the telecommunications network, lower to internationally comparative levels the costs of accessing and using the internet, and expand the mobile telephone network.

  Because the older public policy mechanisms of control and regulation cannot be expected to work, the role required of government in bringing ICT to bear on the establishment of knowledge society is both exceedingly complex and highly delicate. Recognizing this, the UN Commission on Science, Technology and Development recommended that each country, no matter its size or level of development, should produce its own national ICT strategy. We strongly recommend that this be done. The Republic of South Africa is currently completing such a strategy following a three year process of consultations, scenarios and technology foresight exercises. Much can be learned from their experience, including how the time frame might be shortened, although the process of preparing a strategy should be participatory, should involve national and international actors, and should build 'ownership' into the product.

  Many issues will need to be explored in the preparation of a national ICT strategy, but the key question is what Vietnam can best do to obtain, mobilize, assimilate, apply and innovate ICT to its national advantage and to serve its national goals. National goals are, of course, numerous and varied. A central ICT question for Vietnam's Department of Industry is

whether and how Vietnam can insert itself as a manufacturer of ICT. To the Department of Education the main questions are how the technologies can increase the educational and skill levels of Vietnam's youth and what skills, abilities, aptitudes and capabilities will be required for the future. This variety underscores the importance of investing in an ICT strategy through a wide-ranging participatory process.

A further reason for investing in preparing a specific ICT strategy is, as mentioned, that the technologies are changing and the market is shifting far more quickly that any regulator can anticipate. This applies even to the manufacturing side, as has been demonstrated through the work of Timothy Sturgeon and is outlined in Chapter 4 of this report. In terms of new products and applications, a recent technological assessment exercise conducted in Great Britain has confirmed that access to the internet is now easily achieved and at very low cost through the interface between digital radio, satellites and the micro processor. The same exercise confirmed that battery-operated, solar-powered and even 'wind-up' computers will be soon available on a widespread basis. The removal of the previous requirement for electricity and terrestrial telephone lines opens up the possibility of access and applications designed to meet the needs of the remotest and poorest parts of any country. All of these issues should be explored carefully and seriously in the preparation of a national ICT strategy.

- Implementing a new human resource strategy

  At the moment the Vietnamese human resource strategy resembles an old style manpower plan. This needs to be replaced with a new approach which stresses capabilities to solve problems in situations of uncertainty and change. This is precisely what the new curriculum for primary schools seeks to achieve. It needs to be advanced as quickly as is possible and the secondary curriculum should build on this. At a later stage, this approach should penetrate the tertiary level by combining a firm disciplinary foundation with multi disciplinary approaches to problem-solving. Of all the possible investments open to the state as part of a socio-economic strategy, these are likely to provide the highest returns. In manufacturing and industry, East Asian states like Singapore, Malaysia and Taiwan are far advanced compared to Vietnam, but, according to a recent assessment (*The Economist* 2000) they may not be in a similarly stronger position when in comes to taking advantage of ICT.

  According to *The Economist*, the educational systems in most Asian countries places strong emphasis on rote learning instead of creativity. The result, it is argued, is a workforce that may be outstanding in 'imitative opportunities' and in turning existing technologies and products into 'clever new ways of making money', but it generally lacks the qualities of inventiveness, innovation and experimentation. A world-wide comparison of figures on patents lends strong support to this argument. Over the past 20 years, remarkably few patents have been recorded in the Asian tigers. To build full comparative advantage from the ICT revolution, argues *The Economist*, will require a new generation of risk-takers who seek innovation and experimentation and who are oriented to problem-solving.

  If this is correct, then the direction of Vietnam's recent dramatic reform in the direction and learning purposes of the primary school curriculum coupled with widespread, low cost access to ICT (including the internet) is exactly what is required. Not only should it represent the fastest and surest combination of factors to Vietnam becoming quite early in this century a knowledge-based economy, it should also serve to stimulate the rapid economic growth that the country seeks.

  This suggests that, coupled with the new primary curriculum, a major goal should be to ensure that every child in school has access to a computer and, where possible, to the internet. The changing technologies are not only reducing dramatically the costs of the computers themselves, they are also eliminating the need for the expensive infrastructures of electricity and telephone lines. Moreover, the speed of change has also produced a vast surplus of older generation and used microprocessors which may be entirely suitable for learning, experimentation and problem-solving at the primary school level.

  Given the size of Vietnam and the paucity of trained teachers there are also opportunities for satellite based distance learning for all levels of education. Experiments are underway

with this technology and these should be tightly monitored. If successful they should be widely copied and diffused.

An additional factor that requires attention as part of a new strategy is the major gap has been identified in management capabilities and especially in the skills required on issues of technology management. This is a serious shortcoming, both for the managers of enterprises and for the decision makers in government. Although Vietnam has a plethora of new training courses, many seem to be essentially transplants of the Western business school model. The materials used appear to have very little bearing on the technology management skills required by Vietnam, especially those required by SMEs. We believe this shortcoming should be rectified by a new techno-management scheme, an outline of which follows.

A Vietnam Techno-Management Programme (TMP)

Objectives:

- To educate and train the leaders of Vietnam industrialization in the area of technology-management systems.
- To perform technical assessments, systems analyses and syntheses, and planning and management of projects at all levels, both public and private.
- To function initially as Vietnam's principal cooperative windows for international collaboration in the techno-management area

Programs:

- Post-graduate level programs offered to both young college graduates and managers and decision-makers who are already on the job.
- Programs would include (1) a formal TMP which focused on technology management and project administration, (2) non-degree advanced special programs for gaining overviews of modern-day technology management which would be directed to incumbent government officials and enterprise managers, and (3) short courses and seminars to present packaged training on specific topics for those who need them in a hurry and in response to demands from industry.

Organization:

- The proposed TMP should be offered at newly established and reorganized Vietnam National University (VNU). VNU will certainly become the elite school for the future leaders of Vietnam. Its reform-minded leadership is ideal for organising and operating the proposed TMP. The programme can be run as an independent unit of VNU with a world-class facility and international faculty. Also, the success of the programme will require linkages with and study programs at other institutions of excellence in the region and internationally. In order to overcome the barrier of inertias from the traditional sector of the Vietnamese higher education system, the proposed TMP should be run under an international arrangement. It is also suggested that this idea be placed before the World Bank as a matter of highest priority for funding under the very large educational reform programme that is being considered.

Curriculum

- The detailed curriculum, mode of teaching, operational pattern and business aspect should be designed on the basis of careful comparative analysis and through feasibility studies. There are many important models and outstanding examples that should be taken into account, (e.g. MIT's technology management programme, KAIST's Techno-MBA programme, Thailand's TDRI, SPRU and IDS at the University of Sussex). For Vietnam, students may require remedial work before being admitted into formal programs and this should be considered in the design of the programme. Also, Vietnam has a substantial pool of well-trained professionals abroad and some of these could be invited to work with an international team of experts and domestic stakeholders in the planning work for the proposed Vietnam TMP.

Elements:

- The elements of a TMP would require careful study, including the examination of facilities and programs within South East Asia and elsewhere. For consideration in such a study and as possible key elements, we would suggest a four tier programme of:
  i. Short-term seminars for senior decision-makers.
  ii. Six-month programs designed for managers on the job.
  iii. Regular Masters programme for university graduates of engineering and social sciences.
  iv. International study programs in centers of excellence and industry.

- Main skill requirement areas to be addressed (some mandatory and some optional depending on orientation and needs):
  i. Introduction to and familiarization with the application of IT.
  ii. Management information systems.
  iii. Decision analysis through case studies
  iv. Systems engineering and design.
  v. Project formulation and assessment.
  vi. Project management systems (schedules and costing).
  vii. Technology sourcing and intellectual property rights issues.
  viii. Marketing and after-sales service.
  ix. Operations and Maintenance for small and large facilities.

- Building a relevant scientific base

  The experience of the East Asian 'tigers' has shown that their efforts to build a scientific base had little impact on their export led industrialization successes. By contrast, the experience of South America during their import substitution industrialization in the 1960s and 70s required the building of relatively strong local capabilities in both science and technology. In recent years that base has been eroded as its usefulness to Latin American industry has declined. Now it is primarily in a few high technology and advanced scientific areas that there are industrial benefits from the scientific base.

  If science mattered little to the successes of the Asian tigers and its importance and utility to Latin American industry has declined with global economic integration, what exactly is a relevant scientific base for Vietnam? The question is being asked today in many countries, both advanced and developing and it is proving to be a difficult question to answer. At least part of the reason for this lies in the long history which treated scientific and technological knowledge as a linear process. Support to basic scientific research was predicated on the view that it would contribute knowledge which would subsequently be developed through applied research into technologies which would then, in turn, be developed for productive purposes. Institutions were specialized and segmented in order that they could focus separately on each part of this linear chain of activities.

  The intrinsic merits of science and scientific research remain valid, but it is now recognized that the linear approach to innovation needs to be supplemented by a more complex process whereby new knowledge is generated at all stages in the chain of events. This process of knowledge generation recognizes the importance of integration interaction and linkages, between all the actions in the innovation process. Hence the importance of forging links between university researchers and those in industry and government.

  At the same time that our understanding of the process of innovation became more profound, there also occurred other changes in most countries which particularly affected the conduct of publicly funded research. These can be characterized as follows:

  - The curtailment of core financial support and a requirement that research institutes obtain more of their funding from a variety of contract sources. This imposes a need for new management skills as the research institute seeks to meet the different accounting requirements of a variety of donors, sponsors, and clients.

- Greater public accountability for the funds received. This has led to the development of research output indicators and more frequent and thorough assessment and evaluation of research institutions.
- The expansion of collaborative research programs often involving researchers in university, industry and government laboratories. These collaborative programs occur both within and between countries.
- The involvement of sponsors and potential beneficiaries in the setting of research priorities.
- The setting up of new 'spin-off' enterprises based on successful research outcomes. Sometimes, as in university settings, these are established by academic entrepreneurs, other times they are 'privatized' research establishments, and sometimes they are spin-off enterprises as has occurred with the Academy and other research institutes in China.

These are trends which have occurred in almost all countries, but their impact has been particularly pronounced in the transition economies, since their previous science systems were so different from that required by a market economy.

As summarized in Chapter 3, Vietnam has initiated a number of measures to move its scientific and technological research institutes away from the linear model and towards the more integrated approaches required for a national system of innovation. These measures are entirely in the right direction. Greater precision about and insistence on research areas which have a bearing on Vietnam's comparative advantages would aid the reform process. In this regard and as we have indicated previously, the main potential clients (at least over the next 10-15 years) for Vietnamese scientific research are probably to be found in the agricultural and SME sectors and they should become actively involved in the setting of research priorities.

- Defining clearly the role of the state in a national system of innovation

Economic theory tells us that the necessary conditions for markets to perform efficiently include perfect competition, a complete set of functioning factor and product markets, and perfect information. The problem, of course, is that these conditions are not met even in the most successful industrialized economies, which is why governments in those countries play a significant role. Both neoclassical economists and advocates of the developmental state agree that market failures are the primary justification for government activism and direct interventions in the economy. Both views recognize that markets are imperfect and that they fail. Where they differ is in their views on the extent to which market failures occur in developing countries and how they ought to be corrected by the state. In general, the neoclassical view is that most market imperfections will be overcome by private sector institutions, whereas many development studies consider government involvement as a suitable and necessary substitute mechanism. Looked at in this way, the two views are incompatible, the state and the market being viewed as mutually-exclusive forms for resolving resource-allocation problems.

There have been recent attempts to bridge this sharp divide (World Bank, 1997). In order to support thriving markets and to promote industrialization, the concept of the market-enhancing view (MEV) was introduced in 1997 (Aoki, *et al*, 1997). The MEV stresses mechanisms whereby government policy is directed at improving the ability of the private sector to solve coordination problems and overcome other market imperfections which evolve due to the incompleteness of markets, bounded rationality, information asymmetry, and limited knowledge.

The MEV views the role of government not as a substitute for private-sector coordination, but as the facilitator of an institutional environment that encourages private associations, supports private coordination, and improves the exchange of information between the private sector and the government. This view also encourages the use of policy instruments that enhance cooperation with and within the private sector. Hence, public policies should not aim at directly intervening in the allocation of resources, but need to show a bias towards strengthening private sector institutions wherever feasible, because these

institutions are basically more appropriate to solve coordination problems due to their built-in self-regulating property of competition.

It is this MEV approach that we take in making suggestions to Vietnam's government with regard to the role of the state in a S&T strategy whose principal aim is to support international competitiveness.

This MEV approach to gaining international competitiveness is similar to that taken by many countries. The 'best practice' that has emerged involves establishing and nurturing a **National System of Innovation** aimed at stimulating and supporting the competitiveness of firms. There are variants between countries in the role played by government in a national system of innovation, but the general and usual characteristics are those outlined in the typology that follows.

Functions of a National System of Innovation
Core Functions of Government

General	Specific
Policy formulation Allocation	• Monitoring, review, and formulation of national S&T policies • Ensuring effective linkages to and integration with other policy domains (such as the economy, trade, education, health, environment, and defense) • Allocation of resources to S&T from overall budgets and first-order allocation among activities • Creation of incentive schemes to stimulate innovation and other technical activities • Provision of a capacity to implement policies and co-ordinate appropriate activities • Provision of a capacity to forecast and assess the likely directions of technical change
Regulatory and protection	• Creation of national systems for metrology, standardization, and calibration • Creation of a national system to identify and protect intellectual property • Creation of national systems to protect safety, health, and the environment
Financing	• Management of financing systems appropriate for implementation of the other functions of the system • Use of government purchasing power to stimulate innovation in production of goods and services the government requires
Performance	• Execution of S&T programs, including support to research • Provision of scientific services • Facilitation of mechanisms to link R&D outputs to practical use • Facilitation of linkages to regional and international S&T activities • For public goods (e.g. education, public health) encouragement of innovation embodying the results of S&T activities
HRD and capacity building initiatives	• Provision of programs and facilities to educate and train S&T personnel • Creation of institutional capacity in S&T • Provision of mechanisms to maintain the vitality of the national S&T community • Stimulation of public interest in, and support for, national initiatives in S&T
Infrastructure	• Establishment, operation and maintenance (EOM) of information services, including libraries, databases, statistical services, a system of indicators, and communication systems • EOM of technical services, such as metrology, standardization, and calibration • EOM of a system to award, record, and protect intellectual property rights • EOM of mechanisms to ensure the protection of safety, health, and the environment EOM of major national facilities for research

The functions outlined above provide a broad framework for the market-enhancing view (MEV) that we have adopted. This may serve as a helpful component of strategy to delineate the appropriate and necessary role of the state versus the market.

- Incorporating gender and environment into all aspects of S&T strategy
  There are two aspects of technology and industrialization which cut across all of the different issues and measures discussed above. These are issues to do with technology and environment, and issues to do with gender and science and technology. Any science and technology strategy for Vietnam would be incomplete if it did not address these issues.

Technology and the Environment

The choice of technology can have a major impact on the pollution caused by industrial production. Some technologies are cleaner than others and hence the choice of technology can have a major impact on the environment. It is also possible to clean up some of the pollutants which are spewed into the atmosphere and into the rivers by adding new end-of-pipe technologies. The problem for the entrepreneur or factory manager is that to acquire new cleaner technology or to add end of pipe technologies to existing equipment incurs costs, often substantial. Firms are unlikely to incur these costs voluntarily unless they perceive direct economic gain or are pressured to do so. These pressures may be from environment groups or more likely from the government.

Heavy polluting industries and technologies may be of domestic or foreign origin. Foreign investors will often export polluting industries and technologies to overseas sites where environmental controls may not be so stringent as in their home country. It is important for Vietnam to have clear environmental legislation and for the government to prohibit the import or use of equipment and technologies which do not meet these environmental standards.

In China there has been a rapid growth of Township and Village Enterprises. These are now responsible for more than half of all industrial output in China. They have helped create more than 130 million jobs. But many of them have been highly polluting. Some of the repeated polluters, especially in the coal mining, paper, and tanning industries, have been closed by the government in recent years. Rural industry in Vietnam is not so well developed as it is in China, but the latter country's experience would suggest that it would be wise for the Vietnamese Government to set clear environmental guidelines for the development of rural industries.

There is another potentially serious environmental problem in Vietnam caused by some of the industrial zones. Current legislation does not require waste water treatment plants to be installed until the zone is more than 50 percent occupied. The current overall occupancy rate of the 66 industrial zones in Vietnam is only 20 percent. This means that most of the current zones have become high polluters. This seems to be a major short term problem and needs to be rectified.

Gender and Science and Technology

There are two aspects relating to gender and science and technology that are germane to Vietnam. The first is the participation of girls in scientific and technical education, and the participation of women in scientific careers. The second is the differential impact that technical changes have on the lives of men and women.

Both the UN Commission on Science and Technology, and UNESCO have devoted considerable attention to these topics. The former organization has developed a set of guidelines, or transformative actions, to help developing countries address the issues in the context of their own countries. If girls and women do not have equal opportunities to boys and men in acquiring a scientific and technological education or pursuing careers in science and technology then the country denies itself access to its full complement of creative minds.

In Vietnam the participation rate of women in science and technology is higher than in many countries. In most of the universities and research institutes between 20 percent and 30 percent of the scientific staff are women. In some institutions women are members of senior management and in a few cases the heads of institutes are women. Nevertheless, these figures clearly fall far short of 50 percent participation, and we believe that the suggestions of the UN Commission on S&T for Development should be carefully studied and where relevant implemented. (Gender Working Group, 1995).

The differential impact of technical change on the lives of men and women is a topic which is mainly relevant to rural development. Evidence from many developing countries shows that when new technologies are introduced into rural areas as part of development programs it is usually men that benefit rather than women. We do not know whether this is an issue in Vietnam, but given Vietnam's commitment to the principles of equity, we believe that the topic warrants careful investigation.

Developing an Implementation Strategy

Although we know of no study on the subject, it seems obvious that for both developed and developing countries the history of national plans and strategies would show that most are quietly and unceremoniously abandoned soon after they are announced. Often, it would appear that the reason for this is found in the mismatch between available resources and over-ambitious goals. Other examples can no doubt be found of unforeseen external shocks (such as major shifts in commodity prices, sudden interest rate spikes, or economic recessions in trading partner countries) that have doomed plans and strategies to early extinction. In other cases (e.g. the history of 'Tropical Forest Action Plans'), the production of 'the plan' or 'the strategy' was an end in itself, imposed by external funding agencies as a pre-condition for financial support, even in sectors having little if anything to do with the subject of 'the plan.' Lacking any genuine national support or national commitment, the actions required by such plans are never started, let alone completed.

Many failures, however, appear to be more attributable to the absence of implementation strategies. Solid national and external commitment and the availability of internal and donor resources would appear often to have been frustrated by the failure to work through the detailed requirements for implementation. A strategy directed to major development purposes is necessarily highly complex, requiring, as we have stressed earlier, a systemic approach and including major interdependent reforms. The old adage holds that 'the devil is in the details' and this is very much the case with a development strategy.

In a very real sense, therefore, the development of an implementation strategy is far more important and far more challenging than the preparation of a strategy itself. Implementation needs to contend with the unavoidable fact that there is always opposition to major changes. Some opposition is a matter of groups who have vested interests, which includes holding power and authority, that would be affected by changes. Other opposition derives from traditions and even deep belief systems that would be shifted through major reforms. And we know that opposition is very often due to misunderstandings as to what is intended and why.

Because of this, a development strategy and the reforms required by it are not just technical matters; the key lies in changing the mindsets of people. What this involves is a highly complex process of political economy and of political accountability, and such a process can only be successful if it includes significant efforts to explain, communicate, disseminate, consult, persuade and build consensus. This is all the more so for a development strategy whose principal aim is to contribute to the building of a knowledge society. The very nature of such a society is one of 'distributed power', where knowledge and technologies empower communities, workers, students and government workers. Particularly important under such circumstances, therefore, is the involvement and ownership of the reform agenda by civil society and the private sector, as well as by government. It is not merely a matter of such groups understanding the main forces and trends affecting them and why these require that they themselves change. It is also essential for individuals, firms, institutions and government to appreciate what they will have to do and why.

Such a process, however, involves risks and dangers. A paralysis of inaction can be produced by the complexity of the issues and the extent to which opposition can become organized and vocal

as a direct consequence of a consultation process. Also, the processes of consultation, persuasion and consensus-building can become burdensome, debilitating and can serve to delay dangerously the taking and implementing of essential decisions. The problem in the case of Vietnam is that actions are urgent for the nation to avoid losing ground. This increases yet further the challenge to government and the importance of an implementation strategy that also includes monitoring, evaluation of progress and impact, and the agility to make constant and ongoing adjustments based on feedback.

Experience shows that, even with the very best of efforts to build consensus through persuasion and consultation, aggressive opposition to change from some quarters can be expected to continue. The management, therefore, of an infinitely complex socio-economic strategy aiming to build a knowledge society will almost certainly confront opposition and adversity when difficult changes are introduced and major reforms are pursued. This will require decisiveness and strong resolve on the part of government.

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