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VIET NAM *at the* CROSSROADS

The ROLE *of* SCIENCE *and* TECHNOLOGY

K. BEZANSON, J. ANNERSTEDT, K. CHUNG, D. HOPPER, G. OLDHAM, AND F. SAGASTI

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LETTER OF TRANSMITTAL

Professor Chu Tuan Nha
Minister of Science, Technology and Environment
Hanoi, Viet Nam

Dear Minister,

I am pleased to be able to send you the final draft of the report of the Science and Technology Policy Review Mission to Viet Nam. This version of the report contains a section on the return visit of the international team and our responses to a set of questions posed to us at that time. Indeed, in preparing the report, we have tried to address all of your concerns and requests, as well as those of Dr Pham Gia Khiem. Thus, specific suggestions are made throughout the report. For ease of reading, the most central of these have been placed in boxes and are highlighted.

The international economic situation has changed dramatically since we carried out the main review. The extent of the East Asian crisis is only now becoming clear. That crisis will make Viet Nam's own efforts to enter the global economy even more difficult than when we wrote the first draft of the report. We addressed some of the implications of the crisis for Viet Nam in Chapter 15. We believe that the sort of reforms we suggest are even more vital if Viet Nam is to succeed in its goal of industrialization by 2020.

I would like to highlight a few of the points raised in the report that I think are particularly important:

- The sense of urgency identified by Dr Khiem and yourself is fully justified. Viet Nam has not adjusted its systems of science, technology (S&T), and education enough to respond to the new economic and social circumstances facing the nation. With full membership in the Asian Free Trade Area only a very short 7 years away, Viet Nam is at serious risk of entering into its new regional partnership from a position

of serious disadvantage. The recent and continuing financial and economic crisis in Indonesia, Malaysia, the Philippines, and Thailand can only serve to heighten competition over the next few years as those nations attempt to recover from debilitating losses. The required reduction of tariffs by 2006 will expose the entire Vietnamese economy to that competition. Under these circumstances, step-by-step approaches are unlikely to serve the medium-term needs of the nation.

- Some of the Vietnamese we met on our visit felt that it was impossible to prepare policies for S&T and innovation until the nation has a clear socioeconomic policy framework. To the extent that S&T policies and economic policies must work together and be complementary, this is true. But it is not true that nothing can be done. As the report makes clear, S&T policy should inform economic policies just as much as economic policy needs to inform S&T policy. The importance of approaching national economic policy and management from a clear S&T perspective has been clearly demonstrated in the cases of Korea, Singapore, and Taiwan. The forthcoming White Paper on a new national S&T strategy for Viet Nam should make unequivocally clear Viet Nam's intention to make S&T thinking lead and inform economic thinking. It seems to me important that this approach be reinforced from the very highest levels of the Vietnamese government with both encouragement and guidance for the Ministry of Science, Technology and Environment and the National Institute for Science and Technology Policy and Strategy Studies.

- In our report, we stress the need to apply S&T to the agricultural sector. Although it seems to be generally agreed that much higher levels of domestic savings are needed for modernization and industrialization, it appears not to be fully appreciated that in the short and medium term this must come from the traditional sectors. Also inadequately appreciated, especially in the economic ministries, is the ability of agriculture to be very high-tech, involving some of the leading applications of biotechnology and science. Also, at a very fundamental level, the nation is committed to socialist values, including equity. High-tech manufacturing is, by definition, capital intensive, and it tends to reward very highly a very few professionals and skilled technicians. Throughout the world, as the report indicates, income distribution is worsening as a

result of this. Because of this, the S&T priorities (and the investments based on these) involve a profound social-policy issue. The new government of Prime Minister Khai has begun its stewardship by emphasizing the importance and centrality of agriculture and the traditional sectors. This, in the judgement of the international team, should be put into practice through its integration into the forthcoming S&T strategy.

- Among the suggestions made in the report is that a new international consultative mechanism be established (the Viet Nam Forum for Science, Technology, and Modernization). This would be modeled on the very successful China Council for International Co-operation for Environment and Development and would comprise a distinguished international group of leading industrialists, financiers, and technology and development specialists. In addition to affording to you and your government a mechanism for ongoing advice and comment on all matters pertaining to S&T, the forum would, in my view, send a very positive political signal throughout the world. I also believe that the very existence of such a forum would encourage investment and international support for Viet Nam. I suggest this arrangement strongly for your consideration, and if it does interest you, I would be pleased to do anything I can to help to put the idea into practice.

May I take this opportunity to thank you most sincerely for having entrusted to us this very important assignment. My hope is that you will find the trust to have been well placed.

Yours sincerely,

Keith A. Bezanson
Mission Leader

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PREFACE

The idea for this international review of Viet Nam's science and technology (S&T) policy stemmed from a conversation in January 1997 between Dr Pham Gia Khiem, Minister of Science Technology and Environment (now Vice Prime Minister responsible for science, technology, education, training, health, social affairs, culture, environment), and Dr Keith Bezanson, then President of the International Development Research Centre of Canada (IDRC).

The declared intention of the Government of Viet Nam is to become an industrialized society by the year 2020. The general idea is to follow the path that the Asian newly industrialized countries adopted some 25 years ago: gradually moving up the technological ladder in industrial production to penetrate international markets. Central to this transformation is to be a national S&T strategy, which the government plans to announce before the end of 1998.

IDRC had just completed an S&T policy review for China, and it seemed that the approach followed in that review might make a useful contribution to the preparation of the long-term strategy. Dr Khiem, on behalf of the Vietnamese government, asked IDRC and the Canadian International Development Agency (CIDA) to conduct an S&T policy review, along the broad lines of an approach pioneered by the Organisation for Economic Co-operation and Development, as adapted by IDRC. The approach followed in such reviews is highly pragmatic:

- A multinational team of specialists is assembled to bring a number of experiences and diverse perspectives to bear on the examination of national S&T policy and practice;

- The country prepares an assessment of its S&T policy (including its history, its evolution over time, its current characteristics, and its performance) and presents any major contemplated changes; and

- The international team examines the strengths, weaknesses, and performance of the stated policy from the perspectives of its principal

stakeholders (government agencies, research institutes, universities, technical institutes, national and international investors, multinational and national companies, joint-venture operations, small to medium-sized enterprises, international development organizations, etc.).

Thus, the central feature of an S&T policy review is that it attempts to capture and distil the experiences, assessments, and views held of national policy and to engage in dialogue (to provide a mirror) about those experiences and experiences from other parts of the world. IDRC and CIDA agreed with the request, and in September 1997 the team spent 3 weeks in Viet Nam, conducting the review. The government appointed the National Institute for Science and Technology Policy and Strategy Studies (NISTPASS) to be the Vietnamese counterpart in the review.

During the visit, the team met with some 70 organizations, institutions, departments, firms, and associations and some 320 Vietnamese S&T policymakers, policy implementers, and people affected by the policies. The views of these institutions and individuals were solicited on a range of important policy issues specified by the Vietnamese government. Most of the interviews took place in Hanoi and Ho Chi Minh City, but some members of the Mission also visited research institutes, government offices, and the university in Can Tho in the Mekong Delta. In Part II of this report, we present results and impressions arising from this extensive range of discussions and meetings.

For the most part, this report reflects what we were told and what we observed in Viet Nam. We were, however, also specifically requested by Dr Khiem to draw on our knowledge of other countries and to make specific suggestions for the long-term S&T strategy of Viet Nam. We did this with some trepidation, for two reasons. First, we are very mindful of the many examples in the second half of this century of development advice to countries by outsiders that has subsequently proven seriously wrong. Second, we are most conscious of the fact that 3 weeks is a dangerously short period of time to try to obtain an accurate appreciation of the current and the evolving situations of S&T policy in Viet Nam. We have, nevertheless, done our best to comply with the request of Dr Khiem, and our report includes a number of suggestions to be considered in preparing Viet Nam's national S&T strategy.

We were also asked to provide an overview of major issues and trends in the regional and global economy, an assessment of changing issues in technological transformation, and a qualitative assessment of whether, how, and under what

circumstances the successful and rapid transformations of other East Asian countries, such as Korea and Singapore, might be repeated. These requests were all daunting. Again, we have done our best to comply, knowing that the purpose of the requests was to help define the context in which Viet Nam's own development strategy will have to be located.

The Mission coincided with a particularly significant moment in the political history of Viet Nam. A new government was formed during the last week of September 1977. It assumed its responsibilities at a time of international turmoil and of changes that have been, in the eyes of many knowledgeable observers, unprecedented since the time of the industrial revolution, some 200 years ago. The distribution of both wealth and poverty is changing and will change further. *The Economist* magazine has predicted that, by 2020, 9 of the 15 richest countries will be countries we now call developing and that China will have replaced the United States as the world's largest economy (The Economist 1993).

The forces of globalization, driven by the explosion in new information technologies, are accelerating and changing much more than trade and investment patterns. They are also modifying the institutional, political, and social arrangements set up after World War II. It is certain that by 2020 our world will have produced a very new line-up of winners and losers. It seems equally clear that the next 5 years — the period of Viet Nam's new government — will be most critical in determining the category into which Viet Nam falls.

Our report has four parts. Part I is an introduction, in which we address the reasons why we believe it is important, even essential, that Viet Nam develop a long-term S&T strategy to help it attain its goal of modernization and industrialization by 2020. In this introduction, we wrote a second chapter in response to a request from the Vietnamese government, and this chapter describes some trends that will set the international context within which Viet Nam's own modernization will take place.

Part II contains the findings of our 3 week mission in Viet Nam. We identify nine key S&T-policy issues. Each of these is treated in a separate chapter, and for each we report our impressions of what is happening in Viet Nam, based on what we were told, saw, and read. In discussing many of the issues, we have also referred to international experience and have responded to Dr Khiem's request to provide some suggestions for Viet Nam to consider in preparing its long-term S&T strategy.

Part III comprises two related reports, on Viet Nam's traditional sector and high-tech parks, respectively, written by members of the mission. These reports elaborate on important S&T-policy issues.

Part IV contains our conclusions and a chapter summarizing the outcome of the return visit of the team to Viet Nam in February 1998.

The appendixes contain short biographies of the team members and a summary of some important statistical material on Viet Nam's S&T system.

Throughout our Mission and in all parts of Viet Nam that we visited, we were accorded the warmest of hospitality and full cooperation. To list all those to whom we are indebted and grateful would require many pages. To make matters simple, therefore, we wish to extend our deepest thanks to all those people with whom we met; to our friends in NISTPASS and the Ministry of Science, Technology and Environment, who organized and facilitated our work; and to Vice Prime Minister Khiem for having entrusted to us this important mission. We also acknowledge the support of IDRC and CIDA, which extended far beyond the financing that made this possible.

In this report, we have tried to highlight opportunities as well as barriers, strengths as well as weaknesses, and advantages as well as disadvantages. We hope that our observations will be useful to Viet Nam in determining its new long-term S&T strategy and will help ensure that Viet Nam is among the winners. If we have dealt with the negatives that were brought to our attention, we have sought throughout to make the suggestions requested of us that might provide solutions. The usual disclaimer applies: any errors of omission or commission are ours.

Keith A. Bezanson (team leader)
Jan Annerstedt
Kunmo Chung
David Hopper
Geoffrey Oldham
Francisco Sagasti

PART I

Introduction

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Chapter 1
THE FRAMEWORK FOR THE REVIEW

Why a national S&T policy? Arguments against

In recent years, considerable debate has focused on whether national science and technology (S&T) and national industrial policies can still play a role. Starting in the 1980s, researchers in industrial countries have argued that national S&T policies have become obsolete. The argument goes this way: national S&T policies are designed to benefit a national economy by creating and facilitating a competitive edge for the goods and services it produces. A globalized trading arrangement means that not only goods, business, and finance but also S&T move unrestrictedly across national borders. Thus, any possible benefit from national S&T policies will quickly move ("leak") outside a country, and in a globalized world, such policies are therefore doomed to failure.

In its extreme form, the argument against national S&T policy goes further. It is generally accepted that national policies are desirable for macroeconomic stability (for example, exchange-rate policies, fiscal balance). Beyond such fundamentals, however, rather than facilitating a national competitive edge, national S&T policy actually prevents development. Effective S&T decisions, it is argued, can only be made at the level of the individual company or firm; approaches to S&T must be entirely flexible to take advantage of rapid technological change; but national (that is, government) policies are necessarily rigid and run counter to the interests of development.

Again, starting in the 1980s, researchers widely asserted that this same argument against national S&T policy applied in developing countries. Policymakers strongly recommended open borders, liberalization, and privatization. They frowned upon such measures as industrial strategies and S&T policies as counterproductive and wasteful.

Why a national S&T policy? Arguments for

There are also strong arguments to show that S&T policy has a role to play in national economic development. First and perhaps most significantly, the strong argument raised in the past 15 years against national S&T policy is changing as

a result of new evidence. For example, in the 1997 *World Development Report*, the World Bank, following extensive examination, concluded that the role of national policy is critical to establishing conditions for development that go beyond those the market is likely to create (World Bank 1997). In arriving at this conclusion, the World Bank made it explicitly imperative that poorer countries build up the appropriate human capital and fine-tune the complex relationship between the market and society. In this regard, the World Bank observed that the experiences of the East Asian Tigers, as well as the failures of national efforts elsewhere, strongly supported the need for appropriate instruments of modernization, including instruments of national S&T strategy.

Second, firms and companies target the investments that come with globalization, and on which it depends, to locations with a comparative advantage not only in low-cost labour but more often in S&T. For example, companies will invest in research in one country, industrial design and engineering development in another, production in a third, initial sales in a fourth, and the headquarters of after-sales service networks in a fifth. Long-term national policies and actions, particularly in Asia, have been critical in attracting and retaining such investments.

Third and of great significance, if the strength of globalization is in its wealth-creating capacity, its weakness, if undirected and uncontrolled, is in its disregard for, and damage to, the environment and in its exacerbation of gross inequalities both within and between nations. In Japan, such negative consequences are increasingly defined as evidence of market failure, as they deleteriously affect such national purposes as social cohesion, reasonable equity, and political stability.

Why an S&T policy review?

Given the above, it is not surprising that an increasing number of governments, business associations, and communities assign importance to having arrangements to directly support the production, access, and mastery of S&T. A number of S&T-policy approaches and methodologies have emerged, including some that build scenarios and others directed to technology foresight.

An S&T-policy review is a further such approach to developing an appropriate S&T-policy framework. An S&T-policy review assumes that S&T policy must be made in, and adapted to, local conditions and that any model that is simply imported is unlikely to yield the desired benefits. Thus, the intimate involvement of national leadership is a prerequisite for undertaking such a review. The essential features of an S&T-policy review are

- The assembly of a number of S&T-policy professionals from both developed and developing countries;

- The assessment and sharing of previous experiences and the lessons learned from these;

- A substantive national assessment; and

- The juxtaposition, open examination, and tabulation of national views, observations, and recommendations (obtained from government, scientists, technicians, and the business community) and those of the international team of policy professionals.

The traditional review — that is, of the type undertaken by the Organisation for Economic Co-operation and Development (OECD) — has three parts. The first is to prepare a report describing the S&T system in the country, together with identifying current S&T policies. The practice is for this report to be prepared by nationals, although the OECD may provide some assistance.

The second part is to have the review team visit the country. This team comprises S&T-policy professionals from other countries. They are aware of the sort of policy issues of concern in their own countries but are not usually experts concerning those in the country being reviewed. The length of time spent in the country varies but is usually 5–10 days. During that time, the team meets with key policymakers, policy implementers, and stakeholders influenced by the country's S&T and innovation policies. The team writes a report to summarize its findings and impressions. This report is sent to government officials, who circulate it to the people the team interviewed and to an even wider audience.

The third part is to have the review team pay a return visit for a final meeting. This final meeting usually includes a debate between country stakeholders and the members of the review team. It also provides an opportunity for team members to explain their observations and findings but often leads to a vigorous debate among national stakeholders about future directions for S&T and innovation policy in their country. This debate forces different views into the open and subjects them to rigorous review.

This three-part process has been applied over several years and in a significant number of countries. It has usually been found to offer major benefits and advantages to national policymakers by providing

- A fully independent viewpoint on national policies and practices;

- An opportunity for national policymakers to discuss and debate all aspects of S&T policy;

- An examination of experiences, both successful and unsuccessful, in other countries;

- An opportunity to compare multiple viewpoints (that is, those of government, business, foreign investors, banks, and scientists) from within the country; and

- An open-ended examination of policy alternatives, which has often led to new policies.

International Development Research Centre adaptations

Based on its own experience and consultations with developing-country partners, Canada's International Development Research Centre (IDRC) has adapted the OECD approach in slight but important ways. First, IDRC has found that having a local team prepare a substantive country report before the arrival of the review mission has often proven counterproductive, as the local team often produces reports of varying quality and tends to overemphasize existing practice, rather than examining what is and what is not working. Although preparation beforehand is not ruled out, IDRC has concluded that local circumstances may make it desirable to take a flexible approach and allow national authorities to prepare a substantive country report following the first visit of the S&T policy team and after having taken its findings into account.

Second, IDRC review teams have found it important to devote more time to in-country assessment than is devoted to this when the normal OECD approach is taken and to visit more locations than the traditional OECD review team would. Finally, IDRC has concluded that on return visits it is most valuable that the review team meet not only with stakeholders in the capital city (usually the principal partners in the review) but also with those in other cities.

Recently, the adapted approach was implemented by IDRC in South Africa and in China. In the case of South Africa, the request for the review came from the leaders of the democratic movement some 2 years before it came to power; the leaders of that movement, including Nelson Mandela, were actively involved in this review. It played a major role in establishing fruitful discussions on S&T policy between the government and members of the democratic movement. Subsequently, when a government of national unity was established it continued to involve members of the international review team in preparing a detailed national policy, through their work on green and white papers on S&T policy.

In China, a collection of background papers and reports replaced the initial national report, and most of these were from a recently prepared White Paper on

S&T. The S&T-policy review itself had the strong support of the top leadership of the State Science and Technology Commission, including Dr Song Jian, the Minister for Science and Technology. The Chinese policymakers are vigorously addressing the main findings.

The particular feature of these reviews, which the national governments in the countries appear to appreciate, is the review team's refusal to make independent judgements of the quality of research in the country it visits; rather, the team attempts to capture and distil the experiences, assessments, and views of the people interviewed and to engage in dialogue (to provide a mirror) regarding those experiences and those from other parts of the world. The questions the team poses are, of course, a reflection of its own background, experiences, and the assessments it conducted elsewhere, but the emphasis is on understanding national capacities, assessments, aspirations, and possibilities. In China, the team spent 3 weeks visiting the country and talked to more than 400 Chinese stakeholders at all levels of government and in universities, business enterprises, and the scientific community.

The Viet Nam review: framework, scope, and new adaptations

The Viet Nam review differed from the previous exercises in a number of ways:

- The principal and explicit objective of the review for the Government of Viet Nam was to contribute directly to preparing a long-term strategy for S&T up to 2020. As such, the review process was specifically linked to the production of new national policy via a government White Paper, which is to appear before the end of 1998. Because of this explicit linkage, the Viet Nam review was more like a traditional consultancy study than either the traditional OECD review or previous IDRC reviews.

- Previous S&T policy reviews had been somewhat open ended. In this instance, the international team was asked to address, inter alia, seven specific topics of direct relevance to a long-term S&T strategy, namely,

  - Technology import to improve the technological capabilities of enterprises;

  - Research and application of high-technology in economic sectors;

  - S&T for agricultural and rural development;

- Basic research;
- Training, education, and use of S&T human resources;
- The research and development (R&D) institutional network; and
- A system of agencies responsible for S&T management and a mechanism and policy measures to manage S&T.

- Compared to the countries previously reviewed, Viet Nam offered few relevant background documents and very little statistical material. This factor served to reinforce the need to seek the views, experiences, and problems of stakeholders throughout the country but made it difficult to carry out statistical and empirical corroboration.

- Because of the explicit link to the preparation of a White Paper, the Vietnamese government asked the international team to be far more prescriptive than it normally would be.

- The international team also provided some training, with a view to the preparation of the White Paper and a long-term S&T strategy.

Over the 3-week period (14 September to 4 October 1997), the international team conducted meetings and discussions throughout Viet Nam with some 70 Vietnamese institutions, organizations, and firms and about 325 individuals. In almost all of these, members of the team were accompanied by representatives of National Institute for Science and Technology Policy and Strategy Studies (NISTPASS), an arrangement that permitted the team to have ongoing dialogue, seek supplementary data sources, when these could be found, and take advantage of opportunities as they emerged, through scheduling follow-on discussions or meetings unanticipated in the original schedule.

The training contained three elements. The first of these was a week-long course, provided by Dr Jack Smith of the Canadian National Research Council in Ottawa, which presented a range of methodologies that had been used to prepare an S&T strategy in Canada 2 years earlier. The second element in the training was also a week-long course, provided by Professor Martin Fransman of the University of Edinburgh, Scotland, to outline the S&T strategies followed by Japan, South Korea, and Taiwan. These training components helped the Vietnamese team understand the approaches of other East Asian countries to achieving industrialization.

The third part of the training was to have members of the Vietnamese team accompany the international team as it carried out its interviews.

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Chapter 2

THE GLOBAL AND REGIONAL CONTEXT: ISSUES, TRENDS, AND FACTORS IN VIET NAM'S S&T STRATEGY

The Vietnamese government's stated aim is "to apply S&T as the driving force for Viet Nam's economic development" so that it becomes "a modernised and industrialised society by the year 2020" (MOSTE 1998, p. 1). The government further envisages that this will happen in two stages: the government intends initially to obtain, apply, and master imported technologies and subsequently generate new technologies nationally.

Is this realistic? Can it happen? What is the evidence from other countries? What circumstances and strategic factors in the world of today and tomorrow would the government have to take into account in trying to frame a national strategy to support this aim? What is the evidence of success and failure 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? In this chapter, we examine these questions briefly, with a view to establishing a number of considerations central to the S&T policy review and helping to provide a larger background to the S&T strategy discussions in Viet Nam, leading to the White Paper.

It bears stating at the outset that the achievement of a modernized, industrialized economy by 2020 (that is, in 20–25 years) would not be unrealistic. Industrial output has been the basis of the rapid economic expansion of many countries, and the time frame for industrial development has been greatly reduced over the past 30 years. Figure 1 shows the time it takes to double per capita output for selected countries.

This figure show that during the industrial revolution, it took the United Kingdom 58 years to double its per capita output. The United States took 47 years during the middle of the 19th century. During the early years of this century, Japan doubled its per capita output in 34 years. More recently, Brazil doubled its per capita output in 18 years; Korea, in 11 years; and China, in 10 years. The

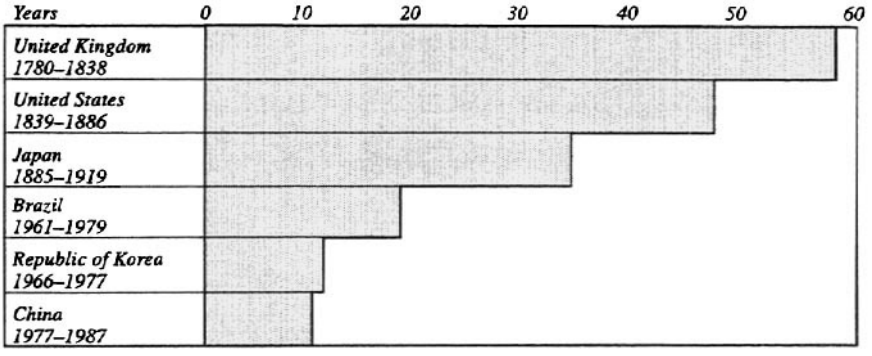

Figure 1. Time for per capita output to double.

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. What we may safely conclude, however, is that the time frames for industrialization have been shrinking impressively and that dramatic gains in industrial output have been made in recent years.

But what about the future? Can Viet Nam achieve the same rapid industrialization over the next 20 years that other countries achieved over the previous 20? Certainly Viet Nam confronts a global context different from that Korea, for example, confronted 30 years ago.

According to an old expression, "When we predict the future the devil laughs." The complexity of global trends today, coupled with the speed of change, should lead us to see a serious caution in this expression. We need to be aware of the forces and trends currently shaping our world and take these as fully as possible into account in policies for the future. But what exactly are these major forces and trends? And if they are so complex and changing so quickly, how can we hope to understand and deal with them? All societies confront these questions today, and much hubris and hypocrisy would attach to anyone pretending to provide answers. In this chapter, we cannot pretend to provide answers but only offer a selective and modest outline of the principal factors to consider.

Globalization

Viet Nam decided to join and be an active player in the global economic and trading community. A major step in this direction will occur in 2006, when Viet Nam becomes a full member of the Asian Free Trade Area (AFTA). At that point,

all tariffs on regional trade must be reduced to 5% or less. A second major step will be when Viet Nam achieves its announced objective of becoming a full member of the World Trade Organization (WTO). Clearly, then, Viet Nam is about to be exposed to the powerful forces and trends involved in globalization. Like the vast majority of nations today, Viet Nam will attempt to turn those forces to national advantage, and it will need to compete for this with other nations.

Of course, globalization generates much debate, but few serious observers doubt that it is creating a porous world in which long-assumed boundaries are fast decreasing in significance. *Globalization* means what it says: the denationalization of economic life. Among the strategic factors associated with globalization are the following:

- *Deregulation* — The core element of deregulation is the abolition of national controls over the cross-border movement of capital. This has been occurring on an accelerating pace throughout the world. It is moving us progressively toward the abolition of differences between countries and regions, differences that had been built up over the 200-year era of national capitalist economies. The process to global economic interdependence is well advanced.

- *Foreign direct investment* — Foreign direct investment (FDI) has expanded dramatically and consistently during the past 15 years, and the trend is expected to continue. FDI exerts pressure on regulatory regimes, almost universally weakened since the early 1980s. This has a good deal to do with tax aversion — international investors seek out low-tax jurisdictions. Falling corporate-tax revenues have also shifted the taxation burden to individuals, and this is forcing social-democratic political parties to abandon their commitments to welfare-state spending. FDI in developing countries exploded in the last 5 years, whereas public financing for development (overseas development assistance [ODA]) stagnated or even declined. In 1990, FDI and ODA were roughly equal, at about 60 billion United States dollars (USD). According to World Bank calculations, for 1996, FDI had increased to more than 320 billion USD, whereas ODA was declining toward 50 billion USD. However, FDI remains highly concentrated in a very few countries.

- *Trade liberalization* — Trade liberalization is particularly evident in the reduction and elimination of tariffs, which has become the dominant issue in international relations. Tariff rates throughout the world have

been falling rapidly and are now assessed at an average 5%. This decline is expected to continue, with the recently established WTO assuming a role of heightened importance in determining tariff rates.

- *Tightly integrated financial markets* — Financial markets, especially the major ones, have become tightly integrated, and this trend will continue. Financial markets have the most sensitive and comprehensive influence on national policies. Their influence is continuous, not episodic. Investors regard each country according to a total package of factors that investors monitor closely, employing either brokerage houses like Goldman Sachs or credit-rating agencies like Moodies. Any change in the package, from macroeconomic policy to labour legislation or expenditure plans, can create a reaction in the market. A political-risk factor is built in explicitly. The penalty for changes not welcomed by the market is a higher cost for capital. This exacts a tax on all citizens and reduces growth and the revenue base. As an obvious result, macroeconomic policies (monetary, fiscal, and expenditure plans) are increasingly becoming homogenized and the possibilities for experimentation become almost nonexistent. This is particularly important because opportunities for macroeconomic experimentation in support of industrialization and export-led growth, available to South Korea, Singapore, and Taiwan in 1960–90, may no longer be available to countries like Viet Nam.

- *Shifting fault lines between rich and poor* — Globalization is producing new gains and losses, new winners and losers. The dividing line once assumed to stand between the affluent industrial North and the poorer South is fading. Streeten (1998) offers the rough balance sheet shown in Table 1.

- *Skewed income distribution* — In almost all parts of the world, income distribution is becoming more skewed, with larger percentages of wealth concentrated in the privileged 10% of populations and declining percentages of wealth falling to the poorer 20%. Viet Nam has placed a high value on equity as a fundamental socialist principle. Globalization will doubtless challenge the extent to which that value can be preserved and protected.

Table 1. Globization.

Good for	Bad for
Europe, Japan, and North America	Many developing countries
East Asia and Southeast Asia	Most of Africa
Output	Employment
People with assets	People without assets
Profits	Wages
People with high skills	People with few skills
Educated people	Uneducated people
Professional, managerial, and technical people	Workers
Flexible adjusters	Rigid adjusters
Creditors	Debtors
People independent of public services	People dependent on public services
Large firms	Small firms
Men	Women, children
Strong people	Weak people
Risk takers	Human security
Global markets	Local communities
Sellers of technologically sophisticated products	Sellers of primary and standard manufactured products

Source: Streeten (1998).

- *A powerful new transnational stratum of society* — A new stratum of society is forming and is increasingly predominant in state-policy formation everywhere. This stratum includes investors, rent seekers, and high-income employees, and their interests derive from individualism decreasingly rooted in the collective social well-being of the individual nation-state. Real transference of power is involved in this. The control of national governments over economic matters is becoming narrowly constrained. The global economy can no longer be managed effectively by a single superpower (for example, as was done by the United Kingdom under *Pax Britannica* until World War I) or by a combination of superpowers (for example, the United States and the Soviet Union following World War II).

- *Supranational management of the global economy* — The global economy must now be managed supranationally, but the existing international institutions, established over decades to deal with growing

global interdependence, are found wanting. Summits of world leaders have failed to produce effective plans to tackle global recession and, most particularly, the return of mass unemployment. Financial and economic stability is proving to be far beyond the reach of the Bretton Woods Institutions, and the United Nations has been unable to deal with political instability in such places as Somalia and Bosnia. International attempts to muster cooperation to respond to environmental deterioration have achieved relatively little. Whereas international cooperation is ever more vital, it seems increasingly difficult to achieve.

- *Locational advantage* — A key factor of globalization is the extent that corporations are free to produce where they wish and that governments anticipate this by adjusting state policies to retain or attract their facilities. Here the evidence is very clear: companies increasingly have global strategies and states increasingly adapt their taxation systems, labour laws, health and safety regulations, environmental laws, etc., to accommodate these corporations' interests. Some argue that low-wage countries currently contribute only 16% of the world's manufactured exports and that therefore low-wage exports do not threaten wages or employment in richer countries. But no such conclusion can be drawn: a good deal of the phenomena of flexible labour markets (for example, casualization, deunionization, wage cuts, downsizing, outsourcing, and shifts to casual and part-time employment) are preemptive responses to the threat of low-wage exports brought by globalization.

Whatever the varying viewpoints on, and interpretations of, globalization, sufficient evidence of important structural changes now clearly shows that we are entering a qualitatively new phase in the international system and that the future cannot be clearly predicted. This greatly increases the uncertainties for an S&T policy or strategy and the risks of policy failure. Viet Nam's decision to join with the forces of globalization will necessarily narrow the government's range of policy choices and presents policymakers with the very serious and delicate task of predicting the impact of the global economy on various kinds of national social formation.

Technological revolution

Behind the forces of globalization is a technological revolution that is fundamentally and radically altering all aspects of business, industry, and manufacturing. At its core are the new information technologies (ITs). These new technologies, based

on a constellation of industries growing rapidly in all the leading industrial countries (for example, computers, electronic components, and telecommunications), have already brought vast improvements in technical performance, as well as a dramatic fall and counterinflationary trend in prices. Their revolutionary effects, however, lie in their influencing, although very unevenly, all other sectors and their changing the very nature of industry, economy, and society. Some time ago, a special supplement to *The Economist* (30 May 1987, entitled "Factory of the Future," succinctly outlined this revolution in industry:

> 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 reorganization 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 this trend must be expected to continue.

Under the title "Change of Techno-Economic Paradigm," Freeman (1992) provided a helpful list of some of the major aspects of the transformation occurring, which is shown in Table 2.

Two among the many implications of these dramatic shifts for a national S&T policy may be mentioned:

- These changes will most likely require flexible approaches and a relatively open framework. Many countries have made industrial planning with specific targeting their preferred S&T policy approach, but it would appear to be more appropriate and more likely to produce success under the old paradigm than under the new. A good rule in S&T policy decision-making today is probably to consider the structure of the whole process in relation to a project's goal and to consider in particular the integration of decisions on investment, production, and marketing with those on R&D. This would entail the constant development of technical and economic forecasts and the need to relate these to science policy and R&D decision-making.

Table 2. Change of technoeconomic paradigm.

Fordist (old)	ITs (new)
Energy intensive	Information intensive
Standardized	Customized
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
Centralization	Distributed intelligence
Specialized skills	Multiskilling
Government ownership, control, and planning	Government information coordination and regulation; vision

Source: Freeman (1992).
Note: IT, information technology.

- In Singapore, South Korea, and Taiwan, governments were the critical actors and played a very central and directive role in bringing about development through industrialization. Based on the success of these experiences, many people advocate similar approaches for other countries. The new paradigm suggests, however, that guidance and direction may now be more appropriately and effectively exercised through a gentler touch, based, as Freeman (1992) suggested, on mastery of an inspired vision of an industrial society and its communication. Interestingly, one of the main authors of previous success, Lee Kwan Yew, the former Prime Minister of Singapore, recently suggested that progress now depends increasingly on democratization, as the complexity of modern technology and of organization around it requires a participative approach (*The Economist*, 9 June 1991).

Creating comparative advantage: some lessons and trends from the Southeast Asian experience

According to development theory in the 1960s, technology transfer is the key to economic and social development. The first major United Nations Conference on Science and Technology for Development was held in 1963. The consensus was that the world market is like a "supermarket," filled with technology "available for the taking." The advice given to developing countries was to take advantage of

this and to shop wisely. In retrospect, this appears 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 the following:

- Far from being obtainable for the exclusive use of a developing country, most technology was only available under restricted conditions (for example, technological know-how remained with its original owner and was not included in the transfer; the goods produced could not be exported legally to other markets).

- Productivity gains from technologies introduced in developing countries were initially equal to those experienced in industrial countries but subsequently diverged considerably, with gains continuing only in industrial countries. This was essentially due to the fact that continuous innovations and incremental small gains from the same technology occurred in industrial countries, not in developing countries.

Circumstances have, of course, changed since the 1960s, but lessons can be learned from previous experience. Proprietorship over technology is, if anything, stronger today than it was three decades ago. S&T policy needs to take this carefully into account and to find the appropriate policy instruments to ensure that technological packages promote national interests. Second, the foundations of a continuous process of innovation are of critical importance — more so today than in the past — and must be made integral to S&T policy.

Experience and research during the 1960–80 period also showed that in attempting to establish new export-oriented industries and new areas of R&D work, a developing country usually began with less of an advantage than industrial countries and leading firms. This gave rise to infant-industry policies, with a range of measures (mainly nontariff arrangements) to protect industries in their early years to give them a chance to become established and competitive. Although the approaches varied, infant-industry practices were key components of the strategies of Brazil, Singapore, South Korea, and Taiwan.

Infant-industry approaches are continuing today, but the much more integrated global economy means these instruments must be more subtle and flexible. Indonesia, for example, has emerged as an internationally competitive exporter of manufactured goods only in the past 10 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 country's banking and financial system, customs arrangements, tax laws, protection

against imports, import monopolies, licencing of investments and production, sea communications, and state-owned enterprises (SOEs).

More generally, the experiences of Japan, Singapore, South Korea, and Taiwan suggest that trade and financial liberalization should be carefully coordinated with technological and industrial change. Most neoclassical analysts do not hold this view but urge quick and wholesale liberalization. They argue that countries should carry out comprehensive import liberalization before making efforts to increase export earnings. This, they claim, is required to eliminate inefficiencies generated by protective barriers and enable a subsequently stronger response to export demand (see, for example, Kreuger 1978). But the East Asian experience supports far more the prescription for more gradual change, with sequencing gauged to the competitiveness of domestic industry, itself promoted by preceding and simultaneous industrial policies (see Helleiner 1988; Krugman 1989; Wade 1990). This lends further support to the importance of imbedding S&T policies in economic and social policies and vice versa.

An important factor is evident from the recent cases of successful transformation through manufacturing exports: international access to innovations and know-how. This does not diminish the role that national R&D may play; however, as is evident from the experiences of Indonesia, Singapore, South Korea, and Taiwan, international connectivity is imperative. The case of Singapore is perhaps most explicit in this regard, because its process was most systematic, both in establishing substantial FDI from foreign multinational corporations (MNCs) and in transferring technology and skills from abroad. Integral to this process was the effort to restrain the demands of workers and trade unions. Foreign labour (professionals, as well as skilled and unskilled manual workers) was also imported to help fill new jobs created by the export-oriented industrialization strategy. The government contended that

> an open door policy is one which at least ensures rapid growth right from the start. When foreign corporations bring their expertise, what we experience, as a developing nation, is a brain drain in reverse. Naturally we pay for this, we pay in the form of profits and know-how fees remitted abroad and high salaries to foreign management and technical personnel ... . (It would be wrong for us, however,) to resent the inflow of management personnel, engineers and technicians from abroad. On the contrary, we regard them as blazing the trail for the new industries which we do not have the knowledge and technology to set up ourselves.
>
> (Goh 1970, cited by Beng 1997)

If balanced combinations of infant-industry measures and openness to international R&D are imperative, indeed, critical, to early efforts to industrialize, one may also make an especially compelling case for applying infant-industry measures to establishing R&D capacities. This case was made by Freeman (1992), who concluded from his research that if a developing country is to graduate from importing technology to producing its own, "there is a strong case, in making R&D decisions, for deciding sometimes to invest in a project **even if the first cost comparison shows a higher cost** from own R&D to a policy of buying a license" (emphasis added).

But such decisions are also neither straightforward nor simple. As mentioned earlier, in the longer run, considerations such as the importance attached to reliance on imitation, licencing, and purchasing know-how versus one's own R&D and problem-solving capacities go beyond economics. These are also political and cultural decisions that depend on the kind of society one wishes to have. Again, to quote Freeman (1992),

> 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.

In the case of Viet Nam, this longer run decision appears to have been made.

From the experiences of Southeast Asian countries, it is also clear that the transition from the initial stage in their industrialization, with cheap labour and labour-intensive manufacturing, to skill-based competitiveness in manufacturing was a difficult and delicate process. Korea made the transition after years of rapid productivity growth but relatively stagnant wages. When it initially attempted the transition in the early 1980s, labour costs began to rise. Until 1988, productivity and the demand for labour continued to increase and the transition to a higher wage, skill-based economy appeared to be going smoothly. In 1989 and 1990, however, a wage explosion dramatically increased labour's share in the value added, and expansion in the number of employees came to a halt (Godfrey 1997).

Singapore in the late 1970s had severe labour shortages. At the same time, the government concluded that the wage-restraint policy of previous years had promoted the retention of labour-intensive economic activities, hindering the natural process of economic restructuring and making the economy more vulnerable to competition from other developing countries. Thus, during 1979–84, the government encouraged significant wage increases. The impact, however, weighed most heavily on firms engaged in labour-intensive activities, and the overall result

was that between 1982 and 1986 employment in Singapore's manufacturing sector actually fell while labour cost rose. This trend was not reversed until 1986, following the government's abandonment of the centralized high-wage policy (Beng 1997).

Indonesia's more recent emergence as an internationally competitive labour-intensive manufacture has involved increasing productivity combined with wage restraints, as had been the case in Singapore some 30 years earlier. In the case of Indonesia, it is not clear whether the transition can be made from cheap labour to skill-based competitiveness, and evidence thus far suggests that it will be both more difficult and more uncertain than it proved to be in previous cases (see, for example, Godfrey 1997).

One lesson here is that wage policy is integral to an S&T strategy, but another is that it is very difficult to manage, especially when "upscaling" to highly skill-intensive manufacturing.

Education and training: special prerequisites

Everywhere we turn today, we are told that "knowledge societies" are the key to future prosperity and that those who can obtain, generate, manage, apply, and adapt knowledge in all its forms (including very much, of course, S&T) will prosper, whereas those who cannot do so will fall further behind. A typical expression of this is found in Marshall and Tucker (1992):

> The future now belongs to societies that organise themselves for learning. What we know and can do holds the key to economic progress, just as command of natural resources once did. More than ever before, nations that want high incomes and full employment must develop policies that emphasise the acquisition of knowledge and skills by everyone, not just a select few. The prize will go to those countries that are organised to learn and to act on what they learn.

It all sounds so grand and so logical. When we pause to think about it, however, we quickly realize it is an oversimplification — and a dangerous one at that. The technological changes that the world is experiencing do mean that skills and knowledge are becoming of ever-greater importance. Without doubt, this should be acknowledged and acted on. But the comparative advantage of a country or a community or an individual depends on multiple factors, and the availability of natural resources remains central. Much of the recent economic success of South American countries in gaining market access to the global economy has depended on South America's comparative advantage in natural resources. New exports of cut flowers, fruit, vegetables, spices, exotic agricultural products, and

wines, along with agroindustry linkages and value-added packaging for these exports, are at the heart of economic prosperity in much of Latin America. The recent industrialization successes of Indonesia, Malaysia, and Thailand have depened heavily on combinations of economic and S&T policies that have increased domestic savings via productivity and efficiency gains in the traditional sectors and the surplus generated by giving priority to investments in agricultural S&T.

Whether a country's comparative advantage is in manufactures or primary products depends on its relative endowments of skills and of land. An essential distinction here is that the production of manufactures requires a higher skill–land ratio than does the production of primary products. The skill–land ratio in Hong Kong, Japan, Korea, Singapore, or Taiwan is clearly much different from that in Chile, India, Laos, Tanzania, or Viet Nam. National policymakers would be most unwise to fail to take these obvious facts into account in developing their economic strategies and their S&T components.

The newly industrialized countries (NICs) of East Asia, which have led the field in export-led industrialization, are in relative terms land and natural-resource scarce. When they began their industrialization processes, they also each clearly started with large supplies of educated labour, including educated female labour. In 1965, Hong Kong, Korea, and Singapore had already achieved universal primary enrolment, well ahead of other developing countries (World Bank 1993). Between 20 and 40% of women completed primary school, compared with less than 5% in most other developing countries. By the mid-1980s, average years of schooling for women had reached 6.6 in Korea, 6.5 in Hong Kong, and 5.7 in Taiwan, not far short of the OECD average of 7.5 years (Barro and Lee 1993).

Much evidence shows that rises in educational enrolment are highly correlated with increasing output and exports of manufactures. In all the East Asian examples of rapid industrialization, educational levels have risen well above those that would be predicted from per capita income. According to the model used in the World Bank's (1993) *East Asian Miracle* study, a large part of growth in these countries can be explained by the extent of education: different parts of education are associated with growth in each country. Primary education is highly significant in all these economies; secondary education is most powerful in Japan but least powerful in Indonesia and Thailand, where secondary education has been lagging and skill shortages have been identified. For the economies studied, 60% or more of economic growth is "explained by the accumulation of physical and human capital, initial income levels and population growth" (World Bank 1993).

But what exactly have education and training to do with manufacturing? Considerable evidence at the firm level shows that the ability to adopt new technologies and the ability to make productivity advances are both attributable to

education and training. For example, Japan's successful introduction of robotics and microelectronics into industry was found to be related to educational improvements of the 1970s and 1980s, and studies in Taiwan show similar findings (see Aw and Tan 1987; Koike 1987).

Considerable evidence also shows that appropriate education and training can reduce overall costs. Most of this evidence comes from industrial countries. For example, studies in the United Kingdom (Prais 1990, cited in Freeman 1992) show the disadvantage of the British worker, who commonly has less education and training than his or her counterpart in competing countries. The British worker may be paid a lower wage, but more expenditure is required for management, supervision, and quality control; consequently, that worker is more expensive to employ. The cost may in fact be even higher, as the evidence shows that the technology is to some extent determined by available skills and that firms with lower skills are unable to adapt to new techniques and technologies.

Overall, there is no doubt that the right combinations of education and training are prerequisite to industrial performance and competitiveness. Workers' flexibility, resourcefulness, and problem-solving capacities are qualities of increasing importance in today's rapidly changing industrial market, and these qualities seem to depend to a considerable degree on such combinations. Indeed, it is important to consider the very large body of evidence about to the changing character of manufacturing production and trade. Fewer and fewer products are made first and then sold to whomever will buy them. According to one estimate, 60% of all production and sales in OECD countries is now done to meet client-specific orders (World Bank 1992). But this must be kept in perspective: many products are still not individually tailored to client specifications. As Cassan and Mavrotas (1997) noted, "some products are little affected by new technology: a can of peaches is still a can of peaches. If this were not so, there would be little opportunity for the less-advanced countries."

The key point, however, is that its the "right combinations" that pay the dividends (both on an individual and societal rate-of-return basis). It is also the case, as demonstrated in numerous studies, that there can be supply–demand distortions at all levels of education and training, negative rates of social return on investments in education, and brain drain. It is clear that education and training are needed for successful industrialization, but it is equally clear that education and training do not cause it.

Innovation

Until the 1960s, focus of S&T thinking was that the process was a continuum from scientific discovery to technological breakthrough and to economic gain.

Little attention was given to the cumulative role of relatively minor innovations, to innovation systems, or to the diffusion of innovation. That has changed. We have learned a great deal about the centrality of innovation to the production of wealth, and much S&T thinking today centres quite justifiably on the role of innovation. Extensive studies have taught us a great deal:

- The process of incremental innovation leads to very substantial productivity gains across a very broad range of industries. Such incremental innovation need not always involve a process of technical change; indeed, it could involve organizational innovation or skill improvements based on experience. These findings do not diminish the importance of productivity gains from advances in science, a brand new invention, a technological breakthrough, or a radical innovation, but they do underscore the fact that a process of continuous innovation is imperative to industrial success.

- Successful innovation is characterized by determined and systematic attempts to build linkages between user and producer (almost always a microlevel or firm-level activity), on the one hand, and with external sources of S&T information and advice (usually involving multiple actors, including government) on the other. Successful innovators typically do their own R&D, but they also make extensive use of other sources of technology. Failures to innovate very often result from a lack of communication with external technology networks, whether national or international.

- The size of the firm does not determine its success or failure at innovation. What does matter, however, is the size of its R&D project. Innovations that fail tend to have involved fewer resources than those that succeed, and this again underscores the importance of resource pooling and connections with external networks.

- Studies of the innovation process all indicate the interrelatedness of the S&T system and the economic and social system in a country. The Science and Technology Policy Instruments project in the mid-1970s clearly demonstrated the importance of implicit S&T policies.

- More recently, the interrelatedness of investments in S&T and of other economic and social factors has led both researchers and policymakers

to develop the concept of systems of innovation. This concept can be applied at sectoral, regional, national, or international levels. The concept makes it possible to analyze the particular constellation of policies and strategies across many different domains that is most likely to lead to innovation and hence enhanced competitiveness.

- Given the inherent difficulties of national planning, it becomes essential that governments put measures in place to promote innovation. Several industrialized and developing countries have found the concept of a national system of innovation (NSI) useful in devising the most appropriate measures to stimulate innovation in their societies.

So important is innovation to a firm's or a nation's competitiveness that many countries have begun to include innovation policy as a integral part of their national policy-making.

In thinking about a long-term S&T strategy, Viet Nam may find it useful to carry out a "knowledge" assessment. Such an assessment can be used to determine whether a firm, institution, city, or country has the ability to create, acquire, assimilate, use, and diffuse knowledge and thus whether it is likely to prosper or even survive in the globalized world. Creating, acquiring, assimilating, using, and diffusing knowledge each requires unique skills, and not all organizations need to undertake each of these activities.

The centrality of these findings for economic success has also led many companies and governments today to invest heavily in both national and international knowledge and technology networks. These companies and countries are also trying to focus R&D resources, with a view to achieving the critical mass needed to produce results. These trends suggest strongly that an S&T strategy for Viet Nam should assign priority to these activities.

Rapid development through export-led industrialization: can it still happen?

The short answer to this question is probably yes, but it will be more difficult than in the past. Interpretations of industrialization successes in East Asia usually emphasize the importance of domestic factors, in particular establishing the right policies. Much of what has preceded has drawn attention to such domestic factors, but emphasis has also been placed on the new context of international factors and trends — and for good reason. East Asian success was in good measure due to international factors. These factors created opportunities for relatively low-cost industrial-production sites to be integrated into the world economy. In the 1960s,

several conditions combined to produce a special set of factors: relatively favourable access to industrial-country markets, greatly increased access to international finance, and increasing relocation of production by MNCs to lower wage countries. The countries able to seize these opportunities had generally already established an industrial base through previous policies of import-substitution, had invested heavily in basic education, and had had determined governments committed to the strong state management of the industrialization process. The successful transition to industrialized status in East Asia is partly due to geopolitical factors. The United States encouraged and supported the economic strength of Japan, Korea, and Taiwan because they were key to the West's defence perimeter. Hence, the East Asian success is partly due to favourable historical and international circumstances.

External factors have been of great importance in industrialization, and such factors today are vastly different from those in the 1960s, when Japan, Korea, and Taiwan made major inroads into Western markets and Singapore was able to launch itself along the same path. Today, Western markets are no longer in the same expansionary phase. Also, a dramatic fall has occurred in the demand for unskilled labour and raw materials per unit of industrial production. Tariff barriers may be falling, but quantitative restrictions (nontariff barriers) have increased, with special discrimination against developing countries. By the later 1980s, 18% of manufactured imports from OECD countries were covered by quantitative restrictions, in comparison with 31% of those from developing countries.

In addition to these trends, a sharp increase has occurred (as outlined previously) in the volatility of the international economy and therefore also an increase in uncertainty. Internationalization and deregulation of financial markets have resulted in unprecedented flows of short-term money of as much as 80–100 times those of trade flows. As Drucker (1986) observed, this has unhinged the relationships between exchange rates and trade, interest rates and investment, and fiscal and monetary policies. Long-term investment is depressed, but short-term flows thrive.

Recent events in Asia confirm this volatility. The currency and financial crisis in Indonesia, Malaysia, Philippines, and Thailand has greatly complicated the regional scene and added major uncertainties about the future. Conflicting interpretations, explanations, accusations, and counteraccusations abound. However, the downturn in the fortunes of these "recent tigers" has clearly established that if the potential benefits of financial integration and private capital are large, so are the risks. The experiences of the recent tigers suggest that the greatest benefits they obtained from financial integration were the spillover effects, such as new

technology and organizational and managerial systems. The speed and magnitude of market reaction are, however, integral characteristics of financial integration. The effects of the current crisis will be felt in the region for many years. This must be expected to make the regional integration of Viet Nam more difficult.

In addition, Japan, the region's most powerful economy, has moved into a period of very low growth, with a strong possibility of recession. And, finally, China's recent policy announcement that unprofitable SOEs will no longer receive financial support from the state likely means that tens of millions of low-cost skilled and semiskilled workers will soon be released into China's vast labour market. It must be expected that China will therefore compete directly with Viet Nam for investment, particularly for entry-level, labour-intensive manufacturing.

The implications of all this for countries wishing to follow in the steps of the East Asian "miracle" economies are numerous. First, integration will replace tariff barriers with nontariff barriers, which are directed especially at light manufactures, precisely the products that countries like Viet Nam are urged to make their principal export. Second, because of recent events, Viet Nam will confront much greater competition from the existing East Asian tigers, which, having lost a lot of ground in recent months, can now be expected simultaneously to push for expansion into the most advanced sectors and to use technology to remain competitive in light manufactures. Third, the massive low-cost labour pool about to be created in China will complicate Viet Nam's prospects for growth in export-led manufactures.

Also, ominous trends in technology will have potentially far-reaching effects on a nation's comparative advantage and competitive position. The increase in the capacity of machines to perform the work of relatively unskilled labour may result in a shift of production back to advanced OECD countries. Alternatively, it may allow developing countries to upscale more rapidly and at lower initial cost.

Because of these new opportunities and risks, we can reasonably conclude that the policies that created the economic miracles of East Asia will not work as well or as easily as they did in the past. The less favourable and more complex international conditions are likely sufficient by themselves to confirm this assessment. It would still be a serious mistake for policymakers to fail to carefully consider previous events in East Asia. However, almost certainly, no ready-made prescription is available to help Viet Nam become an industrial society within a little more than two decades. This is likely to mean that an appropriate set of S&T-policy instruments, tightly imbedded in, complemented by, and complementary to a broad range of other economic, industrial, and social instruments, will be more important and critical than before. Finally, a sound S&T-policy framework

must perforce contend with much greater complexity and uncertainty than in even the very recent past and must facilitate arrangements with sufficient flexibility and agility to respond to changing circumstances and assumptions. An S&T-policy review should be measured by the degree to which it builds a shared perception of the need for such arrangements and its contributions to setting a framework for an appropriate S&T-policy framework.

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PART II

The Review

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This part contains the main findings and impressions of the international team. It deals with the central issues pertinent to the topics we were asked to address and that formed the focus of the interviews. Not all aspects of S&T policy are covered. In particular, we met no representatives from the health sciences, and only one interview provided insights into environmental issues. These areas (and others) constitute important gaps in our research.

For each issue we addressed we have attempted to put what we heard and saw about Viet Nam into a broader context. Where appropriate we have also made suggestions for Viet Nam on how to rectify perceived weaknesses. For easier reading, we present these suggestions in a boxed format.

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Chapter 3

POLICY REFORMS AND INSTITUTIONAL INERTIA

After several decades (and even centuries) of resistance and war against invaders, the Vietnamese people and particularly its national authorities, have a high degree of confidence in Viet Nam's ability to deal with external threats. Moreover, the Vietnamese have a willingness to question views and ideas and a nonconformist attitude toward received authority, which have led to a rather horizontal and non-hierarchical power structure that emphasizes achieving consensus.

The international mission met many people in Viet Nam who strongly advocated that major decisions should be made consensually and that a slow but steady approach should be followed to reform. In the words of one senior policy-maker, "Look at the situation in Thailand. It is the result of trying to move too quickly. The lesson for us is to take things on a step by step basis." Thus, one clear tendency is to approach S&T strategy with a view to making it a graduated instrument for industrialization and modernization, to wait out turmoil, to act primarily on the basis of patient, consensus-building processes with a view to harmonizing all views and accommodating the legitimate concerns of anyone affected negatively by the reform process.

Many other people believed strongly that Viet Nam had arrived at a crossroads and that any continuation of a step-by-step approach to reform would place the country at a serious, perhaps permanent, disadvantage. The people who held this view pointed to the rapidly changing economic, technological, regional, and global context, outlined in the previous section. This new context, they claimed, carries threats. These are not threats from a single, identifiable enemy, but diffuse threats deriving from a variety of sources (world trade, technological changes, diffusion of cultural patterns, financial markets). According to this viewpoint, Viet Nam is in danger of seriously underestimating the magnitude of the challenge it faces.

The different and conflicting viewpoints we found made it clear that Viet Nam is experiencing serious political and economic difficulties in the transition from a centrally planned economy based on command-and-control mechanisms to a market economy based on incentives, risk-taking and a role for

government based on general guidance and encouragement. Several metaphors may be appropriate to describe the present situation:

- The Vietnamese government appears to be in the middle of the river: there is no going back, but people seem to be reluctant and resistant to moving forward with further and deeper reforms; and

- The Vietnamese government appears to be in the driver's seat, pressing at same time on the accelerator (market-reform policies) and on the brakes (persistence of central-planning habits and institutions).

This, then, is the major paradox confronting Viet Nam and its government. On the one hand, a widespread sense of urgency is felt, arising principally from Viet Nam's decision to become a full member of the regional and international communities, first through its membership in AFTA, which is only 8 years away, and second through its planned membership in WTO. On the other side is a propensity to make change slowly, to proceed step by step. This paradox is central to the many key economic, legal, technological, and scientific reforms being considered in Viet Nam, which make it difficult to correctly assess whether a decision can wait until a consensus has been reached or requires firm leadership and speedy action, regardless of whether a consensus is reached. For the technicians, specialists, and officials responsible for preparing a national S&T policy as the driving force for Vietnamese economic development, the paradox creates great confusion about central assumptions and appropriate measures to take.

Viet Nam did not experience an outright institutional collapse and the implosion of central planning structures, as in the former Soviet Union. This allowed Viet Nam's economy to respond more quickly to the policy changes introduced in the late 1980s and early 1990s, such as the abolition of price controls, privatization of agriculture, exchange-rate reforms, and the consolidation of many SOEs.

However, the persistence of the institutional arrangements linked to central planning and the continued predominance of SOEs in industry also allowed the people with vested interests in these institutions to resist further change. The result is the present coexistence of promarket policy statements and the persistence of centrally planned institutional arrangements. The overall direction of the reform process is clear and has been agreed on in principle at the highest political levels, but this coexistence has created a framework of policy inconsistencies, poor implementation and frequent policy changes that carry a high opportunity cost.

Although, as a direct result of government policy, the Vietnamese economy is much more open and subject to competition than only a few years ago,

competition is enhanced through the unofficial economy, which includes a wide array of consumer goods that are smuggled into the country. In large measure, however, the Vietnamese economy remains in the hands of the state and is highly protected. The view of many (which is shared by the members of the international mission) is that Viet Nam is unprepared for the competitive forces about to be unleashed on it, that the risk is high and growing, that the gains of the past decade will quickly be eroded, and that Viet Nam requires urgent, rapid, and comprehensive changes in policy and practice.

With specific reference to S&T policies, the central observation to emerge from this review is that Viet Nam has not sufficiently adjusted its systems of S&T and education to respond to its new economic and social circumstances or to meet the competition that integration into and beyond the East Asian trading market will impose. Competition within and between East Asian nations for technological advantage must be expected to increase very significantly over the next few years. Viet Nam's current policies are based on the perception that S&T can be managed on the basis of a series of relatively modest, incremental adjustments, and that this approach will optimize benefits to the nation. This approach may have served reasonably well in the past, but if it is continued by Viet Nam's new government, it will fail to serve both the modernization aspirations of the Vietnamese people and the government's stated purposes. Continued modest incrementalism will place Viet Nam in danger of serious and permanent disadvantage.

Second-generation institutional reforms (trade liberalization, equitization of SOEs, and financial-sector, labour-market, and tax reforms) are proving to be much more difficult than those in the first wave. These second-generation reforms will require a high degree of political will and determination on the part of the central government.

The possibility of designing and implementing effective S&T policies will depends on whether second-generation reforms materialize in the near future. Viet Nam will have technological innovation and a demand-driven framework for S&T activities only if competitive pressures increase and risk-taking is rewarded. There is an impression that the new government, which came into power in October 1997, is determined to quicken the pace of reform. If this proves to be the case, policy consistency is likely to increase and the design and implementation of S&T policies may face rather favourable circumstances.

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Chapter 4
EXPLICIT AND IMPLICIT S&T POLICIES

Since the 1970s S&T policy analysts have drawn a distinction between policies explicitly directed to S&T instruments (for example, patents, intellectual property rights, and decisions about scientific endeavours to support or the specific targeting of technologies, such as microelectronics or new materials) and instruments not specifically directed to S&T but influential in its performance, success, and failure (for example, economic and financial policies, labour codes, environmental standards). Throughout its mission, the international team was able to garner a very consistent picture of the current framework of explicit S&T policies and the relationship between these and a broad range of implicit policies. Briefly, that consistent picture may be summarized under three points:

- The basic direction of Viet Nam's S&T policy framework is evolving toward the removal of rigid controls, and this is viewed positively by almost everyone with whom we spoke.

- There are, however, too many explicit policies, and the tendency is to create yet more, with the result that generally sound policies are becoming part of the problem, rather than part of the solution. These are serving to create a bureaucratic nightmare of inconsistent signals from government and conflicting decisions from different ministries, such as Ministry of Planning and Investment, Ministry of Industry, and Ministry of Science, Technology and Environment (MOSTE).

- A broad range of implicit policies (and procedures to implement them) conflict directly and seriously with explicit S&T policies.

Some policies are viewed as explicitly supportive of S&T. For example, beginning in 1987, a government decision removed the state monopoly on S&T. This was followed by decrees on foreign-technology transfer (1988); on organizational and individual rights to enter into contracts or to cooperate in S&T activities

(1992); and on external grants in support of S&T (1994). A Civil Law promulgated in 1995 included protection of copyright, industrial property rights, and a legal framework governing technology transfer; a foreign-investment law governing S&T activities in economic projects was also passed. And a Law on Science and Technology, now being prepared, is in its 12th draft (MOSTE 1997).

In addition to these measures, a large number of regulations, including many of an implicit S&T nature, have been promulgated. These relate to the contracting and procurement of technologies; to domestic and nondomestic financial requirements; to ownership; and to specific technological requirements of a sectoral nature. All of these imply an enormous shift from the situation of only a decade ago, when all S&T activity was under the exclusive jurisdiction of the state. By all accounts, however, the process has not been smooth, and we were advised that as a result, some 4 500 separate regulations now pertain in one form or another to investment and technology access, transfer, and application. Many people attempting to work nationally in the new market economy, to build international linkages, and to mobilize S&T to that end expressed the view that the number and extent of regulations have become one of the principal barriers to Viet Nam's industrialization. "These regulations," we were told, "make it impossible to compete. They result in confusion, conflict, and corruption."

Among the specific issues of policy and policy coherence consistently raised were the following:

- *Savings and investment* — Economic and financial policies and the Vietnamese financial system in general may result in a relatively low domestic-savings rate, compared both with other countries in Southeast Asia and with the levels of investment required to support high rates of economic growth in Viet Nam. Academics, researchers, government leaders, and Vietnamese businesspeople emphasized that without much higher levels of domestic savings, the process of technological renewal in the productive system will depend on FDI, joint ventures, loans from international financial institutions and banks, ODA, and informal sources of capital. Although Viet Nam has succeeded, particularly in the early 1990s, in the mobilizing of foreign financing, this has been declining over the past 2 years.

- *Overdependency on external capital* — Beyond the question of the availability of external capital to obtain new technologies, concern was expressed at many levels over the implications of overdependency on such capital, particularly in light of the recent financial turmoil in

Malaysia and Thailand. A view expressed by one Vietnamese businessperson, but reflected in the comments of many, was that unless Viet Nam's financial system is transformed and domestic savings increase greatly, "we will continue to have little choice over where to obtain new technology and to receive outdated equipment and machinery." If the intention of the Government of Viet Nam is to follow such counsel, then policies and practices to increase domestic savings are called for. In this connection, the international team is of the view that the right combination of S&T policies applied to Viet Nam's traditional sectors can generate significant increases in domestic savings. More is said on this in Chapter 5, and useful data are given in Appendix 2.

- *Tax constraints* — The explicit S&T policies of Viet Nam are designed to encourage and support the acquisition of new technologies, but tax laws and the tax-collection system impose constraints on the acquisition of technology, particularly for private enterprises. The manager of a private firm reported receiving frequent visits by district, city, and national tax authorities and indicated his firm was not allowed to deduct the full cost of R&D from its taxes. Practically all the firms we visited, including SOEs, indicated that they had to pay taxes on the import of capital goods and equipment, which, added to the lack of credit, severely limited their capacities to renew their production lines, and several people indicated that their firms faced problems with export taxes and duties on intermediate goods for export products. The announced intention of the new government, to introduce a value-added tax to replace the current turnover tax, was welcomed by all the businesspeople we spoke with. The current turnover tax is universally thought to discourage domestic production, as it makes domestic products more expensive than imported ones and discourages technological innovation. The need for tax incentives to promote R&D and to favour investments in technology-intensive capital goods was frequently mentioned by managers in all types of industrial firms.

- *Credit* — The announced intent of Viet Nam's current S&T policy is to support "domestic R&D capabilities and to apply these to Viet Nam's capacity for production of machinery and equipment" (see, for example, GOVN 1992). The international team met with people at several research institutes where R&D efforts have resulted in the capacity to produce capital goods, but the lack of credit policies and

venture-capital arrangements appears to undermine these efforts. Although access to loans can be improved slightly through the creation of spin-off enterprises, this appears not to have been an effective solution, owing to the lack of credit and medium-term financing. This is one of the problems that will severely limit the possible transformation of national, city, provincial, and industrial research institutes into engineering firms producing and selling capital goods for industry and providing technical and training services. Government officials, research-institute authorities, and businesspeople mentioned on several occasions the need for venture capital at favourable interest rates, with medium- and long-term repayment periods, and for a financial institution with a good knowledge of the problems of pilot-plant financing, technology up-scaling and development, and experimental production.

- *Import substitution* — Several senior government officials drew attention to a complex and delicate S&T-policy problem emerging out of the relations between the trade regime and the acquisition of technology capabilities. Conscious or de facto import-substitution policies, like the ones in place at present in Viet Nam, may provide some breathing space for firms engaged in the production of equipment, machinery, consumer durable goods, and consumption goods. However, unless properly handled — especially in the short lead up to Vietnamese integration into AFTA — with systematic reduction of tariffs, conditioned on export performance, transparency, and reliance on nondiscretionary policy instruments, in a few years many of the existing policies will generate severe domestic problems. We should also note the perception conveyed to us that informal trade may be limiting the impact of protectionism in some industrial sectors, such as garments (in which local firms are being forced to move upscale), consumer electronics (witness the large unsold inventories of local firms), and some small capital goods (for example, small diesel engines). To an extent, this is true, but in our view it is no substitute for a trade regime consistent with industrial development and technological-transformation objectives. Moreover, as mentioned previously, the changes in foreign-trade regimes that Viet Nam has agreed to as a requirement for its membership in AFTA, will radically limit the range of policy measures it can use to protect its domestic industries.

- *Import procedures* — A frequently raised issue (related to the above) is the rather cumbersome import procedures for capital goods, technology services, and spare parts, which are limiting timely access to foreign sources of the technology needed for some sectors of industry to function smoothly. This, we were advised, is affecting equally SOEs, joint ventures, wholly owned subsidiaries, and local private firms. Their representatives expressed their frustration and referred to the high opportunity cost resulting from time spent in transactions with customs officers, even without considering the costs of corruption. All of these issues will come to a head when tariff barriers are drastically reduced by 2006, when Viet Nam joins AFTA.

- *Frequency of policy changes and lack of instruments* — In most of the meetings with policymakers, researchers, businesspeople, professors, and government authorities at all levels, the issue of the frequency of policy changes and the lack of instruments to implement policies was a recurrent theme. This situation generates scepticism and concern. Frequently, we also heard that "we have good policies but they are not put into practice." Statements such as these betray a confusion between declarations of good intention (party statements, ministerial speeches) and effective policy-making, which must include the means of putting good intentions into practice.

To summarize, then, we can say these are some of the problems of S&T policy and policy coherence raised by people we interviewed. Regularly, the international team was told that the state had, on the one hand, turned over large parts of the economy to the interplay of market forces but had, on the other, maintained a monopoly over an array of crucial economic decisions. This was leaving many people in a state of uncertainty about the future and, more importantly, about the risks and the returns from engaging in market-directed entrepreneurship. The most frequently cited factor, one of widespread consensus, is the country's financial sector, which is proving incapable of supporting those very individuals and firms that the government encourages to take advantage of S&T and market opportunities. The responsibility for this is laid by most at the doorstep of government, because of the lack of direction on financial reform.

This underscores the fact that probably the most important question the Vietnamese leadership faces at present is how to translate political will and general policy statements into specific measures and concrete, workable action plans.

This will require much greater clarity and coherence between different policy instruments and, most importantly, in the application of these policy instruments (see box 1).

Box 1

Suggestion

A possible fast track for improving coherence in S&T policy

The Government of Viet Nam recently established the new position of Vice Prime Minister responsible for Science, Technology, Education and Training, Health and Social Affairs, Culture and Environment. This elevates the importance of S&T as a central instrument of national policy and affords an opportunity to bring a broad range of policies into greater harmony.

To take advantage of this opportunity and to bring about needed changes and results in the short term, an initiative similar to ones undertaken previously by Lee Kwan Yew might be of value. The Vice Prime Minister might form a Special Task Force, of no more than 24 members, with one-half from within Viet Nam, some of the country's principal stakeholders in the use of S&T for modernization and industrialization (that is, the most senior individuals in Viet Nam's business and industry community and the heads of a few of Viet Nam's leading R&D institutions). The remaining one-half would be mainly the chief representatives of foreign MNCs that have made significant investments in Viet Nam, along with very senior representatives of financial and development agencies, such as the World Bank and the Asian Development Bank.

The Special Task Force would be needed for no more than 3 months and its mandate would be to recommend to the Vice Prime Minister a package of specific measures, policies, and actions to be implemented without delay to reduce the contradictions in current S&T policies (explicit and implicit) and eliminate certain immediate barriers to effective technological transformations (for example, aspects of licencing policies, customs policies and practices, and certain aspects of taxation).

Chapter 5
THE S&T SYSTEMS OF VIET NAM

Overview of Viet Nam's S&T

In Viet Nam, an estimated 30 000 people are involved in various forms of R&D, including librarians, technicians, and other support staff; more than 22 000 of these people are employed in the national centres for R&D and by ministries and government agencies (all these figures are total numbers of staff, not full-time equivalents.) 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.

The general institutional setup in Viet Nam for 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* — About 180 such R&D units exist, 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 in industrial business enterprises. In Viet Nam, however, industrial firms rarely build their own facilities for experimental development. In the planned economy of Viet Nam of yesterday, the principle was that government took the responsibility for technical change and industrial modernization, and industry manufactured. Among the exceptions to this rule is the state-owned Vietnam Petroleum Company, which runs four of its own laboratories.

- *Some university and other higher-education departments that perform research as part of their normal activities* — Only a limited number of faculties and academic departments at Viet Nam's universities and colleges truly have the personnel, equipment, libraries, and other resources needed to undertake serious R&D. Among these, the two campuses of the national university and the two largest polytechnic universities are

the most research intensive. Only very slowly, step by step, is a research-based university system in Viet Nam starting to emerge.

- *The national institutions for research that 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 (that is, the Office of the Prime Minister). The most significant of these national institutions is the National Centre for Natural Science and Technology (NCNST), with northern and southern branches and facilities in some other parts of the country. Originally modeled after an academy of sciences, it was restructured in 1993 to become more like a centre for applied research and experimental development. It performs advanced basic research mainly in two areas: mathematics and theoretical physics. The National Centre for Social Sciences and Humanities has the same basic structure, but only half the number of people on staff.

These three main components of Viet Nam's national R&D structure are expected to have close links with each other. The functional differentiation allocates applied research and experimental development to the laboratories of individual ministries, whereas the universities and colleges are the prime producers of highly specialized human resources for R&D, and the NCNST has the prime responsibility for the most advanced forms of research and for R&D if no specific ministry is a customer.

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. During our interviews, however, we noted 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.

This observation may seem especially surprising, given that most of the country's R&D is concentrated in Hanoi and Ho Chi Minh City (HCMC). This is all the more so as about one-third of all government R&D institutes and specialized laboratories are concentrated in one area of the capital city: the Nghia Do-Cau Giay-Tu Liem area of Hanoi has more than 75 of Viet Nam's 233 government-funded R&D institutes.

A fiscal crisis is affecting the country's R&D institutions. In nominal terms, not in those of purchasing-power parity, Viet Nam's overall R&D budget is estimated at between 50 million and 60 million USD. Because the general wage

level for R&D scientists and engineers remains low, and equipment is becoming as expensive in Viet Nam as in the rest of the world, it is difficult to calculate the real value of the overall budget for R&D.

Clearly, however, the economic conditions for Vietnamese R&D performance have deteriorated with the growth of the fiscal problems for the state. The lack of appropriate funding and the lack of relevant research equipment have forced the R&D institutions — regardless of their main objectives or responsibilities — to move increasingly into contract research, technical services, and consultancy arrangements with as wide a range of customers as possible. During our interviews and other fact-finding exercises, we were confronted almost universally with work conditions that promote secondary-job functions (that is, holding several jobs or positions simultaneously) among most categories of staff.

The NCNST, for example, now relies extensively on contract research and consultancy, without which it would probably cease to exist. As a result, the NCNST 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 NCNST is less than 8 million USD, and its total staff is more than 2 000. Yet, in comparison with other state-owned R&D facilities, the NCNST has significantly more funds available per researcher. At this time, scientists at the NCNST, regardless of the stage they are at in their careers, are encouraged to pursue advanced basic research outside of Viet Nam, not at the NCNST, and for this purpose they are encouraged to seek fellowships and grants from overseas.

In terms of S&T infrastructure for economic development, in a number of areas Viet Nam does not lack the expertise to enable effective mobilization of science and scientific results or particular technological know-how. At present, however, the national R&D system is organized, financed, and managed in ways that make the transfer of relevant information between sectors difficult and expensive.

An assessment of some of these difficulties follows. The essential point, however, is that the successful economic transformation Viet Nam seeks will require its forthcoming S&T strategy to address the deficiency in the technological infrastructure as a serious issue for the country's innovation policy.

Integration of the S&T and the economic systems

During the past few years, authoritative statements by senior government and party officials have underlined the priority assigned to mobilizing the country's S&T resources for socioeconomic ends. One illustration of this occurred in a 1994

speech by General Secretary Do Muoi at the Party's Central Committee Plenum. Do Muoi emphasized that the nation needed

> to see S&T become a means for development. We must first create a driving force for the improvement of science and technology. This driving force rests with the interests attained by researchers, inventors and those who effectively apply science and technology to various domains. ... It is necessary to say that all intellectual products should belong to their creators. They must be considered special goods and their prices should be set in accordance with their value ... . The science and technology sector must concentrate its research on quickly applying new findings to production and business in order to serve industrialization and modernization. It must meet the demands of new equipment in the national economy, improve existing technologies, modernize traditional technologies and correctly adapt new technologies. It must also help to manage and closely assess imported technologies and pay attention to the development of electronics, informatics, biology and new materials. Through practical renovation activities, it must get close to real life, quickly discover and improve upon the public's inventions, accelerate its studies and clarify issues relating to the strategy for industrialization and modernization.

Earlier in the history of modern Viet Nam, specific technological solutions have been proposed by the government, in accordance with the expertise and resources available, but the government avoided setting specific priorities within whole fields of technology. About 5 years ago, however, a clear ranking emerged in the form of four national-priority programs for high technology. Each is viewed by government as a new attempt to modernize the country's productive forces. High-level interministerial committees monitor and coordinate the national programs for IT, biotechnology, new materials, and automation.

The procedure followed to arrive at these four technology areas is unclear. However, Viet Nam has set the same general priorities for its technological renovation as its largest neighbours (indeed, also the same 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 ways to apply and adapt this technology in firms and institutions throughout the economy. Much less emphasis is placed, at least initially, on generating high technology within Viet Nam, although a degree of experimental development of technology is encouraged.

Our many discussions with both Vietnamese and multinational industry and with international organizations indicated strong support for this balance, although

it is certainly not reflected universally from within the basic-research community of Viet Nam. This approach and this emphasis are very similar to those that led to the successful experiences of Indonesia, Malaysia, and Singapore, and we believe, therefore, that the emphasis in Viet Nam should remain on technical and related services, rather than on scientific research. First and foremost, Vietnamese firms and institutions need to have better access to available modern technology from within the country and from other countries. Only very few companies in Viet Nam can afford the luxury of independently developing products and processes with a high technological content.

It is also important, however, is to establish powerful mechanisms to systematically monitor the technical changes taking place in other countries and obtain, adapt, and diffuse already available technology and related know-how. This imperative, to develop a systematic capacity to absorb and diffuse new technology, exceeds all others.

As policy initiatives, the four national high-tech programs have been widely publicized. It is, of course, far too early to judge the extent to which all four will achieve the ambitious results they aim for. They all have steering committees with experts from different government sectors, but they are all differently managed. The most comprehensive and advanced of the four national programs is that on IT.

The main weakness of the four national programs is structural. Only a few companies are 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 SOEs. However, R&D institutions and high-tech firms from overseas also have a limited involvement (see below). Because of the composition of those involved in the programs, effective diffusion of technology and related know-how is restricted mainly to the government sector. Yet, opportunities for subcontracting and other cross-border production networks will likely depend on how well Vietnamese firms and institutions accumulate and consolidate technology-related skills and experiences. If the programs are to become national, they will need to include a variety of other partners, such as business enterprises. Only in the broader economy are capabilities created to absorb new technology (see box 2).

One of the principal findings of this review, therefore, is that in Viet Nam the relations between the S&T research institutes and the productive sector, including both public and private enterprises, are rather limited and almost nonexistent in some sectors.

Box 2

Suggestion

Given the need for integration into the broader economy, it may prove most valuable to commission an independent and brief review of Viet Nam's four high-tech research programs, with a view to finding effective mechanisms to more broadly involve the industry and other firms.

Research institutions in Viet Nam tend to follow their own logic, mostly inherited from a Soviet (mission-oriented) approach to conducting research, in which the end user (the scientific community, educational institutions, a public agency) does not operate in the market and is identified in advance. Until very recently at least, researchers had little awareness of the need to orient research to the needs of the productive system. However, a few research institutes have been rather effective in obtaining contracts to provide technical services for government departments and SOEs, usually applying well-known technologies. When pressed, researchers, professors, and administrators indicated that they follow the orientations provided by the central government, primarily through preparing projects and submitting proposals for funding as part of the four national research programs: IT, biotechnology, new materials, and automation. The linkage to the productive sector is usually forced by budget constraints, which make it necessary to engage in contract research with government agencies and SOEs, although these contracts involve little actual research.

The Draft Law on Science and Technology

The Vietnamese government is fully aware of the situation described above and has been addressing it in a number of ways. Central among these is a proposed new Law on Science and Technology, prepared by MOSTE and currently in its 12th draft (MOSTE 1997).

The draft indicates in article 39 that

> The State shall consider investment for science and technology as an investment in development.
>
> 1. The State shall, annually allocate at least two (2.0) percentage points of total State budget expenditures to investments in scientific and technological development.

Article 40 of the draft states that

> the Vietnamese State shall encourage and facilitate enterprises, scientific and technological organisations, and individuals working in the field of S&T to obtain financial resources for a variety of sources and in different forms.

It further stipulates that contributions, donations, gifts, and grants from local and foreign sources for R&D will be exempted from taxes.

Article 43 of the draft proposes

> the establishment of a national fund for scientific and technological research, which will fund activities that are not included in the annual plan prepared by the government. This fund will provide grants and loans with no or low interest to research institutions, and will be managed by an Executive Board at the national level.

Provinces and cities are also allowed to establish similar funds.

Article 44 of the draft law allows the establishment of funds for S&T development by "local and foreign organisations and individuals," which in practice would operate like private foundations. They would be authorised to provide grants and no- or low-interest loans to research organisations and would be created on the basis of an initial capital contribution by the founding members and sustained by periodic voluntary contributions.

The proposal to increase investment in S&T to the level of 2% of total public expenditure, if accomplished, would represent more than a doubling of the current level, which stands at less that 1%. As such, it would provide a major indication of the serious commitment of government in making S&T the principal engine of Vietnamese economic transformation. Similar patterns of increased public investment in R&D were followed by Korea, Singapore, and Taiwan. Yet, even at 2% of public expenditure, Viet Nam will lag significantly behind some of its principal competitors, notably, again, Korea, Singapore, and Taiwan, where such expenditures are now in the range of 3% of gross domestic product (GDP) (that is, more than 5% of public expenditure). Korea has announced its intention to invest the equivalent of 6% of GDP in S&T, which would put it well ahead of all other countries.

The apparent determination of Viet Nam's government to lend greater support to S&T was welcomed enthusiastically by virtually everyone with whom we spoke. Also, everyone interpreted the appearance on the announcement of a 2% expenditure level in a proposed national law as an indication of firm resolve.

The international team did, however, see significant expressions of concern over other aspects of the draft law, in particular, the nature of law making and the

nature of the laws and regulations. It was noted, for example, that the draft law continues a trend in the S&T approach and framework that began in 1987 with the decision to remove the state monopoly on S&T. The promulgation of several laws and a proliferation of regulations (see Chapter 4) has entailed an enormous shift from the situation of only a decade ago, when all S&T activities were under the exclusive jurisdiction of the state. By all accounts, however, the process has not been smooth. Moreover, many view several existing policies as half-measures (for example, equitization) or as barriers (a bureaucratic licencing system).

Thus, with specific regard to the proposed law on S&T, many aspects of it would surely be applauded by Viet Nam's scientists and entrepreneurs. Yet, other aspects may serve to reinforce rigidities and a command-and-control approach to technological transformation, rather than creating the new flexibility that is required. The following are a couple of examples (also see box 3). Article 8 indicates that "the State shall control S&T operations by means of law." Article 12, under "Definition of terminology" used in this law, states that "science refers to the knowledge of the laws of nature, society, and **thought**" (our emphasis).

Financing of S&T

According to figures we assembled from both NISTPASS and the General Statistical Office of MOSTE, in 1996 Viet Nam had 233 research institutes and centres engaged in S&T activities and just less than 19 000 S&T personnel. The same statistics indicated that these institutes and their S&T personnel depended almost entirely on government financing for their activities. This situation is clearly set out in a recent MOSTE publication (1996, pp. 11–12):

> 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.

Box 3

Suggestion

A law on S&T should be simple, clear, concise, and enabling. It should remove ambiguities about, for example, intellectual property rights; facilitate ease of interpretation; and, above all, encourage investment and creativity. Viet Nam's draft law has many strengths, but it falls far short of these requirements.

In addition to the four national high-tech research programs, 18 other S&T programs of significant size and standing are funded through the state budget. Eleven of these S&T programs are oriented toward natural S&T and supervised by MOSTE. Seven are classified as programs for the social sciences and humanities and placed under the supervision of the Party.

In addition, 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 (the last year for which comprehensive statistics were available) 226 separate institutions received grants (from state budgets) in support of some 9 000 S&T activities conducted within those institutes. What this means is that the average amount made available to each institution was roughly 200 000 USD and that the average S&T activity received 5 000 USD, although 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. 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 Viet Nam National University of Hanoi (by most accounts the country's leading university), which was receiving for 1997 a research budget from the central government of only about 43 000 USD.

As a result of this, researchers perceive no well-defined and rational criteria for deciding what level of resources are assigned to institutions at different levels (national, city–province, enterprise) and to programs and projects within institutions. Decisions made at the central-government level about the allocation of funds are seen as arbitrary, nontransparent, cumbersome, rigid, and bureaucratic. The budget process is viewed as a source of interference with the proper conduct of research activities, as it does not consider the time horizons inherent to the research project, the minimum critical mass of resources required, and the priorities established by the research institutes. People at some institutions reported that they had practically no freedom to decide on the management of programs

and projects and were not allowed to reassign budget allocations in accordance with unforeseen circumstances.

This situation was summarized by one observer as follows: "The current system is not accountable. There is a solution and it is to use our scarce resources in a very concentrated way. We need a few big allocations over several years to a small number of national purposes." Thus, although everyone welcomed the government's indication of its commitment to devote 2% of its spending to support S&T, one general perception was that the allocation system must change fundamentally to account for the contribution such resources can make to society, the time horizons inherent in effective S&T, and the minimum necessary critical mass of resources.

Because of the large number of institutions and personnel and the very modest funding available from public sources, the government has launched a program of rationalization. Until recently, for example, research activity in some 60–70 generic categories qualified for public funding. That number was reduced essentially to two thematic categories: social development and economic–technical transformation. Under the first, priority is given to R&D that targets Aids prevention, the provision of clean water, and the elimination of poverty. Under the second category are IT, biotechnology, new materials, and automation.

The strategy underlying this process of rationalization has two key components:

- To assign specific research structures to a related corporate structure;[1] and

- To phase out a significant number of institutions through a gradual process of reductions in subsidies, equitization, and mergers or integrations into larger government structures.

These steps are clearly required. The rationalization program was an important first step for government. In addition to steps the government has already taken, however, it might use its launching of a new national S&T strategy as a timely occasion to quicken the pace of reform (see box 4).

[1] For example, telecommunications research falls under the National Telecommunications Industry, and oil-and-gas research falls 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. In the judgement of the international team, this approach is both logical and positive.

Box 4

Suggestion

Accelerating S&T reform to build Centres of Excellence

A new policy could be announced making clear that support for S&T institutions is to be consolidated into a limited number of large, multiyear grants, directed to establishing national Centres of Excellence. The government would need to specify criteria and then invite proposals to meet these criteria. 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 building their strong and integrated S&T institutions.

Basic research in Viet Nam

Basic research was one of the aspects of S&T the Mission was asked to pay special attention to. We have found that in Viet Nam, as in many other countries, a variety of views are expressed on the precise meaning of the term *basic research*. The draft Law on Science and Technology defines *basic research* as theoretical or experimental research that aims to discover new knowledge of the laws of nature, society, and thought (MOSTE 1997).

Some countries make further subdivisions, distinguishing curiosity-driven ("blue-sky") 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 its purpose is to satisfy curiosity. Strategic research, on the other hand, has the hope, even expectation, of achieving long-term economic or social benefit. *Long term* in this definition means usually in excess of 10 years. The mission takes the view that when the Vietnamese government refers to basic research, it means both curiosity-driven and strategic research.

The following subsections cover issues relevant to any discussion of the nature and role of basic research in Viet Nam. It would take much more investigation than was possible in the time available to the Mission to make any detailed analysis of the Vietnamese situation, but our impressions, based on what we saw and heard, are summarized in these subsections.

Location of basic research

In the period before the Doi Moi reform program, most basic research in Viet Nam 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 organization now carries out a mix of basic and applied research and provides technological services. At the same time, the universities are being encouraged to expand their research activities, and several

claimed to be doing basic research. We were unable to discover any recent statistics to give us any measure of current state expenditures on basic research or its distribution. It was clear, however, from many of our interviews that people expected the NRCS to become more demand driven and to increasingly have the obligation to generate its funding through contract research. Basic research and government grants for basic research will focus increasingly on the universities. This approach would be consistent with trends occurring in many other countries.

Priority setting for basic research

Setting research priorities in Viet Nam seemed to us to be a cumbersome and at times bizarre process. It was not enthusiastically welcomed by the scientists we interviewed, nor was it considered transparent, either to us or to Vietnamese scientists. It involves an iteration between the scientific institutes and ministries, but we encountered the general perception that the criteria used were unclear.

In many countries, the state facilitates the setting of strategic research priorities, but 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 period. These usually involve extensive interactions between scientists and representatives of 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 United Kingdom and other governments. South Africa has also begun a major foresight exercise. The appropriateness of this approach for Viet Nam would have to be explored, but it would seem to offer Viet Nam the possibility for a more open and transparent process of priority setting.

Research excellence and ageing scientists

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 made by other scientists worldwide. It also requires a real commitment to science and an opportunity to devote full attention to research issues. Most of these requirements are in short supply in Viet Nam. It is a tribute to those scientists who are still producing world-class science in Viet Nam that they are able to do so despite the limitations.

A particular feature of science in Viet Nam is its aging scientific community. Before 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, Viet Nam has a real shortage of well-trained young scientists, and apparently few new entrants into the profession. It seems to the Mission that this issue deserves consideration by the Vietnamese government. Our view is that it will need to concentrate resources on a few critical areas of science vital to the long-term well-being of Viet Nam. Within these areas, it will be essential to train the best scientists and engineers overseas. Without a cadre of world-class young Vietnamese scientists, it will be difficult to gain proper access to the world store of scientific knowledge and exploit this knowledge for the benefit of the country.

According to the national survey of S&T potential (MOSTE 1996, about 11.2% of the 22 313 persons working in 233 research institutes in Viet Nam in late 1995 had post-graduate degrees; 51.3% had a higher-education degree (BSc or BA); and 37.5% were technicians, workers, or auxiliary staff. The age structure of research staff with post-graduate degrees is highly skewed toward fairly old researchers, with about 60% of those with PhDs aged more than 45 years (Table 3). A proposal for a study on research and postgraduate education prepared by NISTPASS at MOSTE in May 1997 indicated that the average age of staff engaged in research at senior levels was between 55 and 60 (NISTPASS 1997a). The average age of professors and associate professors employed in research institutes (see Table 4) was 59.5 and 56.4, respectively, and the average age of directors of S&T research institutes was 55. Aggregate figures from the 1996 national survey of S&T potential (MOSTE 1996) 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 PhDs.

Table 3. Age structure of high-level staff in research institutes.

Age (years)	Total (%)	PhD (%)	PhD candidate (%)
<31	0.3	0.6	0.2
31–35	2.7	1.3	2.8
36–40	10.6	5.5	11.3
41–45	26.0	12.8	27.1
46–50	20.7	14.2	21.3
51–55	18.3	24.3	18.0
56–60	16.8	31.3	15.3
>60	4.6	10.0	4.0

Source: MOSTE 1996.

Table 4. Average age of professors and associate professors in selected research institutions.

Ministry or agency	All (years)	Professors (years)	Associate professors (years)
National Centre for Natural Science and Technology	53.8	55.1	53.3
National Centre for Social Sciences 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
Ministry of Education and Training	59.1	61.8	58.4
Total	57.2	59.5	56.4

Source: NISTPASS (1997b).
Note: MOSTE, Ministry of Science, Technology and Environment.

The issue of the aging population of Vietnamese scientists engaged in basic science may prove significant in the long term. This is a factor to be born in mind in preparing the forthcoming national S&T strategy. In the short and medium terms, however, Viet Nam's drive for modernization and industrialization will likely depend far more on the national availability of practitioners — people who can apply and adapt technologies — than on the availability of pure scientists able to conduct basic research. Two points should be stressed: first, to neglect the investments required to produce the next generation of scientists for Viet Nam would be unwise; but, second, this should be approached with balance and perspective (see box 5).

At a more general level, the scientific community of Viet Nam is very much concerned about its future and somewhat confused about the role it can play in the course of industrialization. Although in some disciplines Viet Nam's scientific capability is rated good and a few mathematicians and theoretical physicists enjoy an international reputation, very few scientists expressed optimism on the future of basic science in Viet Nam. Many Vietnamese scientists communicated their concerns over the loss of the prestige and rewards they enjoyed during the heyday of Soviet-style academic practice. They are realizing that science for the sake of science cannot be justified automatically in the coming years.

Box 5

Suggestion

Possible measures to address the problem of an aging scientific community

1. Launch, for the next 10 years, a selective postgraduate fellowship program 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.

2. Establish short-term programs, possibly with a summer-school format, to bring university professors up to date with new developments in selected fields of science and engineering.

3. Establish a significant program of small grants for young researchers returning after completing postgraduate studies abroad. This could be structured along the lines of the existing program of the Stockholm-based International Foundation for Science.

Because of this, some Vietnamese scientists, researchers, and academics have the perception that Doi Moi may be good for the country, but it is bad for basic research and for scientists. Before Doi Moi, scientists could get on with their research and live reasonably comfortably. Doi Moi has meant a lack of stability for the scientists, with frequent policy changes and a salary level totally inadequate for maintaining a family. As a result, many have had to take second jobs or leave science altogether. In the opinion of many Vietnamese scientists, the level of scientific excellence has fallen over the past 10 years.

We are not in a position to judge whether this decline in quality has in fact occurred. We can see evidence of some scientists seizing the opportunity to do good research but with an orientation to solve practical problems. In our opinion, this trend away from basic to more applied research should be carried even further. At the same time, areas of science judged (by foresight techniques) to be in the long-term interests of Viet Nam should be identified, and promising young scientists should be given the opportunity to study abroad in those fields.

In contrast to this rather bleak picture is a growing recognition throughout the world that the dominant civilization of the 21st century will require a strong foundation in basic science. Furthermore, the new century is expected to be an age of integration and synthesis of basic research with technology development; multidisciplinary synthesis is expected to be central to new technical breakthroughs. For this reason, many advanced and many NICs are renewing support for basic research. For example, Korea established an institute of advanced study last year. East Asian countries are collaborating in establishing the Asia–Pacific Centre for Theoretical Physics, which started operation also last year. More than 25 Science

Research Centres are now operating at Korean universities under long-term (9-year) large financial (1 million USD per year) support. Enhanced support for basic research, in conjunction with a reform of the educational system, is also happening in Japan and Taiwan.

The pattern of support for basic research is also changing in other NICs. No longer do we observe many examples of an approach based on the Soviet-style academic model. Competitive research proposals are solicited, and they are invariably peer reviewed, often internationally. Outputs of research projects are critically evaluated also through peer reviews. To carry out these objective peer reviews and funding processes, 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 cooperative grants for professors and universities. The Centres of Excellence awards are particularly popular and have often been cited as effective policy instruments for upgrading the potential for academic research (see box 6).

Box 6

Suggestion

A Viet Nam Science and Engineering Foundation

Viet Nam's current process of rationalization of government support for S&T might be enhanced if an appropriate mechanism is established to accelerate the process and sharpen the focus. To manifest more clearly a long-term commitment to S&T development and to overcome the present uneasiness in the Vietnamese scientific community, the Government of Viet Nam might wish to consider establishing an endowed foundation for science and engineering (the Viet Nam Science and Engineering Foundation [VISEF]). VISEF could be structured to ensure long-term support for basic research and human-resource development for Viet Nam and could, at the same time, serve to quicken the pace of reforms intended to support the revitalization of basic science in Viet Nam. International financial support might be feasible for such a foundation.

If a decision is made to establish the VISIF, consideration should be given to making international peer review integral to its operations. This would add greatly to the Foundation's prestige, help serve to invite financial support from outside Viet Nam, and build long-term international linkages in S&T.

(continued)

Box 6 (*concluded*)

The VISEF might carry out some of these activities:

- Evaluation of proposals for award of support;
- Selection and awarding of fellowships;
- Evaluation and award of block grants to universities and research institutes;
- Planning, selection, and establishment of Centres of Excellence;
- Evaluation and award of equipment for teaching and research laboratories;
- Administration of international cooperative research projects;
- Science and Engineering Awards for excellent research work;
- Improvement projects for science education; and
- Assessment of new scientific breakthroughs.

The VISEF would be able to undertake a leading role in promoting education and training in applied systems engineering, a priority that is outlined in Chapter 8.

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Chapter 6
THE ACQUISITION AND ASSIMILATION OF TECHNOLOGY

Following the introduction of Doi Moi more than 10 years ago, Viet Nam opened its doors to foreign investment. It was expected that this would bring much needed capital, new knowledge, and new technologies. This has happened to an extent, but in recent years foreign investment has fallen, and this has been accompanied by a decline in the importation of technology.

Broadly speaking, two approaches are taken to technology development. One is the technological development pushed by new discoveries and breakthroughs. This involves new technologies created initially by technology push. In advanced countries, numerous examples can be given of successful economic advance resulting from technology push. The industrial market sectors of developing countries, however, are often formed almost overnight with the introduction of imported products or services. Many examples can be given of East Asian economies where success in modernization and industrialization has derived from S&T policies based on a demand-pull approach, as well as disappointing experiences resulting from S&T policies focused on the technology-push approach.

During our interviews with policymakers and researchers in Viet Nam, we noticed in many cases a search for policy instruments of the technology-push variety. Inadequate attention appears to have been given the expected evolution of technology demand in the fast-changing national, regional, and international markets. For example, the decision to establish the four focus areas — IT, biotechnology, new materials, and automation — seemed to be based on observations of general trends elsewhere, rather than on an in-depth analysis of current Vietnamese economic structure and markets.

The starting point is also important in this context. According to MOSTE (Thu 1997, p. 3), Viet Nam's technology is

> 50 to 100 years behind that of the most modern countries in the world. Viet Nam's equipment is backward from two to three generations (20 to 30 years) or from four to five generations, depending on each specialised sector, compared with [the] modern level in the world. The coefficient of

value decreases because of technical backwardness and the standard of production organisation is commonly from 0.5–0.7.

Some further factors that emerged during our interviews and bear on the acquisition and assimilation of technology are the following:

- Some significant efforts have been made to adapt imported technology to local conditions, and electronic and software firms perform adaptive research activities continuously. For example, one company adapted the technology acquired through a joint-venture agreement to manufacture refrigerators in accordance with Vietnamese conditions and consumer preferences (variable power supply, noise level, automatic defrosting, speed of ice making, separate compartments for different types of food). In-house research teams, mostly financed by the firm, are in charge of these activities. Joint ventures and technology agreements (for example, to manufacture under an Original Equipment Manufacturer licence) are also perceived as a major source of technical expertise, managerial technology, and administrative practices, which have helped local firms considerably. Access to such soft technologies is obtained through technical and managerial assistance provided by expatriates, who are asked to train local employees, or through visits to foreign enterprises and to joint-venture partners in particular.

- The cost of technology acquired through joint ventures is perceived by some local partners to be rather high, which can be a serious problem in industries that operate with relatively low margins (for example, electronic consumer goods and garments for export). At the same time, some foreign partners view joint-venture agreements as rather rigid, cumbersome, and too troublesome, primarily because of the problems involved in the management of joint ventures between foreign investors and SOEs. The leading local industrial firms, some of which have joint-venture agreements, are trying to improve quality while maintaining competitive prices on export products: "produce with Korean quality and Chinese price" was how one manager described the objective of his enterprise. The desire to obtain, absorb, adapt, and improve on foreign technology has led, at least in one case, to a mix of cooperative and competitive relations with the supplier of foreign technology: the firm has a joint-venture agreement and sells products under the foreign partner's name but also promotes its own brand of products manufactured

with adapted imported technology (much of it obtained through the joint venture).

- The perception is quite widespread among both policymakers and businesspeople in Viet Nam that industrial enterprises wholly owned by foreign corporations do not engage in technology transfer to any significant degree. They are thought to operate as enclaves that keep their technology to themselves, at least in the short run. Although they engage in a significant amount of training activities for their own personnel, the relatively limited turnover of technical staff does not allow their abilities and technical knowledge to spill over to other industrial firms. Indeed, it was reported on many occasions that foreign firms and joint ventures attract highly qualified personnel from SOEs and local private firms, which creates problems because of the shortage of skilled and experienced workers, technicians, and engineers. The established pattern we observed appears to be highly biased to acquiring technologies on a turnkey basis.

- Reverse engineering plays a major role in technology transfer in the metalworking, machinery, and industrial-electronics sectors. We observed some good examples of reverse engineering in the Vietnamese household-electronics firms we visited. Research institutes, which behave very much like consulting and engineering design organizations, carry out reverse engineering based on foreign designs. However, they face a number of constraints regarding financing for the construction of equipment and entering into joint-venture agreements with foreign technology suppliers. This limits their ability to expand operations, increase in-house engineering research, and move up the technological ladder. Nevertheless, one can appreciate the ingenuity they have shown in their efforts to circumvent regulations and deal with restrictions.

- The provision of high-technology services — such as testing, design, calibration, and quality control for manufacturing — is another channel for the acquisition of foreign technology. At least one foreign firm specializing in such services faced policy and administrative constraints (import procedures, customs delays, legal requirements) that limit its capacity to establish links with local firms and reduce its effectiveness as a technology supplier. The people we interviewed repeatedly mentioned the establishment of high-technology parks, particularly in places

with an already significant number of high-technology research centres, institutes, and firms as an initiative to facilitate and speed up the acquisition of effective access to technology services. Other potential benefits of such parks would be improvements in the use of equipment and machinery and greater collaboration between researchers in institutes and those in enterprises. During our visits and interviews, people also mentioned the need for adequate information on foreign sources of technology and the establishment of a "technology intelligence service."

- The Vietnamese industrial sector comprises firms with widely different levels of technology and technological capability. Although the bulk of industrial technology appears to be at least two to three decades behind current best practice (as exemplified by the widespread importation of second-hand equipment, machinery, and production lines), a few relatively advanced technology firms (foreign and joint ventures) show that Viet Nam can successfully move into high-technology production. The technological heterogeneity of industrial enterprises poses the problem of how to manage technological pluralism to increase industrial production, improve productivity, and enhance the competitiveness of Vietnamese industry while creating spaces for relatively efficient low-technology firms to survive and gradually move up the technology ladder. Quality control within industrial firms appears adequate, at least for the domestic market and for low-technology export niches, but it will have to be significantly upgraded and improved to face foreign competition in coming years and to penetrate foreign markets beyond low-technology niches.

- Several issues of intellectual property rights need to be addressed to provide incentives to invest in R&D and adapt foreign technology. Whereas industrial property-right regulations appear to be adequate, a perception widely shared by researchers and businesspeople is that government agencies in charge of these rights do not have the power to enforce existing regulations. Software-production firms complain about piracy of their programs (one firm indicated that for every legitimate CD-ROM they sold, at least two were sold by software pirates); research institutes in industry, agriculture, and biotechnology indicated that they were unable appropriate the benefits of their research results; and creative researchers have almost no incentives to innovate and make the results of their research available to others.

Several routes lie open to allow a country or enterprise to acquire technology from abroad. They can encourage foreign firms to establish wholly owned subsidiaries; the government can promote joint ventures between domestic and foreign companies; or the local enterprises can acquire the technology through licencing agreements. Viet Nam has acquired foreign technology through each of these routes, but we were unable to gather credible statistics on how much technology had been acquired through each, and we do not know what the trends have been over time.

The evidence we collected from our interview is of necessity anecdotal, but it suggests, as indicated above, that most of the imported technology comes as a turnkey package. All the importer has to do is to train people to operate the equipment. Initially this is a very effective way of introducing new technology, but experience in other countries has shown that over a period of a few years the productivity of the equipment declines in comparison with that of the same equipment in firms making incremental improvements to the technology. Also, with turnkey transfers, local firms and suppliers have little opportunity to develop the capacity to compete in the manufacture of components.

A more effective form of industrial development occurs when specific steps are taken to assimilate technology. This implies training for not only the operators but also the technicians and engineers who can modify, adapt, and change the technology. These investments are expensive, and studies in Japan and South Korea (Wilks and Wright 1991) have shown that successful firms in those countries frequently invest as much in assimilating the technology as in importing it in the first place.

One of the most thorough studies of the technological behaviour of East Asian firms was carried out by Professor Michael Hobday of the Science Policy Research Unit, at the University of Sussex, in the United Kingdom. His book, *Innovation in East Asia* (Hobday 1995), presented the results of his research. Primarily he investigated the development of the electronics industry in Hong Kong, Singapore, South Korea, and Taiwan, and within this he focused on firms' strategies. His work showed that in all four territories firms followed a similar progression, building on imported technology. At the heart of this progression was export-led technological learning. Hobday summarized his findings in the diagram reproduced in Figure 2.

Hobday explained the diagram as follows (Hobday 1995, pp. 188–189):

> The left-hand vertical axis represents electronics exports, which also correspond to employment and output growth. The right-hand vertical axis represents the innovation frontier, defined as the point at which R&D becomes central to competitiveness.

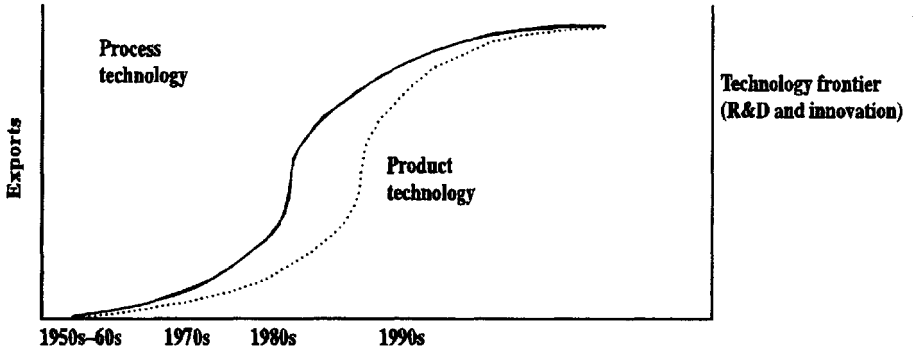

Figure 2. Innovation ion Esat Asia. Source: Hobday (1995). Note: R&D, research and development.

The frontier is a constantly moving, dynamic target. In order to catch up firms must constantly narrow the gap between themselves and the market leaders. The horizontal axis represents the acquisition of process and product technologies by latecomer firms through time, beginning with simple activities such as assembly and graduating towards more complex tasks such as process adaptation and R&D. The relation between export growth and technological acquisition is presented in the shape of a diffusion curve, which corresponds to the slow initial start-up of the 1950s and 1960s, the adoption phase of the 1970s and the rapid take-off in the 1980s. As more latecomers entered to profit from new opportunities, others followed in a Schumpeterian swarming fashion, bringing about the surge in growth during the 1980s. The curve also suggests the possibility of a slowdown in the future as more subsectors of electronics mature.

As the model suggests, latecomers passed through various historical stages of technological development. The first latecomer firms emerged in the 1960s, producing labour-intensive products under joint ventures or sub-contracting arrangements with Japanese, US and European firms. TNCs [transnational corporations] and foreign buyers were initially attracted to East Asia by low labour costs. Foreign firms supplied training, advice on manufacturing processes and product styling, as well as capital goods. At the same time, local technicians, engineers and managers were trained within the subsidiaries of the TNCs. The larger foreign buyers and TNCs supplied formal training courses for assembly workers and technicians to ensure that quality and delivery targets were met. Some TNCs worked closely with local sub-contractors to buy low-cost parts and components, giving rise to a variety of electronics support industries.

> Through the 1960s and 1970s the latecomers learned by manufacturing simple consumer electronics and by assembling and testing semiconductors. Firms entered from the electrical goods sector, clothing and other industries. Other companies started from scratch. Some individuals left their jobs in TNC subsidiaries and began their own companies, often supplying their former employers. Gradually the latecomers learned by upgrading their production processes and by efforts to improve the quality and speed of manufacturing.

Hobday also explored the various government policies of the four territories. Singapore and South Korea followed highly interventionist policies, whereas Hong Kong and Taiwan had more laissez-faire approaches, with the Taiwan government intervening occasionally in semiconductors. Hong Kong and Singapore pursued export-led policies, whereas South Korea and Taiwan combined these policies with import substitution, controlling or banning imports to protect local firms and using government procurement to stimulate local enterprise.

As Hobday also noticed, direct investment in Southeast Asia has been proliferating in form and scope, as well as in national origin and destination. Although equity investments once dominated, over the last decade Southeast Asia has experienced a dramatic spread of newer relational forms of investments by the MNCs, notably interfirm networks. According to Hobday, four types of networks collectively define the MNC production and technology relationships of concern to Vietnamese industrial strategy-makers:

- *Supplier networks* — These include subcontracting, original-equipment manufacturing, and original-design manufacturing arrangements between foreign MNCs and domestic suppliers of intermediate production inputs, such as materials, tools and moulds, parts and components, subassemblies, and software.

- *Producer networks* — These enable competing producers to pool their production capacities and their financial and human resources, to broaden their product portfolios and geographic coverage.

- *Distribution networks* — These comprise the MNC affiliate's forward linkages with distributors, marketing channels, valued-added resellers, and end users, both in export and in domestic markets.

- *Innovation networks* — These facilitate the acquisition of product design and production technology, enable joint product and process

development, and permit firms to share generic scientific know-how and R&D.

In electronics, the semiconductor producers pioneered supplier networks in the late 1960s, gradually moving from tightly controlled joint ventures to looser subcontract and OEM relations. Starting in the 1980s, the other three network forms began to emerge. Taken together, the coalescing networks of firms constitute the infrastructure for integrated production in electronics in East Asia.

For Vietnamese firms slowly moving into technologically more advanced positions, the four types of network open up a range of possibilities. For the Vietnamese government, any strategy for technology and related science must consider these relatively new forms of regional integration. Different parts of regional networks are concentrated in different countries or even in different regions of these countries. The result is a changing division of labour in electronics production across not just Southeast Asia but also East Asia as a whole.

A feasible national strategy for S&T must be based on future scenarios of opportunities and requirements for integration into such regional, cross-border networks. A deeper understanding of changing opportunities will enable the government to select from alternative policy options.

In this report to the Government of Viet Nam, we have pointed out that Viet Nam begins its industrialization push at a different time than the four Asian Tigers did in pursuing their dramatic industrial growth. There can be no direct transfer of their experiences. Nevertheless, we think that a number of common characteristics seem to be associated with their success and that these provide some guidelines for Viet Nam's long-term S&T strategy. These characteristics include the following:

- Industrialization was based primarily on export led strategies.

- The managers of enterprises made the key decisions related to technological learning.

- It took 20–30 years to build all the technological capabilities needed to successfully exploit the innovations derived from domestic in-house R&D. Many technical and engineering skills had to be accumulated in the process. Starting today, the process might take only 10–15 years.

- Government policies to influence the behaviour of entrepreneurs and the managers of enterprises varied considerably between the Tigers. But each showed the following characteristics (also see box 7):

  - Governments followed a set of macroeconomic policies to provide stability, low interest rates, and high savings (that is, they provided an environment conducive to long-term planning and investment).

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

  - Governments developed an appropriate educational and technological infrastructure. This included provision for widespread literacy, vocational education, development of a cadre of engineers, and training and support for research scientists. Vocational courses, often directed to company needs, were carried out in local universities and polytechnics.

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

Box 7

Suggestion

Measures to facilitate acquisition and assimilation of technologies

1. Implement policies that facilitate technology importation but require the full transfer of technological know-how from the overseas suppliers.

2. Encourage the development of export-led industrialization by facilitating overseas business travel, together with similar measures.

3. Ensure that training and education provide an appropriate balance of the many technical (and scientific) skills needed to staff the emerging industrial enterprises. In particular we urge the introduction of a crash program for training the management personnel in charge of technology.

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Chapter 7
SYSTEMS OF INNOVATION AND INTERNATIONAL COLLABORATION

A Vietnamese system of innovation

A strongly shared view among members of the Mission is that in the 21st century the ability to innovate around technologies will be more than ever the major determinant of the competitiveness of firms, regions, and countries. S&T are important inputs to the innovation process, but many other economic and social factors combine with the technological ones to influence success in innovation. In this regard, we point again to the centrality of the skills of engineering systems analysis. Governments have an important role to play in stimulating innovation by ensuring that economic and social policies, as well as their S&T polices, reinforce possibilities for innovation, rather than negating the process.

A useful way to consider the complex interrelationships of the various economic, social, and S&T factors in successful innovation is to think about systems of innovation. Particularly useful for national policy-making is the concept of an NSI. The Mission used this concept in its thinking about, and analysis of, S&T in Viet Nam. We drew heavily on the work of an earlier IDRC Mission to review the S&T policies of China (IDRC–SSTC 1997). That Mission adopted the OECD definition of an NSI, namely a "network of institutions in the public and private sectors whose activities and actions initiate, import, modify and diffuse new technologies" (OECD 1994, p. 3, cited in IDRC–SSTC 1997, p. 58).

This definition led the China Mission to recognize that an NSI could be thought of as a set of functioning institutions, organizations, and policies interacting constructively in the pursuit of a common set of social and economic goals and using the introduction of innovations as the key promoter of change. It is in the interests of every country to ensure that

- A set of institutions, organisations, and policies are in place to give effect to the various functions of an NSI;

- These institutions, organizations, and policies interact constructively;

- Goals and objectives are agreed to that are consonant with an articulated vision of the future; and

- A policy environment is in place to promote innovation.

The Mission to Viet Nam did not have the time to systematically study all the components of the Vietnamese NSI, nor was it able to analyze in any detail its capability to generate, acquire, assimilate, use, and diffuse the knowledge essential to modernization and innovation. (We strongly suggest a more thorough analysis, using this approach.) The Mission was nonetheless able to gain a number of impressions of the ways some of the elements of that system function and identify some of the system's gaps and shortcomings.

The principal impression was that although many of the ingredients of a Vietnamese NSI are in place, they are not yet functioning well as a system. We saw policy-making bodies concerned with S&T; many research organizations and universities; national high-technology initiatives and a variety of incentives for innovation; mechanisms for funding S&T; and strong political support for S&T. But despite the presence of all of these components, the system does not seem to operate as a system. As a result, the pace of technical change and innovation is far slower than needed and desired.

More specifically, we noted the following (some of these observations have already been made):

- The linkages between research institutions and the productive sectors are still relatively weak, compared with those in many other countries. A high priority should be assigned to strengthening these.

- Enterprises seem to invest very little in the technical capabilities needed to assimilate and absorb the technology they acquire either from abroad or from national sources. Japanese and Korean firms usually spend as much on assimilating technology as they do on acquiring it. In Viet Nam, we heard of very few firms with the capabilities to assimilate and master technology. As a consequence, they were unable to introduce the streams of incremental innovations so characteristic of competitor firms in other countries.

- Vietnamese firms seem to have few sources of venture capital, the ready availability of which is such a feature of other rapidly industrializing countries. Without access to such risk capital it is

difficult for entrepreneurs to exploit commercially new technological innovations.

- Countries that have modernized and industrialized successfully all have dynamic innovation systems in which knowledge flows are clearly encouraged. The innovation system in Viet Nam is more static, with only limited flows of knowledge between institutions. This is due in part to the tradition of secrecy in many bureaucracies and in part to a concern over the protection (or lack of it) of intellectual property.

- A major weakness in the effective functioning of the Vietnamese NIS, as reported to the Mission by many interviewees, is difficulty gaining timely access to knowledge. This impedes decision-making, both with regard to policy issues and with regard to sources of the most appropriate technologies. A knowledge-broker service is greatly needed to put people who need knowledge quickly in touch with people who have it. This applies to knowledge in both Viet Nam and abroad (see box 8).

International collaboration in S&T

Why do firms and countries collaborate internationally when S&T are recognized to be at the heart of an enterprise or a nation's competitiveness? This issue is a vital one for enterprise managers and national policymakers in all countries. What, for a given country, is the appropriate mix of competition and collaboration? How does this vary for collaboration in science and in technological development?

Box 8

Suggestion

Constructing S&T policy as innovation policy

It would be most useful to have a more thorough analysis and deliberate attempt to construct an NSI using this approach, together with other factors the Mission had not enough time to examine. To this end, we suggest that a Vietnamese task force be comprised under the direct authority of the Vice Prime Minister and that its work be completed quickly and in time for inclusion in the White Paper on S&T strategy.

Collaboration in basic research is carried out for many reasons, including cost sharing and geographic necessity (for example, research on tropical plants or tropical diseases requires access to the tropics.) For developing countries, international collaboration in science is an important way to keep in touch with advances in the field and help ensure that knowledge in that field flows into one's own laboratory and country.

In Viet Nam, until 10 years ago, most scientific collaboration was occurring only with the Soviet Union and Eastern Europe. That has changed, and now much more such collaboration occurs with the rest of the world, including Asia, Europe, and North America. Every research institute or university we visited had cooperative links with counterpart institutes in these regions. By contrast, we heard of very few current links with Eastern Europe. The links we heard about appeared to have been carefully put together. The agricultural research institutes, for example, all seemed to have appropriate collaboration with the international agricultural centres.

Collaboration for technological benefits usually occurs between firms and universities in what is often called precompetitive research. Governments and international organizations often promote such collaboration for political reasons. For example, the European Union funds collaborative research involving firms and universities in several European countries to strengthen its economic competitiveness and integration. Other regional international bodies, such as the Association of Southeast Asian Nations (ASEAN), also try to stimulate S&T collaboration between institutions in their member countries.

A further type of international collaboration in S&T is increasing as a result of globalization. This is collaboration between scientists and engineers in different countries under the orchestration of a single company. In this type of collaboration, research may be done in one country; design and development, in a second; initial production, in a third; and after-sales service, in a fourth. If a country has S&T assets, its workers can be included in this collaborative program. If it does not, it will be bypassed. It is worth noting that more than 30 MNCs are supporting research laboratories in China because of the excellent (and inexpensive) Chinese research capacity.

International collaboration in S&T has costs as well as benefits. Although the cost to each participant may be lower than that of going it alone, the total cost of a collaborative endeavour is usually higher. Also, as the research gets closer to the market place, the issue of who among research partners owns the intellectual property rights can become serious. Also, problems occur when one partner is scientifically stronger than the other. Under these circumstances, the stronger partner often dominates the research agenda. This can result in a distortion of the

scientifically weaker country's research priorities, which may be unduly affected by decisions taken by the stronger partner.

Many countries have begun to realize that the costs and the benefits of international collaboration need to be carefully weighed before formulating a national strategy for international collaboration. The purpose of such a strategy is to maximize the national benefits and minimize the harmful effects (see box 9).

Box 9

Suggestion

Including the issue of international collaboration in a long-term S&T strategy

We suggest that Viet Nam include the issue of international collaboration in its long-term S&T strategy, to ensure that maximum benefits accrue to Viet Nam from collaboration. In particular, Viet Nam should assess carefully its collaboration strategy with other countries in East and Southeast Asia. It should aim to produce a Vietnamese strategy for international collaboration.

In addition, we suggest that the Vietnamese government establish a new international consultative mechanism to deal with S&T and the modernization of Viet Nam. A few years ago, China established the China Council for International Co-operation for Environment and Development. The members of this council include very distinguished leaders of government, industry, policy institutes, finance, and academia, and its purpose is to counsel the Government of China on environment and development. Viet Nam International Science and Technology Advisory Council could be structured along the same lines. It could function under the chairpersonship of the Prime Minister or Vice Prime Minister and be composed of leading industrialists, financiers, and technology and development specialists. In addition to regularly counseling the Government of Viet Nam, its very existence would serve to encourage investment in Viet Nam.

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Chapter 8

EDUCATION, TRAINING, AND HUMAN RESOURCES FOR S&T ACTIVITIES

In Chapter 3, we noted the centrality of achieving the right combinations of education and training as a precondition for competitiveness, modernization, and industrialization. The World Bank made the same point in a 1996 study, *Viet Nam: Education Financing Sector Study* (World Bank 1996), noting also that it is especially difficult to achieve those right combinations with severely constrained financial resources.

Despite Viet Nam's being one of the poorest countries in the world, its record on education has been impressive, with 91% of children between the ages of 5 and 10 enrolled in school and reportedly 88% of the working-age population being literate. The Ministry of Eduction and Training has a major responsibility for planning and directing the system, although broader policy decisions are taken by the Prime Minister's Office, the Ministry of Finance, and the Ministry of Public Information, and many educational institutions fall under other ministries, sometimes resulting in duplication and confusion (World Bank 1996). Decentralization is a major feature of the system, with different levels of government involved in the administration of public financing and with education below the tertiary level administered entirely by local authorities.

One theme that emerged consistently during our interviews was the inadequacy of the educational system for rural people. This view received independent support in the research of Laufer (1996), who found that the importance of the preschool and creche system for basic health and child development had been underestimated and that funding for rural creches was on the decline. In addition, Laufer found that in 1996 the rural areas had some 20 000 vacancies for teachers. A further and somewhat related factor came out in the 1996 World Bank study (World Bank 1996), which indicated that educational attendance is closely related to the wealth of households. The poorest households send no children for higher education. The state subsidizes a larger proportion of the costs of education at higher levels than at lower or intermediate levels, and this means that the benefits of state provision go disproportionately to wealthier families.

A second theme, raised particularly by employers, is the predominance of monodisciplinary, specialized, and vocationally oriented institutions, along the lines of the Soviet model, serving a single-line ministry. These were generally thought to be inappropriate for helping the country make the transition from central planning to market-led allocation of labour, to have a teaching content with little reference to the market, and to produce graduates with skills that are often not in demand. The World Bank (1996) also commented on this, finding this structure to be a feature in the high unit costs of tertiary education. The World Bank estimated that average recurrent costs per student–year were about 25% higher in monodisciplinary than in multidisciplinary institutions (World Bank 1996).

A third theme, emerging in several conversations, is related to the issue of gender in science. In most of the universities and research institutes we visited, 20–30% of the scientific staff were women. In some institutions, women had become members of senior management, and in a few cases we met female directors. We also heard that the government intended to encourage women to participate in all aspects of scientific life in Viet Nam.

Although the participation rate of women in S&T is higher in Viet Nam than in some other countries, it is still far less than 50%. This means that a considerable pool of potential scientific talent is untapped. The statistics also show a heavy gender imbalance among new recruits to S&T subjects in the universities (see box 10).

The Vietnamese government views the development of human resources as a key to defining levels of development and recognizes the challenges to its reform program of improving its educational system. Government spending has shown consistent increases in absolute terms and as a percentage of total government spending, including increases of 46% in 1993 and 33% in 1994. Many restrictions on private-sector involvement in the sector have been loosened, and public institutions are being allowed to levy user charges, still within strict limits (World Bank 1996).

Box 10

Suggestion

The United Nations Commission on Science and Technology for Development has considered the issue of women's participation rate in S&T. The specific suggestions made in its report (see Gender Working Group [1995], *Missing Links: Gender Equity in Science and Technology and Development*) may be helpful to the Government of Viet Nam in addressing and redressing this imbalance.

Viet Nam has recently restructured its higher-education system and created two autonomous national-university campuses through the merger of several smaller universities and colleges. The national-university campuses now report directly to the Prime Minister (and not to the Minister of Education). From our interviews, people appeared to have few doubts that if properly organized, staffed, and grounded in research, the two national-university campuses would serve as models for reform in higher education. Within the university campuses, however, we were consistently told that the reorganization had been primarily a matter of shifting departments and academic units. The restructuring had not significantly modified the academic or financial and administrative practices of these institutions.

The government hoped that the two national-university campuses would create new synergies and that private and donor investment would follow. According to one senior official of the government, however,

> Thus far, nothing very positive has happened. The process has been approached mechanically and poorly implemented. We had hoped for the emergence of new programmes and curricula that would push the modernisation of Viet Nam and little of this has happened.

A partial, but only a partial, explanation is that the government has made virtually no new investments in the new national-university campuses. According to a senior academic, "in theory, we have a new organisational structure, but it coexists with management and resource allocation practices that still belong to the earlier era of Soviet-style universities." Perhaps not surprisingly, some researchers who had earlier supported the government's creation of the two national-university campuses afterward began to express second thoughts and to consider the reorganization a mistake.

The most comprehensive study of the costs of the expansion of the system (World Bank 1996) indicated that judicious mixes of three main policy instruments — subsidies, cost recovery, and private-sector development — could enhance internal and external efficiencies in service provision of education and training. However, the same study also made clear that some objectives will conflict (for example, expanding enrolment, improving quality, implementing measures of cost recovery, and increasing equity).

The government envisages significantly increased allocations to vocational and technical (VOTECH) training. Such plans relate clearly to the national objective of rapid modernization and industrialization. The World Bank, however, urges a more cautious approach because, as its report noted, the little evidence that is

available suggests that cost-effectiveness differs considerably among programs subsumed under vocational and technical training. In addition, the World Bank noted the potential for the private sector to play a large role and to increase rates of return as economic reform progresses. Thus, the World Bank counseled prudence and argued for a slower approach, with "continuous monitoring and evaluation along the way" (World Bank 1996, p. 134), including regular labour-market surveys and tracer studies. We support the World Bank's argument and suggest that monitoring and evaluation be built into the forthcoming national S&T strategy. As will be made clear in what follows, however, we concluded from our conversations, particularly those with people involved in large joint ventures and MNCs with significant investments in Viet Nam, that Viet Nam has at the moment a large, unmet demand for specific technical and vocational skills and urgently needs a national program to address this situation.

At present, in pursuing Viet Nam's goal to become an industrialized country by 2020, the national authorities are concerned principally with raising the required capital and identifying the key sectors and projects. In the final analysis, however, the experiences of the Asian Tigers indicates that the most important step in the industrialization process is to identify and educate competent planners and managers to compete well against the sophisticated elite leaders of advanced and NICs. Compared with the past quarter century, the next quarter century will have even more rapid technological advances and transformations, steep world-market competition, and extensive globalization. As noted, adaptability, flexibility, and innovativeness will be more important virtues for Viet Nam's next generation of government officials and business leaders. Although such well-qualified leaders may emerge through on-the-job training and trial-and-error practices, a lesson from the experience of the Asian Tigers is that Viet Nam would be well advised to systematically approach the development of a new generation of leaders. This should be accorded top priority in S&T policy.

In this regard, we concluded from our interviews, especially those with people involved in joint ventures and MNCs, that the most critical technical-skills gap in Viet Nam lies in what we would term *applied systems engineering*. We use this term deliberately to distinguish this from the skills normally imparted by institutes for technology or university programs for scientific engineering. We are not referring to skills that go with big science and technological breakthroughs but to the full range of applied and management skills required to make technologies work to full advantage — in other words, to the ability to apply the technologies. We do not wish to underemphasize the longer term importance of the basic sciences or that of a number of issues and problems that emerged during the Mission

regarding both the basic and the engineering sciences (see Chapter 5). In our view, however, these areas are less essential at the moment to Viet Nam's quest for rapid industrialization and do not require the same urgent, remedial attention.

On the basis of both our interviews and the Korean experience of industrialization, we suggest that Viet Nam, in its national S&T strategy, give urgent attention to establishing a technomanagement program. In the Republic of Korea, the contributions of the Korea Institute of Science and Technology (KIST), Korean Advanced Institute of Science and Technology (KAIST), and Korean Development Institute (KDI) were very important in the 1970s and 1980s. KIST is an industrial-technology research institute; KAIST, a specialized graduate school of applied science and engineering; and KDI, a development research institute. An analysis of the history of these institutions shows clearly that their contributions were key to Korea's development, through their building a national capacity to formulate and promote technoindustrial projects and in training top- to mid-level managers. A Vietnamese technomanagement program would not train scientists and engineering scientists but produce specific cadre of people with skills needed for industrialization. It would also function as the "brain" trust for the Vietnamese political, administrative, and business authorities.

Again, as a result of the Korean experience (and to some extent that of Singapore), we suggest that a Vietnamese technomanagement be designed with strong input from the industrial, joint-venture, and MNC community in Viet Nam. It should be approached as an entirely new institutional arrangement, with structures that link learning systems regionally and internationally. It may, of course, be placed within an existing structure, but it should not be constrained by that structure, nor should the inertia that accompanies all long-established institutions be permitted to mould the new program.

Box 11 shows an outline of a possible technomanagement.

The elements of a technomanagement would require careful study, including an examination of facilities and programs within Southeast Asia and elsewhere. To provide possible key elements for consideration in such a study, we suggest a four-tier program, as outlined in box 12.

Box 11

Suggestion

A Vietnamese technomanagement program

Objectives

1. To educate and train the leaders of Vietnamese industrialization in technomanagement systems;

2. To perform technical assessments, systems analyses and syntheses, and planning and management of both public and private projects at all levels; and

3. To function initially as Viet Nam's principal cooperative window for international collaboration in technomanagement.

Programs

Postgraduate-level programs should be offered to both young college graduates and to managers and decision-makers already on the job. Programs would include

- A formal technomanagement program focused on technomanagement and project administration;
- Nondegree, advanced special programs to gain an overview of modern-day technomanagement, directed to incumbent government officials and enterprise managers; and
- Short courses and seminars to provide packaged training on specific topics for people who need it quickly to meet specific demands from industry.

Organization

The proposed technomanagement program should be offered at the newly established and reorganized Viet Nam National University. The Viet Nam National University will certainly become the elite school for the future leaders of Viet Nam. Its reform-minded leadership is ideal for organizing and operating the proposed technomanagement program. The program can be run as an independent unit of the Viet Nam National University, with a world-class facility and an international faculty. Also, the success of the program will require linkages with, and study programs at, other institutions of excellence in the region and internationally. To overcome the barrier of inertias from the traditional sector of the Vietnamese higher-education system, the proposed technomanagement program 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 program 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 feasibility studies. Many important models and outstanding examples should be taken into account (for example, MIT's technomanagement program, KAIST's Techno-MBA program, Thailand's Technology Development Research Institute, and the Science Policy Research Unit and Institute for Development Studies at the University of Sussex). In Viet Nam, students may require remedial work before being admitted to formal programs, and this should be considered in the design of the program. Also, Viet Nam has a substantial pool of well-trained professionals abroad, and some of these people can be invited to work with an international team of experts and domestic stakeholders in planning the proposed Vietnamese technomanagement program.

Box 12

Suggestion

A four tier program consisting of the following should be offered:

1. Short-term seminars for senior decision-makers;

2. Six-month programs designed for managers on the job;

3. Regular masters degree program for university graduates of engineering and social sciences; and

4. International study programs in overseas centres of excellence and industry.

The main skill-requirement areas to be addressed (some mandatory and some optional depending on orientation and needs) would be the following:

- Introduction to, and familiarization with, the application of IT;
- Management information systems;
- Decision analysis through case studies;
- Systems engineering and design;
- Project formulation and assessment;
- Project-management systems (schedules and costing);
- Technology sourcing and intellectual property rights;
- Marketing and after-sales service;
- Operations and maintenance for small and large facilities; and
- Total-quality management systems.

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Chapter 9

GENERATING DOMESTIC SAVINGS: APPLYING S&T TO VIET NAM'S TRADITIONAL SECTORS

As already noted, Viet Nam's level of domestic savings is far too low to finance the technological transformation intended by the government. This was the view of many of the people the international team met. It is also the position of the World Bank, which noted that policies are required to translate the earnings from household business units and "the prosperous agricultural sector" into private savings (World Bank 1995a). Agriculture represents about 30% of GDP and 50% of export receipts and provides a livelihood for some 70% of the Vietnamese population (World Bank 1995a). The agronomists and agricultural-research institutes consulted during this review were of the strong opinion that the agricultural sector would not remain prosperous and would be unable to contribute to the economic surplus required for Viet Nam's modernization without a major effort to apply S&T to the needs of this sector.

The history of Southeast Asia shows that in many countries agriculture has been the early engine of domestic savings and set in place the conditions for unprecedented economic development. Malaysia built its economic growth on its application of S&T to assist in its exports of rubber and oil palm. Thailand traded rice, timber, maize, and cassava exports to build the foundations of its industrialization. Indonesia blended cash crops with timber and petroleum products to fuel its engine of progress.

Most of the agricultural scientists, researchers, and producers we consulted expressed deep concern that Viet Nam's national S&T policy neglects and may continue to neglect the potential to develop the country through the modernization of its traditional sectors of agriculture, forestry, and fisheries. In reviewing the S&T-policy documents available to the international team, we noted good reason for this concern. Current S&T-strategy documents emphasised four areas of economic-development focus over the next 25 years — IT, biotechnology, new materials, and automation — as the foundation concerns for the nation's future industrialization. The documents contained almost no mention of how Viet Nam would produce the required domestic savings or of a phased strategy involving

deliberate application of S&T to the economic and social resources in which Viet Nam now has, from all evidence, a large and distinct comparative advantage. In the view of the Mission, there is a risk here of serious policy failure. A sequence 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 stress the modernization of the nation's industrial base.

The view of many people, therefore, was that 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. A large, unmet, and fast-growing demand for Vietnamese agricultural products is strongly evident in China. The concomitant S&T strategy for the social and economic development of Viet Nam's natural-resource base should be centred on two major goals. First, the country should liberalize and apply the productive energies, enterprise, and skills of Viet Nam's primary-product producers and its rural private businesspeople and investors to meet the needs of a modern primary-product economy. Second, the country should establish conditions to attract foreign investment to complement domestic efforts to create an advanced agribusiness infrastructure.

However, we also encountered strong objections to any S&T–economic strategy according priority to the traditional sectors. Such objections tended to come from economists, rather than from scientists. The largest doubts rested implicitly on a despair over any prospect of improving Vietnamese agriculture, as a result of its small farm sizes and its backwardness. The international team found it difficult to entertain these objections seriously, as development models based on successful primary products were launched under virtually identical conditions in the neighbouring countries of Southeast Asia, a region with characteristically very small, intensively cultivated farms.

We also heard the contentions that the agricultural-product market is fraught with quality and price barriers that Viet Nam cannot hurdle. In fact, the market for high-value Vietnamese products — such as fruits, 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 postharvest food-processing infrastructure that prepares, packages, and handles these perishable products to make 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 multinational food and agricultural-product export firms to assist or, if possible, invest in developing an international market for Vietnamese high-value food products.

Such a strategy would use the excellent array of technologies already developed by Viet Nam's agricultural, crop, livestock, and fishery research institutes and universities. Because of the disaggregated and disbursed nature of primary-product production, the strategy must also enlist the active participation of the domestic private sector as a source of business investment. Private initiative can provide the entrepreneurial talent and investment funds required to build a modern agribusiness complex to serve producers and to create and operate the postharvest processing systems required to meet international-market standards for food and cash-crop economies.

The technical foundation needed to expand the output of Viet Nam's farms to supply new markets is available. The weakness of the national economy to accommodate such an S&T–economic-development strategy lies in the relatively primitive infrastructure of its food-processing and farm-supply sectors. The obvious requirement here is investment in storage-facility, processing, packaging, and preservation technologies to meet the quality standards of the international market.

The technologies needed to initiate a transformation of Viet Nam's rural economy are, for the most part, already known and available. What is lacking is an appropriate incentive structure to launch and support their application. This is a core issue for national policy and central to a successful S&T strategy.

Critical to the earlier economic transformation of Indonesia, Malaysia, and Thailand was the governments' role in ensuring fair agricultural markets and a measure of safety-net protection against the risks of weather and international price fluctuations (see box 13).

Box 13

Suggestion

Some instruments to consider in economic transformation

Public funding for S&T is severely constrained. As already indicated in Chapter 5, the government intends to increase such funding to 2% of total public outlay. To generate the medium-term public savings needed for industrialization, the government should give priority over the next few years to allocating a significant percentage of the new funds to R&D in the agricultural sector. Eliminating the "green disease" in Viet Nam's fruit crops will in itself pay handsome short-term dividends to the Vietnamese economy. Resolving the technological barriers to increased postharvest marketing will do the same. It should be noted that a significant percentage of such S&T in agriculture is likely to be at the very frontiers of science in plant breeding, genetic engineering, and biotechnology.

(continued)

Box 13 (*concluded*)

An Agricultural Price Board, or Commission, might be created with a mandate to announce, in advance of the planting season, a set of floor prices for major agricultural commodities, with the assurance that the government or the state bank will purchase designated products if prices fall below the announced floor prices. Commodities purchased under this program might be stored as a future buffer stock to bring greater stability to product prices within the country or to even out the year-to-year flow of export earnings from foreign sales.

Similarly, most farmers depend at present on local money lenders for a large share of their capital. This dependence discourages these farmers' adoption of new farming practices, and in the case of crop failure the government has no crop-insurance program to help farmers and their families to face the risk of bad weather. An existing official system provides credit to farmers to purchase nonfarm production inputs, but by all accounts the system is seriously underfunded. This results in significant losses of national revenue.

In addition, Viet Nam has few microcredit schemes. Such schemes in other countries of Asia have proven to be of considerable value to rural populations and have facilitated small, incremental gains along the value chain. Moreover, such schemes are being accorded high priority by many donor agencies, including bilateral and multilateral agencies and nongovernmental organizations. A microcredit arrangement specific to an agricultural population but similar to the Grameen Bank, in Bangladesh, might be established on a pilot-project basis. This might be funded, initially at least, by a donor or a consortium of donors.

In sum, we see compelling reasons to support a conjunction of S&T- and economic-development strategy, with initial priority given to the primary-product sector. This approach would hold major promise for the modernization of Viet Nam's rural areas, provision of a large number of new, low-capital-intensive rural-employment opportunities, and generation of the domestic savings and foreign-exchange needed to support a medium-term program of industrialization.

Chapter 10
HIGH TECHNOLOGY

The Vietnamese government has selected four high-tech programs for priority treatment: programs for IT, biotechnology, new materials, and automation. Each of the programs is under the direction of a steering committee. Of these four, the area given greatest immediate attention in Vietnam is clearly IT, and because of the time available, we were encouraged to concentrate on this. We were well briefed on the national IT program and heard many positive comments about its accomplishments. We also encountered, however, some critical comments on its shortcomings.

The national program for IT

During more than 4 years, the Vietnamese government has been implementing a national program to develop IT. According to a senior policymaker, the national IT program "requires that our country further develop IT in every sector," not just in the public sector (that is, among the ministries, provincial administrations, and other public agencies). IT should be used to enhance quality and effectiveness in manufacturing and services, to support the country's overall economic reforms.

Formally, the national IT program derived from a Government Resolution (No. 49/CP/1993), signed by the Prime Minister. Every government agency is ordered to follow the guidelines and achieve specific objectives. At least in principle, every ministry must find ways to implement the national IT program. As in the other national high-tech programs, the 1993 national IT program has a practical orientation. It is not a program that first and foremost will generate new technology but one to promote effective diffusion and application of existing, relatively advanced IT. The focus is on the "effectiveness of the application of computers in socio-economic activities." Left out of the national IT program documents, however, are specific operational goals with clear strategies for their implementation. These are defined by the professionally staffed Office of the Steering Committee for the national program on IT, located directly under the Prime Minister's office.

The IT program was developed with three main concerns in mind: (1) the need for Vietnam to benefit more from the modern information infrastructure, based on computing, multimedia, and data interchange; (2) the ambition to modernize industry and related economic activities and contribute to the emerging IT industry in Viet Nam; and (3) the need to address the competition in IT from neighbouring countries. Regarding concerns 2 and 3, a number of initiatives have been taken to improve the legal and regulatory environment. This includes issues of intellectual property rights in the software industry; importation of computers and other equipment; and tax and quota incentives to develop a base for assembly and other types of production of IT hardware.

The main issue has concerned the education and training of IT personnel. Viet Nam has a relatively good supply of programers but a serious lack of systems engineers, project managers, and other middle managers and persons with academic specializations at the level of a master's degree. These issues remain high on the program agenda.

From the first year of implementation, however, the emphasis was put on the diffusion of IT in government and in some other sectors (for example, in education, training, and R&D). The government was considered a lead user in data communications. The IT program's interministerial Steering Committee (chaired by the Minister for Science, Technology and Environment) gave priority to joint efforts among ministries and offered cross-sectoral coordination in the design and procurement of computers and communication applications. As in the neighbouring countries with more developed IT infrastructures, in Viet Nam computer and communication technologies were to be applied to every aspect of social and economic activity.

In the name of the national IT program, all ministries and operating agencies have been required to develop and implement their own IT plans, which should be comprehensive and also include training and technical development. Similarly, all 61 provinces are to have their own IT plans (initiated and, if necessary, financially supported by the central government through the national IT program). Some of these provincial IT plans are fairly advanced and include both R&D efforts and industry initiatives, such as the Soft Park in HCMC, a high-tech, low-rent building for start-up firms, including small firms developing and marketing computer software.

From our interviews, it seems clear that the national IT program is seen as highly beneficial to the diffusion of IT in Viet Nam. The program has had clear and positive effects not just in central government but also in the use of IT in a number of provinces, the school system, and R&D institutions. But the effects in industry and in the rest of the economy are less obvious. The national IT program

has not improved the production of software (and related hardware). It seems obvious that the industrial ambitions of the program (to create stronger incentives for a software industry in Viet Nam) need to be reinforced and accorded a central place on the agenda.

From our visits to software firms in both the north and south of the country, it seems clear that people see the central and provincial governments as lead users in software products and services. The position of lead user in a high-tech area can be used to help drive the firms and other market players toward new products and services that can become a basis for a software industry. Hence, decision-makers should recognize the need to retain an industrial dimension in the IT program.

Limits of access to data and information

Non-Vietnamese participation has been sought to finance pioneering efforts in computing, multimedia, and data communications. This includes local-area networks for senior decision-makers in the public sector and e-mail access and some other internet services for educational and research personnel. National reviews have been conducted of all ODA projects to search for relevant IT components in ongoing and planned development projects. The idea is to help upgrade and otherwise improve the IT component of each project and to improve the fit of these many independent IT components in the overall IT development of the country.

As a lead agency in government and as a pioneering user of IT in Viet Nam, the Office of the Steering Committee for the national IT program has conducted several experimental projects in both data communications and advanced multimedia applications. Financially supported by Canadian ODA ($8 million over 5 years), the Office has been able to offer advanced consultancy to the government sector in computing and communications, to assist in capacity-building for IT in both central government and all the provincial administrations to develop overall design and necessary standards for data communications, etc.

Assisted initially by a consortium of Canadian firms, the Office of the Steering Committee is involved in a major undertaking to create standards and access procedures for a decentralized national database to provide effective on-line land-management, socioeconomic, detailed population, planning, investment, tax, and other treasury data.

These approaches appeared to us to represent a solid combination of technology access, investment in assimilation, and systematic links to users. However, significant difficulties were also reported during our interviews. The difficulties encountered thus far in this ambitious program do not appear to lie mainly in technology. Since 1994 Viet Nam has had access to all the IT products and

services it needs. The main hurdle has been the lack of government policies and regulations to facilitate the diffusion of modern IT.

For example, the excessive rates set by the telecommunications regulator (Department General of Post and Telecommunications) and the main operator (Viet Nam National Post and Telecommunications) seriously hamper Internet access. In September 1997, a leased line for Internet access cost about 3 000 USD per month for those few people formally permitted to benefit from the World Wide Web. This virtually excludes access for Vietnamese firms and individuals wanting to do business on the Internet, thereby denying to them the potential of this fast-growing part of the world marketplace for goods and services.

In addition, although internet technology has been in place and functioning since 1995, the government retains full control of Internet access, preventing not only businesspeople but also R&D scientists and engineers, educators, librarians, and students from using relevant services, readily accessible via the Internet.

In the course of our many interviews, we were told that contemporary Viet Nam has little acquaintance with the tradition of sharing information freely, even in and between R&D institutions. We were given examples of where the legal and regulatory environment of IT seriously hampered R&D activities and prevented local firms from competing on equal terms with foreign suppliers of IT products and services (see box 14).

Key projects and policies linked to the national program for IT

The Steering Committee for the national program on IT has been a driving force in establishing a national information infrastructure (using Internet standards). The coordination of these many initiatives to improve communications inside and, later, outside the country (including widespread use of the Internet) has been done through this interministerial committee, involving also the telecom-service providers.

Box 14

Suggestion

Removal of impediments to widespread use of the Internet

The application of IT to the development and modernization of Viet Nam is crucial. It will affect all aspects of life and will be an important tool in linking Viet Nam to the outside world. If Viet Nam is to achieve its goal of becoming an industrialized society by 2020, it will be essential to remove impediments to widespread use of the Internet. This is a case in which both implicit and explicit policies must be in harmony. We suggest that Viet Nam's new long-term strategy for S&T pay specific attention to this issue.

As lead user, the Office of the Steering Committee has facilitated on-line communication links for ministries and for heads of provincial administrations. These and other wide-area networks have also been used as a proving ground for new communications technology in Viet Nam. The government has funded these networks, as well as local-area networks inside various ministries, so that experiments can be performed with alternative technical solutions. With the procurement, adaptation, and servicing of these networks, some new technology was developed locally.

Another pioneering effort of the Steering Committee was the National Accounts Registry, which uses the Standard National Accounts classification (a project supported by United Nations Development Programme). Similarly, an information system for natural resources and environmental monitoring was developed for MOSTE and is monitored by the Steering Committee.

The Treasury of the Ministry of Finance has been using the expertise of the Steering Committee in a taxation project (funded by Swedish International Development Agency). A state bank's data system (funded by the World Bank) was the largest of all IT projects. The trade-information system of the Ministry of Trade and the customs-information system are both part of the national IT program.

More generally, the inclusion of various sector programs for IT in the national IT program has secured not only the participation of people with expertise from the Steering Committee but also brought about a technical upgrade of most projects and a harmonization of communications standards and training of specialized IT staff. Development projects have been identified, and some R&D has been performed to match the technical achievements reached by an active procurement of advanced IT equipment and programs from the international marketplace.

More importantly, these hands-on experiences of the Steering Committee in large IT projects have had a direct influence on the policy debate and proposals to the government for changes in various policies, including those affecting higher education, training, industry, and trade. The Steering Committee has the continuing ambition to create a more appropriate and supportive environment for software development, involving such factors as open system standards, procurement policy for the government, copyright issues, and intellectual property rights.

Clearly, the national IT program was never meant to be just a government program, but a cross-sectoral R&D and technology-diffusion program, set in the context of efforts to industrialize and modernize Viet Nam. In our interviews, people strongly recommended that this broad purpose needed to be communicated with absolute clarity by the government and that the implementation of this purpose should be greatly strengthened. For example, the IT program does not

incorporate systematically positive linkages between the proactive IT policy of Viet Nam and its current policies for industry, foreign trade, education, training, administrative reforms, and the communications infrastructure. In some of our interviews, people indicated that they saw this as a serious weakness.

The national IT program identifies some of these cross-sectorial linkages but limits itself in the creation and development of an IT industry in Viet Nam. Yet, concern is growing in the interministerial IT committee over the slow growth of a modern IT and electronics industry in Viet Nam, such as in software development and production for the home and world markets, hardware development and production (of selected equipment), and specialized IT services.

Earlier this year, policy issues in industry and trade relating to the future of IT in Viet Nam were brought to the attention of a high-level ad hoc strategy group, chaired by the former Minister for Planning and Investment. This group is responsible for bringing together IT, telecommunications, and electronics from a long-term combined industry, investment, and trade perspective. During our visit, it was unclear to us how far the ad hoc strategy group would go in its recommendations.

The need for a better human-resource base in IT

In the last few years, the issue of human resources in IT (and electronics) has become ever more pressing. A point already noted (Chapter 9) is that the small, emerging IT industry in Viet Nam does not lack programers, but there is an increased demand for more specialized personnel, such as software analysts, engineers, project managers, and other middle managers, as well as marketing specialists. Although the demand for packaged software in Viet Nam has increased substantially, the local IT firms are still largely unable to meet this demand. Some firms are moving into customized software production, adaptation of standards, and related technical services.

Given these tendencies in the marketplace, curriculum reform is needed at the institutions for education and training at all levels. There is a need to upgrade available equipment for educational and training purposes. In our interviews, several persons advocated a restructuring of IT faculties among the higher-education institutions and the upgrade of facilities, including libraries and documentation centres. It was also suggested that such approaches might be structured to bring about longer term unit-cost savings.

A new IT strategy for the period up to the year 2020 is in preparation, and it is to be completed by the end of 1998. We were told that one of the main characteristics of the new plan is much greater emphasis on the application of IT in agriculture and in the development of the rural areas. This is consistent with the

Mission's own view concerning the need to strengthen the application of S&T in rural areas, and it leads us to make a specific suggestion on this topic (see box 15).

High-tech parks

A technology-policy issue frequently raised on our visit was the planned establishment of a number of high-tech zones, or parks. We heard people express concerns about the number and location of the zones and their phasing and sequencing. We met with only a few people who had any doubt that Viet Nam needed such parks and that the infrastructural investments would bring substantial returns in the long term.

Our own perspective on this issue was one of much greater questioning and even scepticism about the overall merits of the new science and high-tech parks. The world now has more than 800 of these parks. Most are in the developed countries, but several developing countries have also invested in the necessary infrastructure. The intention is to try to locate research institutes, universities, and high-technology enterprises in an environment that is conducive to interaction and leads to innovation and to foreign investment. Some notable success stories have been recorded, but also many failures. Also, a number of attempts have been made to distil the lessons learned. The most recent was the Technopolis meeting convened by the Conference Board of Canada, in Ottawa, September 1997. But too little is known to provide clear guidelines for Viet Nam.

Four candidate sites have been selected for high-tech parks in Viet Nam. One is in the south of HCMC, and the other three are in the vicinity of Hanoi. One of the Hanoi sites is in a part of the city that houses 70 research institutes

Box 15

Suggestion

A pilot program to bring IT to communities in the Mekong Delta

It is suggested that donor funds be solicited to help fund a pilot program to bring the benefits of IT-improved access to information and knowledge to communities in the Mekong Delta. The idea would be to install ITs as a community-centred resource, along the lines of public libraries, which sprang up across the world in the early part of this century. It would be imperative that the system be interactive and that it include the knowledge and information needed by the community (for example, information on agricultural and health issues). A logical choice of a base for such a program would be the university in Can Tho.

Similar programs for poor communities are being developed and tested in other parts of the developing world. Viet Nam might benefit from studying these pilot schemes and adapting them to suit the needs of the Mekong Delta. IDRC's Acacia program in Africa is an example.

and several industrial companies. One of the other Hanoi sites is in the outskirts of the city, and if the decision is made to go ahead with this site the Hanoi campus of the Viet Nam National University, now located in several places in Hanoi, would be consolidated at this new location. The government also intends to establish advanced telecommunications, provide specialized training, a technology incubator, and business-development centres within the scope of the high-tech parks.

We were made aware of a number of feasibility studies of these proposed sites. Joint Vietnamese–foreign teams carried out several of these studies. Japan, Sweden, and the United Kingdom provided inputs. We also understand that the Government of Viet Nam anticipates much of the funding for the parks will come from foreign companies and donors.

The intention of this review is not to make detailed recommendations to the Vietnamese government. We wish merely to underscore that the infrastructural investments need to be very high and that the evidence is mixed regarding likely payoff, based on other countries' experiences. We do, however, suggest some criteria for decisions on the future of the proposed high-tech parks in box 16.

Box 16

Suggestion

Criteria for decisions on high-tech parks

1. *Be careful in selecting the 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 the 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. Detailed site analysis may even determine at a very early stage the probability of success or failure of a high-tech park.

2. *Look into the strengths of the existing technoindustrial 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 contained an analysis of available S&T 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.

(*continued*)

Box 16 (*concluded*)

3. *Identify short-term benefits* — Success is more likely if the high-tech park has both short- and long-term benefits for tenants. The final version of the conceptual design for a park should include everything considered achievable in the first few years of operations and in consecutive time periods.

4. *Combine the efforts of central and local governments* — The chances of success for a high-tech park will greatly improve if decision-makers in the central and local governments achieve a clear consensus on the goals of the high-tech park and the means to reaching these goals.

5. *Consider carefully the implementation strategy* — Developers should not underestimate the complexities of high-tech parks. To succeed, the developers will have to draw on a variety of financial, technical, and human and other resources — to be combined in 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.

6. *Develop a comprehensive policy framework* — This is to be used to clarify problems facing the developers. A blend of policies will influence the development of a high-tech park. 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.

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Chapter 11
S&T AND INNOVATION INDICATORS

Strategies for S&T and innovation must be based on valid, reliable and relevant information on the performance of R&D, access to modern technology from abroad, and diffusion of this technology and related know-how. To a considerable extent Viet Nam lacks such information.

Among the most industrialized countries, over the past decade or more, internationally comparable statistics on S&T and innovation have improved considerably. 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 statistics on R&D and innovation, such as various input, output, and process indicators. Even the technological interaction between branches of industry over national and regional borders is monitored, with the help of skillful statisticians depicting technology balance of payment and trade performance in high-tech and other product areas.

From our fact-finding and interviews, we have come to recognize that Vietnamese decision-makers urgently need to have better access to comprehensive, up-to-date indicators on S&T and innovation, along with overall performance indicators for the Vietnamese economy and the economies of its neighbours and countries in other regions. The current indicators of R&D and innovation in Viet Nam are not good enough. The current indicators do not lend themselves to comparisons over time with various subsectors of the economy or with other socioeconomic indicators.

Furthermore, for its national and regional planning and policy-making, Viet Nam ought to modernize its system of S&T and innovation indicators to take account of the country's transition to a market economy. Decision-makers in Vietnamese government and industry should have the same (or better) indicators as those of their colleagues in neighboring countries. Vietnamese government decision-makers need to know certain details, such as those concerning the flows of funds to R&D and innovation, human-resource and development, and trends in

the mobility of highly skilled personnel. They will also need to compare the outputs of the Vietnamese R&D system with those of other countries in enough detail to take relevant action.

The first step in improving such indicators and statistics is to secure arrangements for standard classifications to be applied. This is needed for any comparison. This also involves developing reliable business and other registers and using these to gather statistics on S&T and innovation.

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

This implies that Vietnamese specialists need to cooperate more actively with statistical and other units abroad, particularly with the international organizations responsible for standardizing R&D statistics on regional and international bases, such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the OECD, among the highly industrialized countries. To some extent, Viet Nam already complies with UNESCO standards; however, as underlined in a recent Southeast Asian program for developing indicators of R&D and innovation, the standards must go beyond that of the elementary statistics processed and published by UNESCO (see box 17).

Box 17

Suggestion

Creating an observatory for S&T and innovation

Viet Nam should create a more advanced system for the production and distribution of indicators of S&T and innovation and encourage use of these indicators for assessments and prognostics. Internationally comparable indicators should be used more frequently in performance evaluations of R&D institutions and assessments of technological services,

(*continued*)

Box 17 (*concluded*)

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 should be made responsible 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 statisticians to make their output fully comparable with that of other countries.

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PART III

Related Reports

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Chapter 12

GENERATING THE SHORT-TERM ECONOMIC SURPLUS NEEDED TO FINANCE INDUSTRIALIZATION: THE CASE FOR APPLYING S&T TO AGRICULTURE

This chapter focuses on the development potential of the agricultural technologies now available from Viet Nam's S&T institutions. These are available for almost immediate application in the development of Viet Nam's agricultural, forest, and fishery sectors, the principal sources of national income. Further, Viet Nam's incomplete integration of its S&T policies into its development policies has had detrimental effects on its implementation of strategies for economic and social growth. This chapter briefly examines these contentions and suggests an alternative path for liberating the productive energies of Viet Nam's people and applying these energies to the development and modernization of Viet Nam's social and economic pursuits.

This alternative path rests on the belief that a national S&T policy is the core instrument for building the foundations for the social and economic development of the country and that the quickest and most immediate way to expand the nation's economy lies in a technological transformation of the agricultural sector from farm to consumer. The S&T basis for such a transformation exists now and is constrained only by the ambiguities and contradictions in three central development policies: an S&T policy that focuses on building almost from scratch an economy based on high technology and industrialization; a domestic economic policy that inhibits private economic activity through a system of controls and licencing while giving monopoly or quasi-monopoly powers to SOEs that are only marginally competitive domestically and decidedly uncompetitive internationally; and a foreign economic policy that seeks Vietnamese membership and participation in international bodies and trading blocs that within a few years will open the economy to the very chill winds of global competition.

The economic and social development of nations with proud histories and ancient traditions and artifacts can be achieved through the application of science-derived technologies to their citizen's productive activities. In reviewing the

present S&T-policy documents available to the Mission, we found an underlying neglect of the potential to develop the country by modernizing its traditional sectors of agriculture, forestry, and fisheries.

A strong education policy at all levels is a precondition for the modernization of Viet Nam's economy. An early and strong S&T involvement in fostering the modernization of the traditional productive sectors would open employment opportunities, increase prosperity, add to the national tax base, and contribute to meeting Viet Nam's short- and intermediate-term foreign-exchange requirements. These earnings will be critical to realizing the longer term industrialization goals of the strategy. To be more than a failed dream, the vision of industrialization with high-technology activities, large investments per worker, and an extensive base of advanced S&T-development institutions must be supported by a strong national economy.

To provide the central core for longer term social and economic development, a national S&T policy must begin with an assessed inventory of productive resources. This inventory must include a realistic appraisal of natural resources, geographic advantages, human resources, skills, state of technical knowledge, and the capacity and capability to increase the social and economic products these resources can provide. The next step is to formulate the strategic policy to provide the operational foundation for obtaining real output from this national resource base. S&T policy in not a dream: it begins with a rigorous assessment of the production potential in the here and now, and its policy contributions emerge from an equally rigorous appraisal of what must be done.

The review and assessment of resource inventories is crucial to screening alternative development paths and opportunities. Each must be evaluated for its time boundaries, skill requirements, costs, and returns. These parameters determine the final composition of a phased strategy to be implemented in the years ahead. S&T strategic vision must explicitly embrace the parameters that condition the tactics of policy implementation.

The evaluations and assessments underpinning Viet Nam's current S&T strategy were unavailable to the Mission. It is not possible, therefore, to comment critically or usefully on the wisdom of focusing on IT, biotechnology, new materials, and automation. It is possible, however, to comment critically on what seems to be neglected.

From a miscellaneous set of external (often, nongovernmental) reports, documents, and interviews, we found that the paths outlined in Viet Nam's present S&T policy have a strong bias in favour of manufacturing and industrial technologies. This results in serious neglect of opportunities to make better use of the nation's traditional human, land, water, and coastal resources. Our belief is that

these traditional resources, now employing about 70% of the work force, can quickly and easily be made very much more productive. There seems to be overwhelming evidence that the productivity of the primary-product sectors can be enhanced through the spread of advanced high technologies, but also with relatively simple, often low-level, technologies. Many of the needed technologies are already available in Viet Nam; many more can easily be acquired from neighbouring countries or abroad.

The bias in favour of high technology and industrialization in Viet Nam's current S&T policy was ably defended by many of senior government officials we met. But the scientists and researchers in agriculture and forestry expressed, almost universally, the concern that the increased productivity possible in these sectors was not included in the current S&T strategy, as a full and complementary development path. Those not resigned to being neglected by the formulators of S&T policy (and there were a few such people) argued with conviction and intensity that they held the technological tools; with relatively little investment, the country could bring the traditional sectors to much higher levels of output through improved farming and forest-exploitation methods and improved post-harvest and food-processing techniques. The Vietnamese government would only need the political will to reform many of its economic-development policies and to carry these reforms through with constancy and vigour.

These scientists and researchers believed that the case for emphasis on the traditional sectors had not been made. They argued that it could be made if S&T policy was more broadly defined, made more broadly analytical, and brought into more comprehensive focus. They suggested that this would require appraising the nation's natural-resource potential, its dynamic and innovative agricultural economy, its highly fertile soils and irrigation-water availability, its huge potential for renewal forestry, its abundant fresh water and marine fisheries, and its recent advances in aquaculture.

In the remarks that follow, the emphasis is on the agricultural sector. Because of time limitations, the other primary-product sectors of forestry, fisheries, and mining were not included in the Mission's visits, although there was some discussion with foresters at the universities visited. However, from some comments made during the Mission's discussions, it seems evident that similar impressive gains in output might be found in these sectors with the adoption of modern forestry practices and the transformation of the rather basic technologies now in use in the mining sector, especially an upgrade of the mineral-extraction methods.

The Mission is of the view that an early and detailed formulation and implementation of a focused policy for the modernization of Viet Nam's agricultural technologies would lead to easily secured, very large dividends:

prosperity, enlarged employment opportunities, and social advance in the country's rural areas. We are also convinced that this would give a significant lift to the national budget, the gross national product, and the nation's current-account balance.

Primary products (excluding oil and petroleum) and rural services to primary-product producers account for almost two-thirds of Viet Nam's GDP.[2] In the past few years, these sectors have experienced a restored dynamism in growth, with rates now exceeding 4% per annum. This dynamic has likely created the conditions needed to sustain a concentrated short-term push to maintain the present momentum and further liberate the productive energies of the almost three-quarters of the Vietnamese people who make their living working with primary products and who thereby contribute the lion's share of national economic well-being.

The inventory: assets

Viet Nam has at least eight separate identifiable agroecological regions. Each region has been well studied by scholars, and their work is well documented. Each has it own set of advantages and disadvantages. Regrettably, the Mission did not have time to visit each region or to undertake a comprehensive review of each region's present and possible future productive potential. However, we did visit the Mekong Delta region, and we were impressed with the following resource inventory:

- The competency of the farmers was impressive, along with their knowledge and their capacity as producers of rice, fruit, livestock, and an array of other products wrested from the land and nurtured with their care.

[2] The mission used data obtained from the World Bank covering the GDP estimates for Viet Nam (World Bank 1995a). These data place the contribution from the agricultural sector at just below 40%. The United Nations Industrial Development Organization report of July 1997, *Viet Nam: A Medium Term Industrial Strategy* (UNIDO 1997), places the agriculture, forests, and fisheries at just under 30%. The difference is not critical to the argument in this section. What is critical is the observation of many people that at present the country's agricultural sector is performing much below its potential, from production to product marketing. Growth rates in the GDP contribution of the sector have been steadily increasing since 1991, and the available evidence suggests that this trend could be accelerated with a sustained drive to modernize the production technology and provide the capital needed to remove marketing and postharvest-processing constraints. These constraints are preventing the sector from reaching its full potential to contribute to the nation's economic and social development. On the balance-of-payment accounts, agricultural products, forestry, and fisheries contribute close to two-thirds of Viet Nam's nonoil exports. The nation would have greatly enhanced opportunities to expand exports with an economic and social development program for the primary-product sectors, underpinned by an aggressive research and technology transfer activity designed to expand output.

- The innovative drive among these farmers who adopted and adapted new rice-farming,[3] fruit-orchard, and livestock-rearing technologies (among others) that have provided rural areas and the agricultural economy with a strong growth dynamic.

- The climate and soil can produce an abundance of food for both farm families and the market.

- High-yielding rice varieties are remarkably uniform (indicating the high purity of varietal seed sources), well tended, and without serious signs of nutrient deficiencies or significant damage resulting from pests or plant diseases.

- The poultry and hogs we saw were of good quality, and the meat products were of a commercial standard, although the technologies used in the meat-packing industry will be in need of some obvious upgrading if Viet Nam's prepared livestock products are to enter the more demanding regional and global markets. If the meat-processing industry is modernized and some innovations are made in the transportation infrastructure, Vietnamese meat products will easily find ready markets in China, Hong Kong, and other Southeast Asian nations.

- Also impressive were the Mekong Delta research institutions for rice and fruit. Both the quality of the research and the research staff's strong desire to make their work relevant to the farming community were very evident and impressive.

- These research institutions will be national assets in Viet Nam's quest for rapid economic growth. Properly supported, they will be powerful sources of new farm-level technologies. The applied orientation of the staff will ensure that their findings are passed on to the local extension services and directly to farmers through demonstrations and training programs. Both of the research institutions we visited work with very

[3] It is of interest to note that between 1988 and 1996 paddy output increased by 57% (from 17 million t to 27 million t). Most of the increase was due to a 37% increase in yields, resulting from an expansion in irrigation facilities (cropping intensities were up by 21%, although cultivated areas declined by 17%), an increase in fertilizer use, and the use of high-yielding varieties of rice. Given the tools, the Vietnamese farmers are very proficient at doing their job.

small budgets and in relative isolation, with limited, but very important, information access to international sources of advanced technologies.

- Can Tho University has a major agricultural faculty, with an aggressive teaching and research program in agricultural sciences that is pioneering in the development of direct contact with local cultivators. The Mission believes that this academic and out-reach institution should have greater interaction with the region's research institutions of the central-government ministries, through formal linkages, including personnel sharing. Such linkages would be likely to generate a strong synergy among all the region's research, administrative, and educational personnel.

- The Mission was gratified to learn of close collaboration occurring between the Mekong Delta research stations and international agricultural research institutes in Asia and abroad. These links are an important source of varietal material for local adaptation, knowledge of the latest agronomic and other scientific practices, and interchange of information and data through interaction with a worldwide network of researchers.

The inventory: liabilities

The Mission learned of several constraints to the rapid expansion of agricultural output and a more productive agricultural economy in both the Mekong Delta region and in other parts of the country. These must also be included in the inventory:

- Realized farm-gate prices paid to the farmer for rice and fruit are depressed because of the unequal marketing power of many farmers against a few middlepeople buyers. It is hoped that the new cooperative law will encourage farmers to mount a combined front to redress this imbalance of power between buyers and sellers. The Soha State Farm in Can Tho Province is an important buyer of rice in the region and is well equipped to provide postharvest services for the farmers in the immediate area. But more needs to be done to encourage farmers to form informal groups to market their surpluses and ensure a fair return for the risks they take with their innovations and for their investments in family labour and purchased inputs.

- Discrimination against Vietnamese rice in the international export market appears to result from a lack of a widespread use in Viet Nam

of modern postharvest quality-control technologies, such as dryers, sorters, and high-tech storage facilities. The Mission learned that some Vietnamese rice (as well as coffee) was being purchased by off-shore middlepeople at lower than the prevailing international prices; the purchased rice was then sent to Singapore (and perhaps to Hong Kong) to be sorted, dried, regraded, and resold in the international market at full value, with the difference pocketed by these enterprising middlepeople. In response to a query as to why this was not being done by Vietnamese exporters, the answers were fuzzy, but central to them was the monopoly role of the two large rice-exporting SOEs, VINAFOOD 1 and 2, which dominate the rice-export sector. Other factors were the use of export quotas that channel export opportunities to a select few dealers, a lack of ready investment capital to facilitate investment in rice-processing equipment and improve quality for both the export and domestic markets, a fear of obligations under the rice-export tax, and the general difficulty of mobilizing private-entrepreneurial activities to compete in a business that is now a state-dominated activity. One informant said that "government will not allow private or joint investment in this kind of activity, it would compete with the SOEs."

- These responses suggest the need for a comprehensive S&T policy that is detailed, that is supported by the nation's political power structure, and that clearly defines the role of the financial and market sectors in supporting adoption and spread of new technological innovations. In this example, investment in postharvest technologies would raise the quality of Vietnamese rice exports, which would in turn command a higher price. Making such opportunities for such investment available to the private sector would introduce competition in marketing from farm to consumer, releasing a dynamic that would foster more innovation and technological change at all levels of the rice economy.

- The rice anecdote is not an isolated case. The same stories of poor quality control over exports and the consequent loss of foreign-exchange earnings were cited for coffee and rubber, and this may apply as well to other primary-product exports.

- At Mekong Delta universities and research institutions, people felt a sense of isolation from the main stream of the scholarly work in their disciplines. They explicitly hoped for the early introduction of ITs to

break this isolation by opening easy access to information sources and interactive exchanges with professional colleagues within and beyond Viet Nam. The research workers and institute administrators found the fax machine an important part of their information access.[4] Already, some of the Mekong Delta scientists are talking about extending ITs, such as the Internet or local Intranets, to farm and rural communities (based on the local schools or community centres) to transmit the latest findings of their research and experimental work to their rural clients.

The promise

This section focuses on the intersection of S&T and economic development. If Vietnamese S&T policy has a legitimate claim on the resources of the nation, it must focus on operational goals to ensure that S&T is applied to further economic and social growth. A central concern of the people who formulate S&T policy must be to diagnose and integrate aspects of general and specific economic development to establish and foster the conditions conducive to technological innovation. These are prerequisites for the transformation of the national economy. In what follows, we touch on many of the elements needed to mesh a robust S&T policy for innovation with aspects of economic policy designed to promote growth and development.

The current S&T policy for Viet Nam has been criticized for being oriented to urban growth and capital-intensive industry and thus ill-suited to the economic structure of an agrarian, small-business society. This is not to question the wisdom of a longer-term urban-industrial orientation. The issue is one of timing, phasing, and building from strengths.

There is little justification for society as a whole to bear the immediate risks of this segment of the economy, given the nature of primary-product production and marketing, the economic services required by primary-product producers, the weather and other risks borne by people engaged in primary-product enterprises, and the volatile characteristics of primary-product pricing and markets. The present emphasis on primary-product service SOEs should be reconsidered in this light. A case in point is the acquisition and handling of fertilizer by the Viet Nam General Corporation for Agricultural Materials (VIGECAM) and other parastatals (notably provincial administrators). After the collapse of

[4] E-mail was anticipated by many, and it was believed that it would open significant avenues for keeping in touch with colleagues throughout the country. The Internet is a much awaited addition to help contact international research and academic centres and break the barrier of relative silence felt by many of these dedicated researchers as they work at small stations located at considerable geographic distances from the more dynamic national centres of science and research.

arrangements with COMECON, in the early 1990s, VIGECAM and the provincial authorities imported fertilizers almost unchecked, certainly uncoordinated, and by 1993, the country had a large oversupply. As a result, in 1994, VIGECAM received the authority to import 60% of total estimated fertilizer needs. This has lessened some of the problems of oversupply, but the internal distribution to meet the timing demands of local crop cycles still has many problems.

Fertilizer shortages in some regions at particularly critical times in the planting and manuring cycles for various crops is an oft-cited farm-supply complaint. Because Viet Nam's agriculture is very diverse, regional crop cycles create differing peaks and troughs in farm-level fertilizer demand. Rainfall and flooding uncertainties add additional difficulties for anyone attempting to make smooth predictions of farmer off-take. Thus, the central supply agency and the parastatals face problems with local shortages in one region being out of phase with an oversupply in another part of the country. Viet Nam bears the costs of wastage in storage and in extra transportation levies to move supplies among regions, the losses in lowered crop output resulting from underfertilization, and the frustration of farmers with their difficulty operating a nationwide supply system. Indeed, as long as fertilizer (along with other farm-supply products) is handled by a single major SOE controlling a centralized procurement and distribution network for the entire nation, the people of Viet Nam will be bearing unnecessary risks and incurring unnecessary costs of state-sponsored inefficiency.

In other countries, these risks and costs fall on a group of private importers and distributors, who deal in relatively small lots of fertilizers and are in close touch with the local needs, local microclimatic variations, and the immediate demands of the relatively small, geographically scattered, rural-farm communities they serve. The flexibility of a private agribusiness-service sector is the key to meeting and controlling the social costs of the decentralized and inherently risky economic conditions of producing primary products. Transferring these risks to local markets and local businesspeople means transferring the costs from society to competing individual entrepreneurs. A strategy of building a strong, private agribusiness sector in the rural areas would transfer these manifold risks of primary-product industries to individual businesspeople and provide rural producers with a competitive array of services tailored to their local circumstances and needs.

Average rice yields in Viet Nam are already greater those of many Asian countries. But yields per hectare per crop in the best-endowed areas of Viet Nam are lower than those in similar rice-farming areas in the more advanced Southeast

Asian nations. The fault is not with the farmers or the research stations. The fault is with the inadequate support systems available to the farmers. We characterize these systems as follows:

- An underpaid and undertrained extension service, often isolated from the mainstream of agricultural research (difficulty attracting agricultural graduates to the rural areas has weakened the provincial extension services and was often cited as a significant impediment to the on-the-ground effectiveness of extension workers, who are the principal means of transferring new farming technologies to cultivators);

- Poor communication and incomplete demonstrations of the latest farm production and cultivation technologies;

- Premodern methods of caring for livestock;

- Inadequate postharvest facilities;

- Primitive, often exploitative, marketing systems; and

- Weak communication of market information, prices, and harvest expectations, notwithstanding the effectiveness of rural radio as a notable exception.

Television programs directed at farmers are now being tried and appear to be very effective, as well as being appreciated by the rural audience. Videotapes that extension workers can leave in the villages for people to further study also appear to be effective ways to demonstrate new production technologies. It seems likely that as mass-communication techniques improve and as the universities and extension services gain more experience with them, many of the present deficiencies in communicating new technologies to the rural peoples will be overcome.

Weaknesses of particular note can also be found in the timely availability of crop-production inputs and the storage and processing plants that should make up the infrastructure of a modern agricultural economy. Although these inadequacies cannot be rectified easily or quickly throughout the whole country, Mission members believe an aggressive early program of modernization, focused on regions with high production potential, can generate large dividends through the rapid expansion of farm output for domestic and export markets. With suitable

policies and implementation tactics, foreign-market studies supported by aggressive marketing of a Vietnamese agribusiness community could make the agricultural sector the early engine of remarkable growth. Rural investment would increase greatly and create thousands of new jobs, with relatively low investment per worker. This would also be a vibrant source of the foreign exchange and domestic savings needed to establish the industrial base for subsequent phases of the S&T strategy.

Viet Nam has more productive natural resources in agriculture and coastal fisheries than its neighbours. These should be exploited in the first stage of the nation's growth strategy. The tactics for implementing such a strategy should become central to a phased S&T policy. Critical to the implementation tactics of the early phase of this strategy would be the role of the government in ensuring fair agricultural markets and providing a safety net for the risks of weather and price fluctuations that must be borne by the farmers.

Government programs are needed to encourage the private sector to expand the agribusiness sector to provide farm-product processing, supply farm inputs and input-use advice, and generate new employment opportunities in rural communities, agricultural-service centres, and villages. A strong agribusiness sector would ensure the sustainability of a powerful dynamic in rural areas.

The Mission did not visit the uplands or more remote areas of the countryside. People who knew more than the Mission members about Viet Nam, expressed caution over the inadequacy of the rural infrastructure in many parts of the nation, to support a dynamic rural service sector and agribusiness complex, especially the inadequacy of market facilities, roads, transportation, communications, and available electric power. To rectify these difficulties will take time, but a vibrant rural sector in the early stages of growth offers the promise of an expanded tax base, which can finance social investments in rural infrastructure.

For this reason, the Mission suggests initiating the proposed strategy in areas of high production potential, with embryonic off-farm appurtenances of a modern agricultural and rural economy. As the development strategy unfolds, tax receipts from the new prosperity will enable the various levels of government to launch and sustain these activities. And in line with current practice, the government should continue its supervision to ensure fair markets, encourage farmers to cooperate in handling and selling their crops and livestock, and enforce weights and standard measures for farm products and purchased inputs.

If the government takes these actions and follows up with a determination to make them effective, it will establish the enabling conditions to garner the domestic and foreign investment needed for Viet Nam's agricultural transformation. Investment in the much larger agricultural-infrastructure projects in irrigation

and drainage and in building a fertilizer and agrochemical and -machinery industry could follow in the later phases of an overall industrialization program.

This chapter has given little attention to the agricultural economy's increasing need for plant nutrients. A 1996 report of the Food and Agriculture Organization of the United Nations (FAO) "Fertiliser Donation and Distribution: Viet Nam, Project Findings and Recommendations," reviewed the results of fertilizer-demonstration trials in five rice-growing areas of the country, covering a total of 769 ha. These trials indicated that farm applications of fertilizer were considerably below economic optimum. Regression analysis of the FAO results, adjusted for regional differences, indicates that additional fertilizer, especially added nitrogen, increased paddy yields by more than 0.41 Mt/ha for each 10 kg/ha of additional N and P_2O_5 over present farm-level applications. Overall, fertilization rates in Viet Nam are below those of the other Southeast Asian countries. It is highly probably that as new rice varieties are developed and as the rural-agroindustrial infrastructure expands to better serve the farm economy, demand for fertilizer will grow rapidly. Newly discovered gas fields off the coast of Viet Nam promise a domestic feedstock supply for the manufacture of nitrogen fertilizers, such as urea. The decision to manufacture will depend on the relative economics of the classical make-or-buy choice of any manufacturing enterprise. But whether from domestic sources or imports, farmer adoption of new rice varieties now being developed within Viet Nam will increase the demand for local supplies of fertilizer. This demand will only add to the already substantial growth in fertilizer use resulting from current trend toward commercialization in the agricultural economy and its greater orientation to the production of marketable surpluses and cash crops.

The doubts

In discussing the impediments to energizing the agricultural sector, the mission encountered many people with doubts. The agricultural scientists and researchers had little doubt that it could be done but doubted the sustained resolve of the government to mobilize and sustain such a strategy. Each had his or her own vision of what could be done, and each had priorities that closely paralleled the observations of the others. Mission members found the observations penetrating, often insightful. Indeed, we observed and were greatly impressed by an agricultural-research establishment that had accomplished multitudinous tasks on minuscule budgets. We found this all the more impressive because of the extra-heavy burden of rigid and bureaucratic administrative processes unsuited to providing flexibility

in the management of research. It is not surprising, therefore, that their doubts reflected a wariness about the lasting quality of a program requiring the continued attention and steadfast resolve of government.

Other doubts were focused on the international market for Vietnamese agricultural products. The contention was that this market is fraught with quality and price barriers that Viet Nam cannot hurdle. In fact, no one has really ever assessed or tapped the market for high-value Vietnamese products, such as fruits, vegetables, fish and livestock. To successfully enter this market, the national development strategy must be built on a postharvest food-processing infrastructure to prepare, package, and handle perishable products to make them a valued item in regional or global markets. To pursue sales in these markets, it may be useful to seek the help of large multinational food and agricultural-product export firms to assist or, better still, to invest in developing an international market for Vietnamese high-value food products.

The marketing problem is, in fact, not unduly complicated. The development of a food-industry infrastructure involves a fairly straightforward application of well-known technologies and business principles. With the right investment incentives and government policies that foster and encourage private investors to build storage facilities, refrigerated depots, meat-packing plants, food processing factories, and transport capacity, the international market can be opened to Viet Nam's exports. Viet Nam's Southeast Asian neighbours did just that. Their experience provides a valuable lesson in how to walk the road to success in international agricultural marketing.

Most of the doubters were people who implicitly despaired of improving Vietnamese agriculture because of its small farm sizes and its current backwardness. The Mission did not seriously entertain these objections, as development models based on primary products were successfully launched under virtually identical conditions in the neighbouring countries of Southeast Asia — a region with very small, intensively cultivated farms.

Agriculture and the environment

The research scientists raised a caution centred on the impact of high-intensity farming on the natural environment. For example, difficulties are almost certain to arise in controlling pests and diseases, and these need to be taken very seriously. The solution to this difficulty, however, rests on the talents of the same scientists who raised the concern. When challenged, these scientists offered many

solutions to this problem, all resting on innovative research, the spread of new plant varieties, and improved methods of integrated pest management.

Mission members familiar with agriculture added the maintenance of soil fertility as an environmental caution, although this not raised specifically by the Mekong Delta farm scientists. High-yield, high-intensity farming can deplete soil nutrients, especially trace elements vital to sustaining crop yields, and in the upland areas it will be necessary to constantly monitor the condition of the soils. Such monitoring can have its beneficial side: the baseline analysis of the soils often reveals previously undetected but correctable nutrient and soil-structure problems that limit the initial productivity of land.

Of more general concern to scientists and researchers in the Mekong Delta (and a valid concern in other agroecological areas as well) is one the Mission takes very seriously. It is the impact of high-input, intensive farming on the environmental balances of the Mekong Delta's complex hydrological ecosystem. This matter will require careful long-term research, but it should not be forgotten that development and population pressures in the region are already causing alarm, as they are an immediate threat to the unique ecology of the Mekong Delta. A few signs show this threat abating under current trends and conditions. In fact, it would be a gratifying result if a new agricultural-development strategy is launched in the Mekong Delta with built-in environmental safeguards and amelioration, included in its design and implementation.

The agricultural-research milieu

Visits to agricultural universities and research institutes revealed a dynamic, strong research establishment, supporting the acquisition, adaptation, assimilation, and development of modern technologies suited to Viet Nam's agricultural economy and production environment. Two examples are worth specific mention:

- The Cuu Long Delta Rice Research Institute (CLDRRI) is working to adapt a new variety of rice that offers significant yield increases for Mekong Delta and other rice farmers. The base genetic material was supplied from the International Rice Research Institute (IRRI) in the Philippines. Tests and adaptation trials are now under way at the CLDRRI. The new variety is of long duration, to bring it through the rainy season, with harvest occurring after the rains. This is an important attribute if yields per hectare are to be as high as predicted. Harvesting after the rains in the dry season reduces the need for artificial drying

and a concomitant investment in dryers.[5] The long-duration growing season intercepts more light for carbon fixation from photosynthesis, a major element in higher yields. The long season will also open greater opportunities for integrated pest management, thereby reducing reliance on pesticide chemicals. The new genetic materials give the plant an upright stature, with stiff straw that can support a long and heavy panicle. It tillers well and, with proper fertilization (it does require heavy applications of nitrogen) it permits high plant-population densities, another lift to yields. Presently, these new varieties yield 14–15 t/ha of paddy per crop.

- The CLRRI will cross this exotic varietal material with locally adapted varieties to preserve pest and disease resistance of the Mekong Delta environment and, after testing and demonstration, will release the newly adapted varieties to local cultivators. Discounting experimental yields and assuming that the yield potential of the basic genetic stock is preserved, perhaps even enhanced, the release of varieties incorporating these new genes may increase the average production of a typical Mekong Delta rice farm by one-third to more than one half.

- The CLRRI has strong ties with the IRRI. It participates in the international rice biotechnology network, sponsored by the Rockefeller Foundation, and has close contacts with other rice-research centres in India, Southeast Asia, and elsewhere abroad. These contacts bring a flow of information that keeps the CLRRI research staff members abreast of new developments in their disciplines, and enables them to provide up-to-date information to farmers.

- The Long Dinh Fruit Research Centre (LDFRC) is selecting superior clones for many different fruit products produced in Viet Nam. LDFRC researchers are certain that Viet Nam has an enormous unfilled domestic and export demand for all of these many fruit varieties

[5] Noteworthy is the need for a small, easily transportable village-level rice dryer. Evidently, such a machine has been designed and manufactured by Sameco of the HCMC Department of Industry. However, it is not easily available in the local market. In fact, there is some question whether, even if available, it would be an attractive investment for most farm villages. Because it costs a reported 17 million dong (VND) for a capacity of 2 t per 8-hour shift (about enough for two-thirds of a hectare at average yields), the feeling was expressed that the Sameco machine is hardly an efficient substitute for a larger dryer plant that can serve many farms or a village (in 1988, 12 987 VND = 1 United States Dollar [USD]).

> providing they meet the quality requirements of these markets. The LDFRC's international ties with Australia, India, Indonesia, Israel, Malaysia, Taiwan, Thailand, and the United States, to name but a few of its collaborators, keep the centre well abreast of what is happening outside Viet Nam. Efforts to free the nation's citrus farmers from the devastation of the green disease, which destroys the tree stock of the citrus orchards, are among the LDFRC's most important applied-research activities.

The staff members at both the CLRRI and LDFRC will become eager users of a newly introduced system of e-mail when the global Internet is more widely available in Viet Nam, and they are looking forward to using it to extend their interaction with other research organizations throughout the world.

The Mission was most impressed during its visits to the CLRRI and LDFRC with the strength of the orientation and dedication of the staff members to their scientific and academic responsibilities. More impressive, however, was the research scientists' dominating concern to develop and transmit new, adapted, and tested productive plant materials, cultural practices, and knowledge to their farmer clients, enabling them to enhance farm incomes and agricultural output. The CLRRI and LDFRC were, however, not alone in their concern to serve their clients. Virtually all the institutions engaged in furthering the course of national economic development had a strong sense of serving the nation through the application of new technologies. This topic dominated discussions at the food-technology and agricultural-research institutions and at the agricultural universities working on research, teaching, and rural extension. It was the central topic at provincial departments of S&T, at environmental project centres, and at the planning departments and chambers of commerce in major cities.

Virtually without exception, however, our discussions with personnel at these centres and departments revealed a high level of frustration with how slow, confusing, and contradictory were the government policies they were expected to administer. In the end, they expressed widespread frustration over difficulties influencing and making more realistic the policies they were supposed to work with and implement. As one person put it,

> We work with the best we can and develop new opportunities for the people we are supposed to serve but we have no voice in the policies of the Government. At our level these policies seem too often to ignore what our clients want and need and which can only be provided if the Government permits or directs. We know the problems of the people, but

> we have no role in making or implementing — or should I say, the non-implementing of — policy.

Others added that the opportunities to liberate the productive energies of the people were all around them, but, as another person put it, the liberation "seems to be stymied by but a conscious failure of government to act or even permit others to act." Even the most dedicated public servants privately complained that policy duplication, policy conflict, policy ambiguity, policy uncertainty, even policy vacuums, conspired in one form or another to restrict and constrain their ability to fulfil their responsibilities and obligations as public employees. In the summation of one senior official, "the main issue facing the economic development of Viet Nam can be summed up in three words: Policy, policy, policy!"

The need for large investments in postharvest technologies is a particular case in point. This need is evident to the researchers in all the institutions dealing with farm crops. The necessary technologies are known. They can be imported or obtained in Viet Nam. In fact, Vietnamese firms have designed and produced some machines needed to protect farm harvests. But people who have tried to take advantage of the commercial opportunities offered by investments in postharvest activities expressed frustration with a policy framework they claim provides more disincentives than incentives for firms to commercialize technologies and their downstream applications.

A scientific constant the world over is that the public-sector researchers, university professors, and extension workers of a nation are not content with their pay scales. This discontent was forcefully expressed at our meetings. It was claimed that public-payroll researchers in food and agriculture receive salaries one-half or less than those paid in the private sector. The discrepancy causes low morale, a continuous search for better career prospects, and in too many cases the researchers' taking second or third jobs or consultancies to augment personal income. Frequently, these extracurricular jobs supersede, in time and attention, the original public-service contract. More crucially, low wages discourage the truly talented researchers' entering the public service, which consequently reduces the excellence available to serve the needs of the nation. Indeed, the wonder is that taking into account their salaries and the conditions under which many of them live and work, these researchers and teachers are as dedicated and involved in the work they do as they are, as well as in the service they give to their clients. These problems must be expected to increase as Viet Nam's economic transformation proceeds. This matter should be addressed in the forthcoming national S&T strategy.

Mission members with experience in other research and university institutions abroad were deeply impressed with the very high level of technical competence and professional skills of the people the Mission encountered, despite the pay and conditions. Because the time the Mission spent at the research institutes and universities was so brief, many of the members were strongly tempted to prolong their stay at most of the places visited, to profit further from discussions with the talented people who extended their hospitality and gave so generously of their time and wisdom to the outside intruders.

The issue of fair compensation for the scientists and other research workers should become a high priority for an appropriate pay-review body. Perhaps the government should consider establishing a formal Viet Nam Agricultural Service cadre for people who qualify as highly skilled and trained professionals, with appropriate emoluments and in-place promotions and salary increases, reviewed for each member of the service every few years. As an added bonus, the prospect of joining an elite service on graduation might reverse the disturbing decline of the past few years in student enrolments in the agricultural faculties of the nation's universities.

Inadequate research budgets are also a worldwide complaint of most research institutions. Again, at least in the case of agricultural research in Viet Nam, the research workers seem to have a valid complaint. External ODA to the universities and research institutions provides an important budgetary lift that appears to be well and properly used. However, as a leading researcher put it,

> They [people at his government ministry] have given us more autonomy in how we formulate and carry out our research and have told us to contract with the private sector for research projects. But we serve farmers. Who among them will contract for our research? We have more autonomy but no more money. I would like to have my research group made even partially accountable for what we do to raise the incomes and productivity of our farm clients and, then, have our budget tied to that accountability. Let them [people at the ministry] give us support for what we do for the nation. Let them put support for each of the research institutes on that basis and we will, together, show them what we can do for the country."

How central-government research budgets are prepared and how the project allocations are made were unsolved mysteries for the institute directors and researchers with whom we met. They prepared and submitted research project proposals to higher authority for approval, but they compared the processes and criteria used in decision-making more to a lottery draw than a system of rational

review and priority assessment. They were of the view that the research priorities they indicated had little influence on the outcome. They told us that as a result, research enthusiasm flags, morale and confidence in the central administration fall, and in the extreme cases institute directors surreptitiously divert funds to the research regarded as a priority. Unfortunately, this erodes respect for the budgetary process and for the implementation of the unknown (or unappreciated) S&T policies that are supposed to underlay the budget allocation process. A participatory, consultative process in budget allocations would go a long way to dispelling ignorance while building confidence among people in the research community with those who administer public funds.

Partly as a result of the assistance of external donors and partly as a result of the efforts of the government to support the physical facilities of its S&T institutions, research-staff members at the places the Mission visited expressed satisfaction with the general adequacy of their facilities. As might be expected, however, they called for additional or upgraded scientific equipment — a common plea of scientists across the globe.

Some concern was expressed at both the university and research-centre levels about the difficulties communicating with other institutions within the country. It was hoped that the new e-mail system would solve some of the difficulties. One suggestion was to establish one or more internal (that is, within Viet Nam) Intranets to link centres of similar interests via common communications protocols to permit these centres to share a full array of documents too bulky for e-mail. Researchers obviously regarded the relative difficulty communicating with their peers at similar institutions in the country as a bottleneck to improving research efficiency and better integrating national research activities. Also mentioned with some frequency among the communications gaps was the need for easier access to official government data sets, especially those containing economic data. The case in point was the tracking and analysis of the nation's sugar policies and a review of that policy with economists and other scientists at other Vietnamese institutions. Data on stocks, import contracts, production, and acreage were believed to be collected by and available from the central and provincial governments. Access to these data was requested for independent economic analysis. Because sugar prices in Viet Nam are volatile and because sugar farmers are vulnerable to price swings, an early analysis of crop prospects and national stocks would be valuable information to guide cultivators in planning their year's planting and for sugar factories in assessing the likely cane and product prices they would face in their refining operations. The essence of this plea was to open more of the nation's economy to independent, academic analysis, as part of the process of generating a more widespread policy dialogue. A national Intranet for

economic and policy research centres would be an obvious answer to this need for easier access to official government data sets.

In summary

The Mission is convinced that Viet Nam's new S&T strategy requires a phased or sequenced approach which, in its initial stages, assigns both high priority and major resources to modernizing the primary-product sectors, especially agriculture, forestry, and fisheries.

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. The concomitant S&T strategy for the social and economic development of the nation's natural-resource base should be centred on two major goals. First, it should seek to liberalize and apply the productive energies, enterprise and skills of Viet Nam's primary-product producers and rural private businesspeople and investors to meet the needs of a modern primary-product economy. Second, the S&T strategy should strive to establish conditions conducive to foreign investment to complement domestic efforts to create a truly advanced agribusiness infrastructure to serve primary-product producers.

The proposed two-pronged strategy would use the excellent array of technologies already developed by the nation's agricultural, crop, livestock, and fishery research institutes and universities. Because of the disaggregated and disbursed nature of primary-product production, the strategy must also enlist the active participation of the domestic private sector as a source of business investment. Private initiative can provide the entrepreneurial talent and investment funds needed to build a modern agribusiness complex to serve producers and to create and operate the postharvest processing systems required to meet international-market standards for food and cash-crop commodities.

The technical foundation to expand the output of Viet Nam's farms to meet the needs of new markets is available and considered more than adequate. The weakness of the economy to accommodate such an S&T economic-development strategy lies in the relatively underdeveloped infrastructure of its food-processing and farm-supply sectors. Investment in storage, meat-packing plants, fruit-preservation systems, etc., must be the main focus of a program to build modern agribusiness complexes in those areas with the resource base to increase the production of high-quality outputs. These outputs, when properly processed, must be able to meet the quality demands of the international market.

The implementation of the proposed strategy for primary-product development rests on the already proven capacity of farmers to innovate by rapidly using new production techniques. Because the technologies needed to initiate a

transformation of Viet Nam's rural economy are known or are readily available in the country, what the country most needs to do now is to build an incentive structure to launch and support these technologies' application and use. This is a core issue for national policy. Indeed, the national policy's full implementation will bear with heaviest weight on the resolve and will of the government. Strong concerted action must be taken on all government fronts to initiate a set of comprehensive incentive policies to foster and encourage the transformation of the primary-product sectors from their traditional role of supplying mainly the domestic market alone to that of also supplying the demands of regional and global buyers.

Indeed, the lessons from successful transformations of other Asian nations strongly suggest that the conjunction of an applied S&T strategy with an economic--development strategy for the primary-product sector can vitalize the rural economy and society. Its implementation can modernize rural areas, provide many new rural employment opportunities in relatively low capital-intensive jobs, and earn the foreign exchange needed for a broader program of industrialization.

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Chapter 13
THE EMERGING HIGH-TECH ZONES IN VIET NAM

The actual locations for research, experimental development, and related services is seen as a key factor in a more effective economic exploitation of new technology. Science-based technology needs a critical mass of specialists and an environment in which communication among these specialists is made easy and effortless.

During our interviews, we were repeatedly told that Viet Nam should make optimal use of its academic and other highly qualified specialists and let them become increasingly involved in product development, engineering design, testing, and standardization, etc. Moreover, we encountered a growing concern among senior Vietnamese decision-makers that the country's S&T infrastructure needs to be radically improved. In the past few years, a set of actions have been taken to make contacts among scientists easier and increase the mobility and improve work conditions for technical and other specialists. However, much remains to be done.

The most spectacular among the government's intended efforts to improve S&T infrastructure — and to help shape innovative capabilities for industrial and other purposes — are two high-tech parks. During the past 4 years, detailed plans have been made in both Hanoi and HCMC to relocate the R&D laboratories and facilities of the two campuses of the national university to the vicinity of two high-tech zones. The purpose is to stimulate closer interaction between academic staff and other specialists among Vietnamese and foreign firms and institutions. It is assumed that the spiral pattern of innovation, involving university–industry–government experts in a high-tech park, will capture the evolution of multiple linkages at different stages of the expected commercialization of S&T and related know-how.

Two key questions raised in our many conversations on the intended high-tech efforts are the following: Could these high-tech zones — with the active participation of foreign direct investors — be effective in creating and shaping much-needed innovative capabilities in Viet Nam? Will the parks become nodes in international networks of S&T and industrial experts interested in transferring and adapting significant technological capabilities to Viet Nam? The two questions are of genuine concern in today's Viet Nam, as an effective high-tech park will

require substantial investments and involve considerable risk-taking for the park developers.

The two parks are to differ from the export-processing zones (EPZ) and other designated industrial areas in the two metropolitan areas. The parks' tenants will benefit from a more advanced infrastructure (including power supply and telecommunications), specialized-training and other educational institutions, a technology incubator, and business-development centres, which could tailor services to high-tech companies. Still, the park tenants will have special privileges, compared to those at the EPZs.

The high-tech industrial park of HCMC is to be placed in an attractive environment in the Thu Duc area, where the new campus for the southern branch of the National University is currently being built. The project was launched several years ago by the city administration (the People's Committee) and is now part of the national high-tech-park program. A corporation to develop and manage the park has been established, and the recruitment of anchor tenants to invest in the park is on its way. In this process, foreign institutions and firms have provided inputs to the design of the park (a prefeasibility study) and to its implementation strategy. However, in 1997, the central government in Hanoi imposed a set of controls on the park's development, which may impel the Department of Science, Technology and Environment to reconsider its current plans for the park's development.

The high-tech park in the Hanoi area, if implemented, will be placed in the Dong Mo-Ngai Son area about 30 km from the centre of the city, where the new campus of the northern branch of Viet Nam National University is to be located — next to a national cultural centre and an attractive industrial zone. The park plans were recently examined in a joint study conducted by the Japan International Cooperation Agency (Japan) and an expert team from MOSTE. The first phase of Hanoi's high-tech development may take place in the western part of the city itself, along a "high-tech corridor," where more than 70 of the country's R&D institutions and some foreign-owned high-tech service facilities are already located. The Ngia Do-Tu Liem area may emerge as the Science City of Hanoi. As in the case of the high-tech Park in Dong Mo-Ngai Son, the Prime Minister has ordered further studies, before a final decision can be made to go ahead. Together with interested partners, the Department of Science, Technology and Environment, Hanoi, has developed detailed plans for a "pre-engineering zone" to be located in the Nam Thang Long area, not far from the Science City and the capital's international airport.

In the long term, all four high-tech zones may be developed, but the sequencing of the investments could become a matter of controversy. At present,

the two major high-tech parks in Hanoi and HCMC remain the centrepieces in government thinking. Although the feasibility studies for the two high-tech parks in Hanoi and in HCMC are not fully complete, the highest level of government appears to be generally committed to implementing both projects. Both projects appear to be integral to the government's plans for industry and modernization.

However, the necessary investments have yet to be allocated for the basic infrastructure for both high-tech parks. The government hopes to receive the bulk of this funding from MNCs and from governments of other countries. Except for contributing to the feasibility studies, the central government has made direct capital investment only in the road to Dong Mo-Ngai Son. The government continues to search for overseas partnerships to make the parks internationally attractive sites for high-tech investments. Several governments have shown an interest but have made no legally binding commitment. Despite the apparent lack of financial resources earmarked by the central government of Viet Nam to high-tech projects, the Commission of the European Union (EU) and several EU member governments have signaled an interest in supporting Viet Nam's policies for industry and modernization.

To pave the way for more European firms and institutions to invest in Viet Nam and to expand the base for economic cooperation between Western Europe and Viet Nam, the European Commission has consulted with MOSTE and the Ministry of Planning and Investment about a high-tech-support program. The very first part of this program is already being implemented: transferring experiences of successful European science parks, research parks, high-tech industrial parks, etc., to Viet Nam.

Vietnamese high-tech experts have, on a bilateral basis, shared experiences with representatives of several European high-tech parks, such as Sophia-Antipolis (France), Ideon (Sweden), and Symbion (Denmark), particularly on how to make a high-tech park economically feasible and commercially successful. Various EU nations, such as the United Kingdom (through the British Council) and Sweden, have made experts available through university–industry collaboration schemes, also on a bilateral basis. A similar bilateral collaboration is under way between Japan and Viet Nam, endorsed by both governments. Both government and industry are supporting the conceptual design for the Hanoi high-tech park in Dong Mo-Ngai Son. On behalf of the Japanese government, experts from JICA have participated in a feasibility study for high-tech investments in the Dong Mo-Ngai Son area. One of the central questions is how make a high-tech park in Viet Nam economically effective.

The high-tech parks in the Asia–Pacific region, more so than those in the highly industrialized countries of the West, emphasize high-tech manufacturing

over R&D. In Southeast Asia, this reflects the current resource profile of NICs with relatively limited R&D activities. Compared with other developing regions, the links between technology, industry, and commerce seem to be more direct in Southeast Asia.

Early in their development, most high-tech parks in Southeast Asia converged with FDI, with subsequent shifts toward local industry. The main exceptions to this step-wise development, from global to local, are found in parts of China, where some high-tech parks or research parks began with an emphasis mainly on local R&D institutions and firms.

It is clear from our interviews that Vietnamese high-tech-park experts consider each high-tech park a unique combination of resources, whether it is called a science park, research park, or technopole. Each and every park is moulded by different socioeconomic and political circumstances, driven by firms and institutions with different perceptions of high-tech networking and an ever-changing mix of available local resources. The impression given is that the two high-tech parks should serve as models for the country's industrial achievement, with rapid industrial growth, environmentally clean production facilities, foreign-induced technological change, plus other innovations, and exceptional international connections.

Ideally, a high-tech park in Viet Nam will offer plenty of unexplored commercial opportunities for its foreign direct investors and provide new challenges to the domestic firms and institutions interested in linking up with high-tech firms from overseas. If properly handled, these new links will make the transfer of high technology and related know-how to Viet Nam faster, economically much more effective, and possibly also more appropriate to the country's socioeconomic development. For the Vietnamese park developers we have interviewed, no high-tech park in the world could easily serve as blueprint model for a new park in Southeast Asia. It is widely recognized that a park in Viet Nam must follow its own course for investments to fit its particular objectives, its socioeconomic environment, and creative atmosphere.

To establish a high-tech park anywhere amounts to undertaking a megaproject. To do so in Viet Nam today will likely require substantial investments from the government (or high opportunity costs if funded by others), and the risks are extremely high. To succeed, the orchestration of investments — particularly those for infrastructure — must be accomplished at an early stage. Park developers usually only get one chance; if mistakes are made, they cannot always be repaired. Initially, a number of anchor tenants will help set the pace and direction for the park's development and raise the park's reputation among international industrial firms. If these early activities go wrong, the whole park may

have an image problem that will take considerable time and effort to repair, if repair is even possible.

What to consider while constructing the high-tech parks?

Having examined the documents from the prefeasibility studies for the high-tech industrial park in HCMC and the more recent feasibility studies for the Hanoi high-tech park, we would like to suggest the brief general checklist in box 13 for the consideration by Vietnamese decision-makers.

The interviews also pointed to specific issues in the actual design of a high-tech park, in both Hanoi and HCMC, and benefits that might be achieved in the first 5 years of a park's operation, given a particular conceptual design. Based on evidence from similar initiatives elsewhere, it would be important to clearly specify at the planning stage the park's goals and objectives and its means of achieving them, as well as specifying the constraints and difficulties with equal clarity.

Such clarity is required if obvious and easily resolved disincentives to high-tech development are to be removed. For example, during our visits to companies and institutions, we were told that Viet Nam imposes a number of such disincentives to high-tech investors for import and export of specialized technical equipment, such as a lengthy approval process for any application and other bureaucratic practices. Labour codes, systems of human-resource management, and legal frameworks may also be among the implicit S&T policies that bear on the success or failure of high-tech parks. For example, based on the interviews we held, special attention should be given to the legislation applicable to Vietnamese scientists and engineers establishing new high-tech firms and institutions.

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PART IV

Conclusions

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Chapter 14
CONCLUDING REMARKS AND SUMMARY

During our Mission, we observed many strengths in Viet Nam's S&T, and these provide an important base to build on, most particularly,

- A strong political commitment to the integration of S&T instruments into the larger socioeconomic objectives of the country and to making S&T a driving force in Vietnamese modernization and industrialization;

- An inventiveness and ingenuity that is conducive to absorption of new technologies and, most importantly, to the management and adaptation of those technologies to local requirements and the needs of Vietnamese society;

- An existing network of institutions engaged in S&T activities that can be mobilized to make S&T a driving force in Vietnamese economic development;

- A clear indication of Viet Nam's intention to establish national institutions (that is, the two campuses of the national university that will combine excellence in research, learning, and teaching with the needs of production and competitiveness; and

- In some sectors (notably in agriculture), people have a very strong sense of what exactly needs to be done through S&T to meet the needs of production and competitiveness.

These are important strengths, and to these must be added the universally acknowledged inventiveness of the Vietnamese people under the adverse conditions that history inflicted on the country. Also, Viet Nam has had many accomplishments in more recent years in its quest for modernization. These factors give justified reason for optimism about the future

Yet, throughout our interviews and conversations (including those with very senior officials of the new government), it was clear that Viet Nam has now arrived at a crossroad. The new forces of globalization and regionalization are posing completely new challenges for all countries, whether they are developed or developing. For Viet Nam, as for the rest of the world, the past is no longer prologue.

The central observation of this Mission is that Viet Nam has not sufficiently adjusted its systems of S&T and education to respond to its new economic and social circumstances or to meet the competition that integration into and beyond the East Asian trading market will bring. Viet Nam's current policies of relatively modest, incremental adjustments will fail to serve both the modernization aspirations of the Vietnamese people and the stated purposes of the government. In the neighbouring countries of East Asia, spectacular technological advancements — centred around ITs, biotechnology, and other high technologies — are reshaping the material basis for agriculture, industry, and the rest of the economy. Modest incrementalism may place Viet Nam at a serious disadvantage.

Among the issues and difficulties highlighted in this report are the following:

- Policies are inconsistent and even contradictory. Economic, financial, legal, banking, credit, and institutional policies often work in contrary directions and may undermine otherwise sound policies for S&T.

- Decision-making processes pertaining to the entire S&T system are slow, burdensome, and bureaucratic. If these problems are not addressed quickly, they will seriously hamper Viet Nam's efforts to integrate itself into AFTA and the global economy. We made a number of suggestions to streamline the S&T systems and processes.

- Viet Nam does not have well-developed systems or capabilities for technical and economic forecasting or foresight. This places the country in a vulnerable position in comparison both with its more experienced neighbours (China and the Tigers) and with others in the globalized marketplace.

- Viet Nam has limited technology acquisition under existing arrangements, and some local partners perceive the cost of technology acquired through joint ventures to be high (most of which involve turnkey producers of final products, rather than of parts or components).

- Viet Nam has a weakness in the assimilation of new technologies and underinvestment in assimilation following the purchase of new technologies. This is not the case in other countries in the Asian region, and this problem needs to be addressed urgently, as it places Viet Nam at a disadvantage.

- The national R&D system in Viet Nam is highly fragmented. The limited resources available are not strategically well targeted. (In Chapter 4, we made a number of suggestions for actions to improve this situation.)

- Perhaps most seriously, the international team was reminded repeatedly of very serious underinvestment in technology management and systems engineering. Without urgent attention to this issue, Vietnamese ownership and control over its S&T will be constrained in the competitive world it is entering.

The S&T Strategy should accord a high priority to the application of S&T to the traditional sectors — especially to agriculture, forestry, and fisheries — including postharvest technologies and agroindustry. These are vital investment areas for the nation and a source of productive and sustainable livelihoods for some 70% of the population. The energy and dynamism of these sectors — if aided by investments, including investments in building and applying S&T — will be essential to generating the economic surplus (domestic savings) that Viet Nam needs to achieve its goal of modernization and industrialization by 2020. We emphasized this point and suggested a number of S&T issues to be addressed in this context and a number of applications of high technologies in these sectors.

The national system for the allocation of resources to higher education and to research should be modified dramatically and given a clear strategic focus. We made a number of somewhat specific suggestions in this regard. Our conclusion is that the scarce resources available can yield high dividends if these suggestions are put into place and that the new mechanisms will also attract external sources of capital.

An urgent and ambitious effort is required to establish a broad national capability in technology-systems management. We are not referring to capabilities in basic or engineering science but to a national cadre adept in

- Information techniques;

- Management-information systems;

- Decision analysis;
- Project formulation and assessment;
- Project management, including scheduling and costing;
- Technology sourcing and intellectual property rights;
- Marketing and after-sales service;
- Operation and maintenance of both large and small facilities; and
- Total-quality management.

Our report placed a very strong emphasis on this. We concluded from the full range of discussions during this Mission that without such an effort, the foundation for a national S&T strategy will be vulnerable.

We also emphasized the requirement for an NSI, including linkages with international knowledge networks. Innovations occur almost always at the firm level, but high value and high return on investment can result from national systems that encourage and support such innovation through taxation policies, incentives, awards, and other supports. In our report, we made some suggestions.

Linked to the above is the need to make an S&T strategy address and provide a national enabling environment for the acquisition, absorption, and transformation of technologies. We have addressed this issue and made a few suggestions about factors, policies, and some experiences elsewhere that may be useful to consider.

The four priority areas for Viet Nam's S&T strategy are ITs, biotechnology, new materials, and automation. These are well known to be priority areas in many other countries, as they are the enabling technologies transforming all aspects of production and distribution. The real issue is how to judiciously apply and appropriately balance these technologies to gain comparative advantage. This is exceedingly difficult, as it requires truly vast combinations of knowledge and systems built on agility, flexibility, and entrepreneurship. If such combinations are to be achieved, a strategy is imperative. The idea that this can be achieved by way of a plan must be discarded: a good strategy serves as a compass, not as a roadmap. It invites and enables flexible responses and rapid adjustments to changing conditions and opportunities, and we believe this is both what Viet Nam requires and what it is in the process of building.

Accordingly, our report emphasized the importance of a broad, enabling framework and building instruments, policies, and arrangements to support ongoing economic and technical forecasting and foresight. We suggested establishing a new international consultative mechanism, the Viet Nam Forum for Science, Technology, and Modernization (see box 9). The forum we have in mind would function under the chairpersonship of the Prime Minister or the Vice Prime Minister and would comprise international, regional, and national leaders of business, industry, and finance (supported by people in the membership with certain complementary skills). Its task would be to provide independent and ongoing counsel to Viet Nam to move its S&T strategy and modernization forward; by its very involvement and commitment, it should mobilize international awareness of, and support for, Viet Nam's efforts to modernize its economy.

The members of the international team considered that we have been greatly honoured and privileged to be invited to carry out this important assignment. We are firmly convinced that Viet Nam has a major window of opportunity but that the window will close quickly and Viet Nam needs to take urgent action. We hope that the above indicates how seriously we approached our task and that our report may be a helpful to Viet Nam in realizing its national objectives.

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Chapter 15
FOLLOW-UP AND FEEDBACK

The methodology for international S&T-policy reviews requires a return visit from the team for discussions with a broad representation of the individuals consulted during the initial visit. These discussions are sometimes referred to as the confrontation sessions, the idea being that the findings, conclusions, and suggestions of the international team should be held up for rigorous review, assessment, and feedback from the principal national stakeholders. This component of the methodology has been deliberately constructed to depart from the standard international consultancy, in which the written report is usually the final product. In S&T reviews, the report is intended to serve as a dynamic product, generating discussion, ongoing debate, examination of policy alternatives, and a continuous process of review and adjustment.

The members of the international team returned to Viet Nam in February 1998. The report had been very widely distributed and, in preparation for the return visit, NISTPASS had organized a series of discussions with stakeholders. These had been organized in each of seven working groups, one for each of the main themes addressed by the team. These groups reviewed the relevant sections of the report and drew up a list of issues for further debate with the international team. These issues were raised in the course of a full-day discussion on 12 February in Hanoi. More than 100 Vietnamese stakeholders participated. In addition, discussions were held with representatives of NISTPASS and with the Minister of Science, Technology and the Environment on 11 and 13 February.

The stakeholder meeting: feedback and commentary

In opening the conversation with stakeholders, Dr Bezanson cautioned that the timing of the report might raise special issues. The interviews had been held, comments received, and the report written in September and October of 1997, predating the full realization of the financial and economic crisis in East Asia by a few weeks. The broad geopolitical framework then shifted somewhat, together with, for the short term at least, the financial and economic prospects of the region as a whole. At a minimum, he suggested, this would increase intraregional

competition and destabilize some aspects of the environment for policy convergence within the region (for example, AFTA). He recalled that the Minister of Science, Technology and Environment had provided a set of basic assumptions at the start of the mission and that these were made explicit in the report. Among the key assumptions were that Viet Nam would become a full member of AFTA by the year 2006 and would obtain membership in the WTO shortly thereafter. These assumptions had guided the comments of many stakeholders during the first visit, as well as guiding the thinking of the members of the international team. The new context and the extent to which it influences the AFTA and WTO intentions of Viet Nam's political leadership might have a major bearing, particularly on matters of timing and the pace at which changes are implemented.

Notwithstanding the East Asian economic crisis, which appeared with such suddenness and ferocity, the central structural aspects of the report remain valid in the judgement of the international team. Viet Nam's systems of S&T have not been adjusted to accord with the goal of integration into the global marketplace and a broad range of implicit S&T policies remain at significant variance with that goal. Dr Bezanson outlined some of these in his introductory remarks, notably that unlike the East Asian Tigers over most of the past two decades, Viet Nam is running high current-account and fiscal deficits. Also, the domestic-savings rate in Viet Nam is less than half that of the Tigers. Unless these factors are addressed and corrected, the stated goals of rapid modernization and industrialization are likely to prove elusive.

A central message of the report underscored during the introduction to the stakeholder meeting was that the application of S&T in Viet Nam's traditional sectors should be accorded the very highest priority and that the much higher rates of domestic savings required by Viet Nam are likely to depend on this. Yet, there has been relative neglect in this area in recent years, and it seemed to the team that there was a risk of further relative neglect under a national policy that accords importance to IT, biotechnology, new materials, and automation. The report also suggested the need to focus on innovation, not just on S&T. Other main messages and suggestions were to build the capabilities for managing technology, streamline the policy-making process, ensure that both implicit and explicit science policies are in harmony, and take a cautious approach to basic research.

The international team was advised during the stakeholder meeting that its report had been very well received, met with widespread approval, and was regarded as provocative and candid. It was emphasized that the report had stimulated extensive debate and questioning. This was especially gratifying to the members of the international team, as a principal purpose of the review had been to do exactly this. Given that it was widely viewed as provocative, however, what

was surprising was that the areas of disagreement and dispute seemed to be so very few. Some of this may have been due to the size of the forum; meeting with smaller groups with specific interests might have revealed more extensive points of difference in people's interpretations. However, the work that NISTPASS had done with its seven working groups may have generated a high degree of consensus-building.

In any case, we have little to report in the way of substantive or major disagreement. Quite to the contrary, the commentary suggested a high degree of consensus on all major aspects of the report, including the importance of a priority application of S&T to traditional sectors. Almost all of the questions and comments were aimed primarily at obtaining greater elucidation of key points.

One suggestion was that the report would have benefited from paying more specific attention to factors of Vietnamese history and culture. This appeared to the international team to be a more philosophical than practical point and to imply issues featured in debates on the philosophy of science for many years, including the cultural specificity of science, its social ethics, and the boundaries of the reductionist method and positivism. These are all fascinating avenues of thought, but clearly beyond the scope of this S&T review. In addition, given the terms of reference and methodology of our exercise, it is doubtful that even a team with vast knowledge of Vietnamese history and culture would have produced a very different report.

A second general comment related to the team's interpretation of the phrase *step by step*. The international team had interpreted this phrase, repeated frequently by our Vietnamese interlocutors during the September interviews, to mean an incremental approach. Our presumption, it was pointed out, equated incremental with a relatively slow process of decision-making. Such slowness, we noted in our report, would disadvantage Vietnamese interests, especially in light of the relative weaknesses in the national S&T system, coupled with the timing for accession to AFTA. It was pointed out that the step-by-step approach could also mean a logical and systematic process of decision-making, without the intervals between policy components necessarily being long. The international team recognized the validity of this second interpretation of the phrase, but emphasized that it had no doubt that the majority of Vietnamese stakeholders who used the phrase during the interviews had done so in an manner entirely consistent with the team's interpretation.

The procedure followed in the return visit to Vietnamese stakeholders differed from previous IDRC S&T reviews. In Viet Nam, there was only a single meeting with stakeholders, in Hanoi. In the other reviews, there had been other sessions in other cities, some of which had been with smaller groups with specific

interests. The approach adopted by NISTPASS, to have a single stakeholder conference following a process of consultation by the principal host agency, has the clear advantages of parsimony and bringing all interest groups to the same conversation. What this approach lacks, however, is both diversity and the opportunity for the candor that can come with one-on-one settings and exchanges. Comparing the Vietnamese experience with those of previous reviews, the international team concluded that on balance the more diversified approach remains preferable. The two approaches taken as complementary and in sequence might represent an ideal, but such arrangements clearly involve issues of time and cost.

Additional consultations

On 13 February, following the stakeholder meeting, meetings were held with the NISTPASS team responsible for preparing the long-term S&T strategy for Viet Nam. These conversations confirmed widespread approval of the report. For the most part, these meetings focused on clarification and matters of detail. We were advised that Viet Nam's political leadership wished now to proceed expeditiously to formulate a national S&T strategy, establish the proposed Viet Nam Forum for Science, Technology, and Modernization, structure a new technomanagement program, and apply S&T in traditional sectors. On these matters, the NISTPASS team requested further information.

NISTPASS is now mandated to proceed with the detailed preparation of the long-term S&T strategy, and the international team was asked whether we would counsel it concerning specific methodologies.

As a part of the international review process, IDRC and the Canadian International Development Agency (CIDA) arranged for Dr Jack Smith of the National Research Council of Canada to spend a week in Viet Nam to teach a course on the methodology of preparing an S&T strategy. Dr Smith described some 52 different approaches and methods considered in preparing the Canadian Science and Technology Strategy, published 2 years ago. This set forward a menu requiring judicious selection, but the methods and approaches are variable and all require adaptation to specific circumstances. In this regard, the international team has little to add to Dr Smith's presentations and his emphasis on tailoring the process to meet circumstances. A factor the Vietnamese team will need to carefully take into account is the relative weakness in reliable statistical material. The international team encountered this problem in its work and commented on this in the report.

The review of existing policies, including an assessment of their effectiveness, is an essential ingredient in the preparation of an S&T strategy. The report

of the international team has, we hope, made a modest contribution to this ingredient.

The innovation approach to an S&T strategy

The NISTPASS team wanted to know how, in preparing the long-term S&T strategy for Viet Nam, it could benefit by focusing on the concept of innovation.

The international team had stressed the concept of innovation because it enables the role of S&T to be put more clearly and centrally within economic and social policy. Economic competitiveness is now a concern of all countries. Technical, institutional, and managerial innovation is at the heart of a country's competitiveness. When innovation is made a central policy-making focus, the role of S&T becomes much clearer. If S&T policy-making is carried out independently of economic and social policy, it is more likely that the emphasis will be on technology "push," without a commensurate concern with market "pull"; a greater focus on innovation means that the technology supply and demand dimensions are more likely to be in balance.

An emphasis on innovation also provides a way of harmonizing socalled implicit S&T policies, inherent in a country's economic, social, and fiscal policies, and its explicit S&T policies. In many countries, including Viet Nam, these explicit and implicit policies are often in conflict. The team believes that by putting a greater emphasis on innovation, Viet Nam is more likely to succeed in making both its implicit and its explicit policies contribute to the strengthening of the ability of Vietnamese firms to innovate and compete in world markets.

Innovation is not the only concern of S&T policy or strategy, but in many countries it has been neglected. That is why we believe it is important to emphasize the issue.

Our report pointed out that many countries have found it useful to think of an NSI, and a few, such as South Africa, have used the concept to help them develop their S&T policies and strategies. Not everyone believes that the concept of an NSI is sufficiently well advanced to provide a solid basis for policy-making. Furthermore, as an innovation approach cuts across the interests and domains of several ministries, it is sometimes resisted by vested interests. Nevertheless, the team thinks that the concept of an NSI is useful in looking at the effectiveness of a country's S&T system. The tools and approaches developed to examine a country's NSI can provide a helpful check list for anyone responsible for developing a country's S&T strategy.

Such a check list was developed by the international team reviewing the Chinese S&T-policy reforms. Table 5 was included in the China report but might be a useful starting point for a Vietnamese framework for innovation.

Table 5. Functions of an NSI.

General functions	Specific functions
Core functions of government	
Policy formulation and resource allocation	Monitoring, review, and formulation of policies and, in some countries, plans concerning national S&T activities
	Linkage to other policy domains (such as the economy, trade, education, health, environment, and defence)
	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 coordinate 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 intellectual property
	Creation of national systems to protect safety, health, and the environment
Implementation functions	
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 all kinds of research and technological development
	Provision of scientific services
	Provision of mechanisms to link R&D outputs to practical use
	Provision of linkages to regional and international S&T activities
	Provision of mechanisms to evaluate, acquire, and diffuse best-practice technologies
	Creation of innovative goods, processes, and services embodying the results of S&T activities

(continued)

Table 5. Concluded.

General functions	Specific functions
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	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

Source: IDRC–SSTC (1997).
Note: These functions — both policy related and implementation related — are carried out by different stakeholders in any country's NSI, with the particular combination being unique to that country. EOM, establishment, operation, and maintenance; HRD, human-resource development; NSI, national system of innovation; R&D, research and development; S&T, science and technology.

An international advisory mechanism on S&T policy and practice

The NISTPASS team requested some brief elaboration on how an international advisory mechanism on S&T policy and practice might be shaped and its possible composition and terms of reference.

As a previously centrally planned economy moves to a market economy, more and more decisions about the role of S&T will be made outside government. The new environment will require multiple inputs to decision-making, and these must come from multiple sources, both within and outside of the country. The role of government becomes much more that of a general facilitator, rather than a regulator and more that of the communicator of vision than a principal actor. It becomes critical in such a transition to have a reliable mechanism to obtain advice from both national and nonnational sources and from outside government channels. Almost all market economies have a variety of such advisory mechanisms to advise individual ministries and agencies of government. Most also have an advisory council that reports to the prime minister or president on issues in which S&T cut across the interests of several ministries or agencies. These advisory

councils comprise suitably qualified people representative of the business community, higher education, and civil society. In its early drive for modernization, Singapore replied heavily on a number of such mechanisms. Thus, the international team believes that a carefully structured and well-supported Viet Nam International Science and Technology Advisory Council (VISTAC) would provide a most valuable service to the country.

A model for such a council can be found in the China Council for International Co-operation for Environment and Development (CCICED). The CCICED is a group of about 50 international and Chinese leaders in the field of environment and development. The CCICED meets once a year and presents its policy recommendations directly to the senior Chinese leadership.

The CCICED has established a number of working groups on different aspects of environment and development. Each working group comprises about six Chinese and six foreign members, all of whom are experts in the working-group theme. The working groups meet twice a year and commission research on carefully selected topics. The working groups draw their conclusions from the research and make recommendations. Their reports are submitted to the CCICED for its consideration, and after debate recommendations are forwarded to the Chinese leadership. All of the recommendations are given careful consideration by the Chinese authorities, and many have been implemented. The funding for the CCICED comes mainly from CIDA, which has contributed $15 million over a 5-year period. The funding for each working group comes from different sources.

Our suggestion for Viet Nam is to establish something similar to the CCICED but focusing on S&T policy. We envisage a council of about 30–40 members, half of whom would be Vietnamese, including some overseas Vietnamese. The rest would be leading international figures from the business world, academia, and people knowledgeable about S&T policy issues. We expect that many of the foreign members will be from East Asia.

Working groups would be established in each of the areas of concern to the Vietnamese authorities. For example, working groups might be established on such topics as

- S&T education and training;
- Technology transfer and the role of foreign corporations in Vietnamese industrialization;
- S&T and the traditional sector;

- International collaboration in S&T; and
- Research foresight.

Establishing VISTAC would be a way to ensure that government received the very best of advice on all these matters in the most impartial and authoritative ways. If it is decided to go ahead in principal with VISTAC, then a prospectus should be prepared, together with a budget. The detailed draft of this could be written up within a few weeks by a small team of experienced professionals. On the basis of this draft prospectus, Viet Nam would be able to seek expressions of interest from international donors.

A technomanagement program for Viet Nam

The NISTPASS team wondered if we might offer some further thoughts on how to put such a technomanagement program into practice and queried further why we had not drawn attention to polytechnical schools.

To answer the later query, we drew attention to the fact that a technomanagement program would be aimed at preparing people to manage the full process of technological transformation. We believe our report makes this clear. This is entirely different from education for specific subsets of technical skills. Success in the competitive global marketplace will require highly skilled people who can manage full technological process, and our suggestion is that new arrangements must be tailored to meet this objective.

When the international team began its work, it was asked to draw on its knowledge of other East Asian countries to make specific suggestions for Viet Nam. The experiences of Singapore and Taiwan and, most particularly, of South Korea led the team to suggest that Viet Nam should establish a major technomanagement program. We envisage this as comprising a training program to improve the skills of both government and corporate managers and a consultancy activity to carry out technology assessments and research-foresight activities.

In the report, we set out some of the activities and approaches of a technomanagement program for Viet Nam. These were intended as examples of the sorts of activities that might be pursued. If the Vietnamese government agrees in principal to establish such a program, then clearly a detailed feasibility study should be carried out. Several technomanagement programs already exist in both developed and developing countries. Some of these are degree programs, and others are short courses especially designed for in-service training in industry and government. The feasibility study should review these existing programs and identify one or two that might be willing to work with Vietnamese counterparts in designing a

program appropriate for Viet Nam. The feasibility study should also identify the most appropriate institutional arrangements in Viet Nam to implement its techno-management program.

The terms of reference of the feasibility study might be as follows:

1. Identify the specific needs of Vietnamese firms and government departments for training in the management of technology and innovation;

2. Review existing technomanagement programs in other countries;

3. Identify a few of these programs that are particularly appropriate for Vietnamese needs and suggest ways in which representative of these programs might work with Vietnamese counterparts to prepare a crash program of training;

4. Identify the needs of Vietnamese government departments and industrial firms for technology-management advice, technology assessment, and research foresight (from this review, design the institutional mechanisms to provide these services and advice); and

5. Prepare a budget for a 5-year technomanagement program and a budget for providing advice and consultancy in this and related fields.

The feasibility study should be carried out over a 6-month period.

Particular applications of S&T to strengthen traditional sectors of agriculture, fisheries and forestry, and to improve life in rural areas

The NISTPASS team wondered if we might offer a few additional thoughts on just what types of measures might be given priority in strengthening the traditional sectors and how to go about implementing these.

The international team has three main suggestions:

1. *Strengthen the agricultural-research system in Viet Nam* — The Vietnamese researchers are already well integrated with their colleagues overseas and in international research centres and have good ideas on what new research is needed. They are, however, frustrated by a lack of financial resources and by a variety of bureaucratic obstacles. A system of professional incentives is needed to encourage scientists to work in rural areas. We suggest that as a first step an international team should carry out

a thorough review of research and the application of research results and that their report be used to provide a basis for specific recommendations. Our own coverage of the traditional sectors was too limited to make many specific recommendations.

2. *Improve access to new technologies for rural industries* — Many developing countries experience difficulties acquiring technologies needed to develop rural industries. We did not visit enough of the countryside to make any judgement as to whether this is also a widespread problem in Viet Nam. But if it is, we would suggest two successful foreign programs for study by Viet Nam. One of these was established by Ashok Khosla and the Development Alternatives group in India. Their approach is to recognize that for technologies to be used in rural industry, packages of technology, finance, technical services, and marketing advice are needed. These packages are provided for specific proven technologies by way of a franchise. The second example is the SPARK Program in China. Here too, the technology provided is robust and is complemented with the provision of credit and follow-up technical assistance through government programs. These programs were designed for the specific situations in India and China and are not likely to be replicable in the Vietnamese situation. Nevertheless we recommend that they be studied to learn any possible lessons for Viet Nam.

3. *Develop a program on Information Technology for Rural Communities* — The international team has been impressed by a number of experimental programs currently under way in other countries to bring the benefits of ITs to poor communities. By providing access to knowledge for poor farmers through the use of computers, it is anticipated that they will be able to improve their economic livelihoods and quality of life. These experiments are still in their early stages, but the results are sufficiently encouraging to persuade some international donors to invest substantial resources to give poor communities access to ITs. We have found much enthusiasm for mobilizing ITs for development in Viet Nam, and we are aware that in Viet Nam some thought has been given to programs to provide access to these technologies in rural areas. We did not have the time or opportunity to study these schemes. We do, however, strongly recommend that a major experiment be carried out in a few selected communities to assess the potential benefits of improved access to knowledge provided by IT.

Concluding session

A concluding session took place with the Minister of Science, Technology and Environment, the NISTPASS team, and the international team. At this session, the following points were agreed on:

- The report of the international team would be published. This would include a chapter summarizing the follow-up discussions in Hanoi. IDRC would be responsible for the publication in English; and NISTPASS, for that in Vietnamese.

- The international team would provide brief responses to the specific questions posed by NISTPASS within a few weeks of our visit.

- Any further elaboration or feasibility studies would require a commitment of intent to implement from the Vietnamese and additional donor funding.

It was also decided that the NISTPASS team would send copies of the draft of their long-term strategy to the international team for comment. If funding permitted, some members of the international team would return to Viet Nam for further discussions of the strategy document.

Appendix 1
BIBLIOGRAPHICAL NOTES ON THE INTERNATIONAL TEAM

Keith Bezanson (Canada) is Director of the Institute of Development Studies, University of Sussex, United Kingdom. Previously he was the President of IDRC in Ottawa, Canada, and before that the Administrative Manager of the Inter-American Development Bank in Washington, DC. He has also been Canadian Ambassador to Peru and Bolivia, and Vice President of CIDA.

Jan Annerstedt (Sweden) is a Director of the Nordic Centre for Innovation in Lund, Sweden. He has been visiting professor in Science and Technology Policy at Vietnam National University and visiting professor in the Management of Technology at the Department of Science and Technology, Republic of the Philippines. He was also a Senior Research Fellow at the Research Policy Institute, University of Lund. He was an Associate Professor of the Department of Social Sciences at Roschilde University in Denmark from 1973 to 1997.

Kun Mo Chung (South Korea) is Professor at the Energy Systems Research Centre, University of Ajou, Korea. He has twice been the South Korean Minister for Science and Technology. He was also President of the Institute for Advanced Engineering, Chair and President of the Korea Science and Engineering Foundation, Chair and President of the Korea Power Engineering Company, and President of the International Atomic Energy Agency. He has been Professor of Electrical and Nuclear Engineering at the Polytechnic Institute of New York, and he was Academic Vice President of the Korean Advanced Institute of Science and Technology.

David Hopper (United States), after retiring from his distinguished career at the World Bank — as Senior Vice President and, previously, as Vice President for South Asia — has been serving as a senior advisor and trustee to numerous development- and agricultural-research institutions, including the Overseas Development Council and the Consultative Group for International Agricultural

Research. He was the first President of IDRC. Under the auspices of the Rockefeller and Ford Foundations in India, he played a pioneering role in the Green Revolution in South Asia.

Geoffrey Oldham (United Kingdom) is an Honorary Professor with the Science Policy Research Unit (SPRU), University of Sussex, United Kingdom. Previously, he had been a geophysicist with the Chevron Oil Company. He helped establish SPRU and was its Director from 1980 to 1992. He was Associate Director of IDRC in the 1970s and was its Science Adviser from 1992 to 1996. He has been Chair of the United Nations Advisory Committee on Science and Technology for Development and was the United Kingdom Delegate to the United Nations Commission on Science and Technology for Development. He was made a Commander of the Order of the British Empire in 1990.

Francisco Sagasti (Peru) is a Director of Agenda Peru. He was also the Director of GRADE, a Peruvian policy-research institution. He has been a Senior Advisor to the Policy and Review Department of the World Bank and the Chief of the World Bank's Strategic Planning Division. He was the Field Co-ordinator of IDRC's Science and Technology Advisory Committee on Science and Technology for Development. Earlier he was a staff member of the Organization of American States, helping to develop a technology policy for the Andean region of Latin America. Dr Sagasti was Chair of the United Nations Advisory Committee on Science and Technology for Development.

Appendix 2

STATISTICAL INDICATORS OF SCIENCE AND TECHNOLOGY

Status of science and technology institutions

Table 6. S&T institutions by structure and administration.

Structure and administration	Number of institutions	% of total
Institutions with subbodies	69	29.6
Established by		
Government	108	46.4
Ministries or government agencies	125	53.6
Institutions with their own information section	94	40.3
Institutions with their own library	95	40.8
Institutions issuing their own journal	113	48.5

Source: Data compiled from Vietnamese ministry sources.

Table 7. S&T institutions by establishment time.

Establishment time	Number of institutions	% of total
Before 1945	5	2.1
1946–1955	6	2.6
1956–1975	64	27.5
1976–1985	88	37.8
1986–1995	70	30.0

Source: Data compiled from Vietnamese ministry sources.

Table 8. S&T institutions by ministry and government agency.

Ministry or government agency	Number of institutions	% of total
National Center for Natural Sciences and Technology	24	10.3
National Center for Social Sciences and Humanities	25	10.7
Ministry for Science, Technology and Environment	7	3.0
Ministry of Industry	36	15.6
Ministry of Agriculture and Rural Development	30	12.9
Ministry of Marine Products	8	3.4
Ministry of Public Health	32	13.7
Ministry of Construction	11	4.7
Ministry of Transport and Communication	5	2.1
Ministry of Education and Training	6	2.6
Ministry of Labour, Invalids and Social Affairs	4	1.7
Ministry of Trade	3	1.3
Vietnam Petroleum Corporation	4	1.7
General Department of Hyddrometerology	4	1.7
General Department of Land Management	3	1.3
Institute for Marxism–Leninism and Ho Chi Minh ideology	7	3.0
Others	24	10.3

Source: Data compiled from Vietnamese ministry sources.

Table 9. S&T institutions by type of science.

Type of science	Number of institutions	% of total
Natural sciences	29	12.4
Agricultural, forestry and aquatic-products sciences	34	14.6
Medical sciences	33	14.2
Technical sciences	69	29.6
Social sciences and humanities	68	29.2

Source: Data compiled from Vietnamese ministry sources.

Table 10. S&T institutions by source of S&T funds.

Source of S&T funds	Number of institutions	% of total
Not funded through government budget	7	3.0
Fully funded through government budget	162	69.5
Only partly funded through government budget	64	27.5

Source: Data compiled from Vietnamese ministry sources.

Table 11. S&T institutions by size of S&T funds.

Size of S&T funds (million VND)	Number of institutions	% of total
≤250	29	12.6
251–500	28	12.2
501–750	19	8.3
751–1 000	19	8.3
1 001–1 500	21	9.1
1 501–2 000	17	7.4
2 001–3 000	23	10.0
3 001–5 000	33	14.3
>5 000	41	17.8

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 12. S&T institutions by number of personnel.

Number of personnel	Number of institutions	% of total
≤10	9	3.9
11–50	96	41.2
51–100	52	22.3
101–150	27	11.6
151–200	21	9.0
>200	28	12.0

Source: Data compiled from Vietnamese ministry sources.

Science and technology personnel

Table 13. S&T personnel to 1 July 1997.

Type of S&T personnel	Number of persons	% of total
Female	9 420	42.2
Professors	123	0.5
Associate professors	390	1.7
Post-graduate degree	2 509	11.2
PhD	186	0.8
PhD candidate	1 977	8.9
MSc or MA	346	1.5
Higher-education degree	11 447	51.3
Others	8 357	37.5
Technician	69	13.9
Others	68	23.6

Source: Data compiled from Vietnamese ministry sources.

Table 14. Number of S&T personnel by type of science.

Type of science	PhD (*n*)	PhD candidate (*n*)	MSc or MA (*n*)	BSc or BA (*n*)	Others (*n*)
Natural sciences	91	501	24	1 392	530
Agricultural, forestry, and aquatic sciences	26	285	108	2 197	2 768
Medical sciences	13	157	31	1 615	2 210
Technical sciences	35	499	39	4 388	2 465
Social sciences and humanities	21	535	144	1 855	384

Source: Data compiled from Vietnamese ministry sources.

Table 15. Structure of S&T personnel by type of science.

Type of science	PhD (%)	PhD candidate (%)	MSc or MA (%)	BSc or BA (%)	Others (%)
Natural sciences	48.6	25.3	6.9	12.2	6.3
Agricultural, forestry, and aquatic sciences	14.4	14.4	31.2	19.2	33.1
Medical sciences	7.0	7.9	9.0	14.1	26.5
Technical sciences	18.7	25.2	11.3	38.3	29.5
Social sciences and humanities	11.3	27.2	41.6	16.2	4.6

Source: Data compiled from Vietnamese ministry sources.

Table 16. Number of S&T personnel by ministry and government agency.

Ministry or government agency	PhD (*n*)	PhD candidate (*n*)	MSc or MA (*n*)	BSc or BA (*n*)	Others (*n*)
National Center for Natural Sciences and Technology	96	507	24	1 116	274
National Center for Social Sciences and Humanities	8	262	35	715	121
Ministry for Science, Technology and Environment	6	100	6	599	235
Ministry of Industry	18	190	11	2 060	1 576
Ministry of Agriculture and Rural Development	19	309	115	2 196	2 674
Ministry of Marine Products	5	30	8	286	185
Ministry of Public Health	13	152	31	1 604	2 207
Ministry of Construction	2	44	4	539	197
Ministry of Transport and Communication	2	57	—	556	251
Ministry of Education and Training	7	94	57	299	37
Others	10	232	55	1 477	600

Source: Data compiled from Vietnamese ministry sources.

Table 17. Structure of S&T personnel by ministry and government agency.

Ministry or government agency	PhD (%)	PhD candidate (%)	MSc or MA (%)	BSc or BA (%)	Others (%)
National Center for Natural Sciences and Technology	51.3	25.6	6.9	9.7	3.3
National Center for Social Sciences and Humanities	4.2	13.3	10.1	6.3	1.4
Ministry for Science Technology and Environment	3.2	5.1	1.7	5.2	2.8
Ministry of Industry	9.6	9.6	3.2	18.0	18.9
Ministry of Agriculture and Rural Development	10.7	15.6	33.2	19.2	32.0
Ministry of Marine Products	2.7	1.5	2.3	2.5	2.2
Ministry of Public Health	7.0	7.7	9.0	14.0	26.4
Ministry of Construction	1.1	2.2	1.2	4.7	2.4
Ministry of Transport and Communication	1.1	2.9	0.0	4.9	3.0
Ministry of Education and Training	3.7	4.8	16.5	2.6	0.4
Others	5.4	11.7	15.9	12.9	7.2

Source: Data compiled from Vietnamese ministry sources.

Table 18. Structure of S&T personnel by qualifications.

Ministry or government agency	PhD (%)	PhD candidate (%)	MSc or MA (%)	BSc or BA (%)	Others (%)
National Center for Natural Sciences and Technology	4.8	25.1	1.2	55.3	13.6
National Center for Social Sciences and Humanities	0.7	23.0	3.1	62.7	10.6
Ministry for Science, Technology and Environment	0.6	10.6	0.6	63.3	24.9
Ministry of Industry	0.5	4.9	0.3	53.4	40.9
Ministry of Agriculture and Rural Development	0.4	5.8	2.2	41.3	50.3
Ministry of Marine Products	1.0	5.8	1.6	55.6	36.0
Ministry of Public Health	0.3	3.8	0.8	40.0	55.1
Ministry of Construction	0.3	5.6	0.5	68.6	25.1
Ministry of Transport and Communication	0.2	6.6	0.0	64.2	29.0
Ministry of Education and Training	1.4	19.0	11.5	60.5	7.5
Others	0.4	9.8	2.3	62.2	25.3

Source: Data compiled from Vietnamese ministry sources.

Table 19. Structure of higher-degree personnel by age.

Age (years)	PhD (%)	PhD candidate (%)
<31	0.6	0.2
31–35	1.3	2.8
36–40	5.5	11.3
41–45	12.8	27.1
46–50	14.2	21.3
51–55	24.3	18.0
56–60	31.3	15.3
>60	10.0	4.0

Source: Data compiled from Vietnamese ministry sources.

Table 20. Change of workplace of S&T personnel.

Change of workplace	PhD	PhD candidate	MSc or MA	BSc or BA	Others
Number of people moving in	10	164	22	1 150	569
Percentage of total S&T personnel	5.3	8.2	6.3	10.0	6.8
Number of people moving on	16	168	28	1 269	1 186
Percentage of total S&T personnel	8.6	8.5	8.1	11.1	14.2
Ratio of people moving in to those moving on	160.0	102.4	127.3	110.3	208.4

Source: Data compiled from Vietnamese ministry sources.

Major physical infrastructure and funds for science and technology

Table 21. Allocation of equipment by type of science.

Type of science	Allocation (billion VND)	% of total	Per person (million VND)
Natural sciences	42.1	12.2	16.5
Agricultural, forestry, and aquatic sciences	61.4	17.8	12.1
Medical sciences	75.5	21.9	18.9
Technical sciences	142.9	41.4	19.9
Social sciences and humanities	23.3	6.7	8.2

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 22. Personal-computer use by type of science.

Type of science	Number of PCs (*n*)	S&T labour force (*n*)	Number of persons/PC (*n*)
Natural sciences	351	2 359	6.72
Agricultural, forestry, and aquatic sciences	169	4 101	24.26
Medical sciences	203	3 404	16.76
Technical sciences	935	6 324	6.76
Social sciences and humanities	411	2 557	6.22

Source: Data compiled from Vietnamese ministry sources.

Table 23. Funds of S&T institutions by source of funds in 1994.

Source of funds	Allocation (billion VND)	% of total	Per person (million VND)
Domestic sources	618.9	90.0	28.2
Government budget	396.3	57.6	18.1
Own fund	222.6	32.4	10.1
Overseas sources	68.9	10.0	3.1

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 24. Funds of S&T institutions by type of science in 1994.

Type of science	Allocation (billion VND)	% of total	Per person (million VND)
Natural sciences	95.1	13.8	37.5
Agricultural, forestry, aquatic sciences	89.6	13.0	17.6
Medical sciences	142.7	20.8	35.4
Technology sciences	292.9	42.6	39.7
Social sciences and humanities	67.5	9.8	23.0

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 25. Funds of S&T institutions by ministry and government agency in 1994.

Ministry or government agency	Allocation (billion VND)	% of total	Per person (million VND)
National Center for Natural Sciences and Technology	68.0	9.9	33.7
National Center for Social Sciences and Humanities	22.9	3.3	20.1
Ministry for Science, Technology and Environment	24.6	3.6	26.6
Ministry of Industry	156.6	22.8	41.1
Ministry of Agriculture and Rural Development	87.8	12.8	17.4
Ministry of Marine Products	12.0	1.7	20.8
Ministry of Public Health	142.2	20.7	35.5
Ministry of Construction	47.9	7.0	60.9
Ministry of Transport and Communication	20.3	2.9	23.4
Ministry of Education and Training	9.8	1.4	19.8
Vietnam Petroleum Corporation	28.5	4.1	88.2
General Department of Hydrometerology	10.1	1.5	50.0
General Department of Land Management	12.8	1.8	32.0

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 26. Structure of funds of S&T institutions by source of funds and by type of science in 1994.

	Domestic source		
Type of science	Government budget	Own fund	Overseas source
Natural sciences	74.1	24.1	1.8
Agricultural, forestry, and aquatic sciences	72.0	18.2	9.8
Medical sciences	55.5	16.7	27.8
Technical sciences	41.9	53.0	5.1
Social sciences and humanities	87.8	6.4	5.8

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 27. S&T expenditures of S&T institutions by type of science in 1994.

Type of science	Expenditure (billion VND)					
	Research, salary, and management	Investment outlay	Equipment and machinery	Tax	Other expenditures	
					Total	Production
Natural sciences	50.9	11.7	16.9	1.6	10.5	1.0
Agricultural, forestry, and aquatic sciences	56.5	8.9	7.1	1.1	12.9	9.5
Medical sciences	45.6	14.4	24.0	0.5	37.8	12.6
Technical sciences	111.4	19.1	14.5	7.4	130.9	102.8
Social sciences and humanities	45.0	7.2	7.0	0.3	4.9	0.3

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 28. Structure of S&T expenditure of S&T institutions by type of science in 1994.

Type of science	% of total					
	Research, salary, and management	Investment outlay	Equipment and machinery	Tax	Other expenditures	
					Total	Production
Natural sciences	55.5	12.8	18.4	1.8	11.5	1.1
Agricultural, forestry, and aquatic sciences	65.1	10.3	8.5	1.3	14.8	10.9
Medical sciences	37.3	11.8	19.6	0.4	30.9	10.3
Technical sciences	39.3	6.7	5.1	2.6	46.3	36.3
Social sciences and humanities	69.9	11.2	10.9	0.4	7.6	0.5

Source: Data compiled from Vietnamese ministry sources.

Table 29. S&T expenditure of S&T institutions by type of science in 1994.

Type of science	Expenditure (billion VND)					
	Research, salary, and management	Investment outlay	Equipment and machinery	Tax	Other expenditures	
					Total	Production
Natural sciences	50.9	11.7	16.9	1.6	10.5	1.0
Agricultural, forestry, and aquatic sciences	56.5	8.9	7.1	1.1	12.9	9.5
Medical sciences	45.6	14.4	24.0	0.5	37.8	12.6
Technology sciences	111.4	19.1	14.5	7.4	130.9	102.8
Social sciences and humanities	45.0	7.2	7.0	0.3	4.9	0.3

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 30. Expenditures of S&T institutions by ministry or government agency in 1994.

Ministry or government agency	Expenditure (billion VND)					
	Research, salary, and management	Investment outlay	Equipment and machinery	Tax	Other expenditures	
					Total	Production
National Center for Natural Sciences and Technology	33.3	9.2	15.3	0.1	8.3	0.3
National Center for Social Sciences and Humanities	18.5	1.0	1.2	0.1	1.9	—
Ministry for Science, Technology and Environment	13.3	2.3	2.6	0.2	2.5	—
Ministry of Industry	47.7	7.3	5.3	4.5	85.7	77.1
Ministry of Agriculture and Rural Development	54.4	8.6	7.8	1.2	13.0	9.1
Ministry of Marine Products	7.8	2.1	0.1	0.0	1.5	1.5
Ministry of Public Health	45.4	14.4	24.0	0.5	37.8	12.6
Ministry of Construction	20.7	3.3	0.9	0.8	20.3	15.3
Ministry of Transport and Communication	10.8	4.7	0.5	1.5	5.6	5.5
Ministry of Education and Training	5.8	1.0	1.0	0.1	0.9	0.9
Vietnam Petroleum Corporation	17.7	0.2	4.8	1.3	2.5	0.7
General Department of Hydrometerology	6.1	1.8	1.0	0.2	1.0	0.7
General Department of Land Management	2.8	0.1	0.2	0.3	9.4	2.1

Source: Data compiled from Vietnamese ministry sources.
Note: VND, Vietnamese dong (in 1998, 12 987 VND = 1 United States dollar).

Table 31. Structure of S&T expenditures of S&T institutions by ministry and government agency in 1994.

	% of total					
					Other expenditures	
Type of science	Research, salary, and management	Investment outlay	Equipment and machinery	Tax	Total	Production
National Center for Natural Sciences and Technology	50.3	13.9	23.1	0.2	12.5	0.5
National Center for Social Sciences and Humanities	81.5	4.4	5.3	0.4	8.4	—
Ministry for Science, Technology and Environment	63.7	11.1	12.6	0.8	11.8	—
Ministry of Industry	31.7	4.8	3.5	3.0	57.0	51.2
Ministry of Agriculture and Rural Development	64.0	10.1	9.2	1.4	15.3	10.7
Ministry of Marine Products	67.5	18.6	0.9	0.1	12.9	12.8
Ministry of Public Health	37.2	11.8	19.6	0.4	31.0	10.3
Ministry of Construction	45.0	7.2	2.0	1.7	44.1	33.3
Ministry of Transport and Communication	46.8	20.5	2.2	6.2	24.3	23.7
Ministry of Education and Training	65.9	11.4	11.4	1.1	10.2	10.2
Vietnam Petroleum Corporation	66.8	0.8	18.1	4.9	9.4	2.6
General Department of Hydrometerology	60.4	17.8	9.9	2.0	9.9	6.9
General Department of Land Management	21.9	0.8	1.6	2.3	73.4	16.4

Source: Data compiled from Vietnamese ministry sources.

Other selected indicators and statistics

Table 32. GDP structure by sector.

	Structure of GDP (%)					
Sector	1991	1992	1993	1994	1995	1996[a]
Agriculture, forestry, and fisheries	42.4	34.9	31.7	29.7	28.4	27.5
Industry and construction	23.5	23.7	30.4	28.7	30.0	30.8
Services	34.1	41.4	37.9	41.6	41.6	41.7

Source: UNIDO (1997).
Note: GDP, gross domestic product.
[a]Preliminary.

Table 33. Savings and investment.

	% GDP					
	1991	1992	1993	1994	1995	1996[a]
Investment	15.1	17.0	24.9	25.5	27.1	32.4
Government	2.8	5.8	7.0	6.6	5.7	5.5
Nongovernment	12.3	11.2	17.9	18.9	21.4	26.9
National savings	13.2	16.3	17.4	16.9	17.1	17.5
Government	1.3	4.1	2.5	5.0	5.2	5.5
Nongovernment	11.9	12.2	14.6	11.9	11.9	12.0
Foreign savings	1.9	0.7	7.5	8.6	10.0	14.9

Source: UNIDO (1997).
Note: GDP, gross domestic product.
[a]Preliminary.

Table 34. Foreign investment projects committed and realized as of January 1997.

Year	Number of projects (*n*)	Capital committed (million USD)	Capital implemented (million USD)	Ratio (%)
1988–91	365	2 985	620	20.8
1992	194	2 290	463	20.2
1993	268	2 970	1 002	33.7
1994	362	3 843	1 500	39.0
1995	404	6 168	2 000	32.4
1996	326	8 497	2 156	25.4

Source: UNIDO (1997).
Note: USD, United States dollars.

Table 35. Sources of foreign investment as of January 1997.

Country of origin	Number of projects (*n*)[a]	Total capital (billion USD)	Share of capital (%)
Hong Kong	210	3.3	12.6
Japan	182	2.5	9.6
Malaysia	51	1.0	3.8
Singapore	150	4.5	17.2
South Korea	178	2.5	9.6
Taiwan	258	4.1	15.7
United States	60	0.9	3.5
Other countries	736	7.3	30.0

Source: UNIDO (1997).
Note: USD, United States dollars.
[a] Excludes revoked or canceled projects.

Table 36. Distribution of FDI commitments by economic sector, 1988–96.

	1988–91	1992	1993	1994	1995	1996	1988–96
(Million USD)							
Agriculture and forestry	393	108	38	96	132	137	904
Construction	88	14	416	284	803	798	2 403
Hotel and tourism	491	376	994	750	900	4 055	7 566
Industry	823	973	1 191	1 636	1 374	2 322	8 319
Oil and gas	526	634	173	73	−193	52	1 265
Transport and communication	368	23	25	70	752	749	1 987
Other	296	162	133	934	2 400	384	4 409
Total[a]	2 985	2 290	2 970	3 843	6 168	8 497	26 853
(% total)							
Agriculture and forestry	13.2	4.7	1.3	2.5	2.1	1.6	4.2
Construction	2.9	0.6	14.0	7.4	13.0	9.4	7.8
Hotel and tourism	16.4	16.4	33.5	19.5	14.6	47.7	24.7
Industry	27.6	42.5	40.1	42.6	22.3	27.3	33.7
Oil and gas	17.6	27.7	5.8	1.9	−3.1	0.6	8.4
Transport and communication	12.3	1.0	0.8	1.8	12.2	8.8	6.2
Other	9.9	7.1	4.5	24.3	38.9	4.6	14.9

Source: UNIDO (1997).
Note: FDI, foreign direct investment; USD, United States dollars.
[a] Includes investment by domestic joint-venture partners.

Table 37. Distribution of FDI disbursements by economic sector, 1988–96.

	1988–91	1992	1993	1994	1995	1996	1988–96
(Million USD)							
Agriculture and forestry	54	17	44	56	76	50	297
Construction	89	44	37	81	207	209	694
Hotel and tourism	143	100	131	191	420	446	1 431
Industry	150	218	342	435	491	747	2 383
Oil and gas	68	20	357	621	690	301	2 057
Transport and communication	46	41	61	70	85	146	449
Other	70	23	30	46	31	257	457
Total[a]	620	463	1 002	1 500	2 000	2 156	7 741
(% total)							
Agriculture and forestry	8.7	3.7	4.4	3.7	3.8	2.3	4.4
Construction	14.4	9.5	3.7	5.4	10.4	9.7	8.9
Hotel and tourism	23.1	21.6	13.1	12.7	21.0	20.7	18.7
Industry	24.2	47.1	34.1	29.0	24.6	34.6	32.3
Oil and gas	11.0	4.3	35.6	41.4	34.5	14.0	23.5
Transport and communication	7.4	8.9	6.1	4.7	4.3	6.7	6.4
Other	11.3	5.0	3.0	3.1	1.6	12.0	6.0

Source: UNIDO (1997).
Note: FDI, foreign direct investment; USD, United States dollars.
[a] Includes investment by domestic joint-venture partners.

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Appendix 3

ABBREVIATIONS AND ACRONYMS

AFTA	Asian Free Trade Area
ASEAN	Association of Southeast Asian Nations
CCICED	China Council for International Co-operation for Environment and Development
CIDA	Canadian International Development Agency
CLDRRI	Cuu Long Delta Rice Research Institute
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
GDP	gross domestic product
HCMC	Ho Chi Minh City
IDRC	International Development Research Centre
IRRI	International Rice Research Institute
IT	information technology
KAIST	Korean Advanced Institute of Science and Technology
KDI	Korean Development Institute
KIST	Korea Institute of Science and Technology
KOSEF	Korea Science and Engineering Foundation
LDFRC	Long Dinh Fruit Research Centre
MNC	multinational corporation
MOSTE	Ministry of Science, Technology and Environment
NCNST	National Centre for Natural Science and Technology
NIC	newly industrialized country
NISTPASS	National Institute for Science and Technology Policy and Strategy Studies
NRCS	National Research Centre of Science
NSI	national system of innovation
ODA	overseas development assistance
OECD	Organisation for Economic Co-operation and Developnent

R&D	research and development
S&T	science and technology
SOE	state-owned enterprise
SPRU	Science Policy Research Unit [University of Sussex]
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United States dollar(s)
VIGECAM	Viet Nam General Corporation for Agricultural Materials
VISTAC	Viet Nam International Science and Technology Advisory Council
VSEF	Viet Nam Science and Engineering Foundation
WTO	World Trade Organization

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