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MICROELECTRONICS AND INFORMATION TECHNOLOGY

IN VIET NAM*

Towards a National Policy Framework

REPORT PREPARED BY THE

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INTRODUCTION

Among the developing countries of Asia, Viet Nam is one of the latecomers in microelectronics and information technology, but, so far, no attempts have been made to give the full details of existing computer resources, maintenance facilities, training programmes, etc. And, little is known about the range of computer applications for administrative and related services in today's Vietnamese government and industry.

This report provides an initial compilation of basic background information. By way of its structure and contents, the report may also be viewed as the terms-of-reference for a larger, techno-economic survey.

It has been found impossible to provide elements for an analysis of a rapidly changing technology without situating the economic circumstances under which the technology would be developed or diffused. Information technology has reached a stage of "swarming", where no industry or subsector of industry, nor any government activity, will be uneffected. Lessons from many countries show that the economic and social impact of microelectronics can hardly be underestimated.

Although limited in its scope, this document also seeks to provide insights into activities in the computer and related electronics industry subsector of Viet Nam as well as the changing requirements for the diffusion of modern computer applications. It is the first attempt to sum up the features of what may be called the Vietnamese information industries (encompassing communications equipment, software and information services). *To be rewritte*

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The facts presented and the assessments discussed in the text that follows have been grouped into six policy-relevant "functional areas." Each of these highlight a limited number of strategic issues that might be considered by both government and industry as well as by international agencies.

The first of these policy-relevant "functional areas" relates to the many new applications of information technology within government. The promotion of the country's economic and other infrastructure by way of information technology is the second. The third "functional area" brings into focus the systematic application of the microprocessor in manufacturing industry. The fourth "functional area" comprises the crucial manpower issues. The fifth is the emerging software production; and the sixth and final provides a closer look at the preconditions for a Vietnamese microelectronics industry.

It is hoped that the report will help initiate a policy process towards a more coherent national policy framework. The six "functional areas" could then become building blocks for an overall policy for the development of the Vietnamese information industries.

BACKGROUND

This study was initiated in the spring of 1989 by UNIDO and the United
Nations Development Program (UNDP) in co-operation with the government of Viet
Nam at a time when several United Nations agencies, operating in Viet Nam, had
become heavily involved in development projects which, directly or indirectly,
provide substantial support to information technology. A whole series of UNDP
and other externally funded projects, bringing on extensive computer
utilization and related training of manpower, are currently being planned or
implemented. Cf. Appendix 2 for an up-to-date listing of these projects.

The experiences accumulated through UNDP projects, as well as
observations made in the formulation process of these projects, have indicated
the following as the major problem areas of creating computer capabilities and
operating computer facilities in today's Viet Nam:

- Limited number of the most relevant specialized manpower as well few
  opportunities for the development of human resources,

- Low technical level of available hardware and software,

- Limited number of computers and related equipment,

- Lack of technical advisory, maintenance and repair services,

- Insufficient institutional framework: limited facilities and activities
  in universities, institutes, centers, specialized commercial companies,
  etc.

This report has been prepared by Jan Annerstedt, UNIDO consultant, under
the auspices of the Regional and Country Studies Branch of UNIDO. The
consultant has gathered the facts and summarized opinions during two missions
to Viet Nam in 1988 and in 1989, both of which included a series of interviews
with experts as well as visits to a sample of industrial firms, government
agencies, R&D laboratories, technical universities, etc. A list of persons
interviewed in 1989 is included as Appendix 1.[1]

The analytical framework of this report was developed as part of the
preparations for a research project[2] financed by SAREC (the Swedish Agency
for Research Cooperation with Developing Countries) and carried out at the
Nordic Center for Innovation Program (Sweden), the Program for Technology
Policy and Social Development of Roskilde University (Denmark), and the
Institute for Science Management (Viet Nam).

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[1]   The persons met with during the UNIDO Industrial Strategy Mission to Viet
      Nam in June 1988 are listed in Appendix 5 of the report "Viet Nam's
      Industrial Development - An Assessment", PPD/R.28.

[2]   Annerstedt, J. "Viet Nam's industrial rehabilitation. How could
      technology and science contribute?", Nordic Center for Innovation,
      Lund, 1989

II. State-of-the-art assessment in Viet Nam

1. COMPUTERS IN VIET NAM: WHERE ARE THEY INSTALLED?

Until today, the Socialist Republic of Viet Nam has had no general policy for the development and diffusion of information technology or for computer applications in different sectors of nation's economy. The Vietnamese government has not yet felt a need to formulate a long-term strategy for the development of this specific high technology field. However, it has encouraged its scientists and engineers to acquire the knowledge and skills necessary for the transfer of information technology into the country and has tried to stimulate the importation of computers and related electronics equipment for the purpose of industrial rehabilitation and modernization. But fiscal and other restraints for this transfer of technology has slowed down the processes of acquisition and diffusion.

As a consequence, Viet Nam is not only a late-comer in the systematic use of information technology for industrial purposes, but also a developing country in Asia with a relatively small number of computers in use.

With a total population approaching 70 million, the number of microcomputers in the major regions of Viet Nam can be counted in hundreds and the minicomputers by the tenths. According to some expert sources the number of microcomputer in use in the Ho Chi Minh City area is 300 while about 500 in Hanoi and vicinity.

Taking full account of the direct imports by industrial and other companies as well as the transfer of electronics through private channels and the donations from abroad would, however, make the total figure three to four times higher. In mid-1989, the national total of microcomputers may then have been of the order of 3-3,500.

This national estimate, which cannot be confirmed because of lack of official statistics, includes all computer brands from simple Taiwanese or Korean clones of IBM XT or AT to the more sophisticated Apple Macintosh SE with internal hard disk memory, optical readers, laser printers and other advanced peripheral equipment. The great majority of the microcomputers in Viet Nam, works on operating systems based on MS-DOS, i.e. they are compatible with the standard IBM personal computer.

About half of all computers in Viet Nam are installed in the industrial sector, with no significant differences in the degree of distribution between state-owned and privately owned companies. In 1989, the industrial firms in the both the northern and southern provinces represent the biggest single group of buyers of computers. It is a general belief that the private companies have more money available for investments in machinery and product development, which might cause a change in the relative intensity of high technology.

In general, the electronic equipment applied in industry and for administrative purposes is seldom the most appropriate, neither today, nor at the time of acquisition. Complaints are often heard about inadequate computer equipment and more so if comparisons are made with what is available on the world market. However, decision-makers in Vietnamese industry have had a very

limited freedom of choice between different technical solutions. Ever since
the unification of the country in 1975, Viet Nam has been suffering from the
embargo on western technology. The embargo makes it difficult and expensive,
though not totally impossible for the Vietnamese end-user to find the most
appropriate technical solutions to problems of economic modernization.
However, for many reasons, it has not even been possible to develop an
indigenous electronics industry based on imported microprocessors and other
foreign components. By the end of the 1980s, it is difficult even to identify
and size up an electronics subsector in Vietnamese industry simply because of
its limited size. However, a small number of companies and government
laboratories have already developed and tested their own capabilities in
assembling electronic equipment such as consumer electronics and
microcomputers. Recent inspections of some of these facilities in Viet Nam by
Japanese and Korean electronics company experts have shown that the technical
and other standards for this type of industrial production have reached an
acceptable level of sophistication.

The government of Viet Nam is more and more concerned about the many
internal restraints to the systematic application of electronics and related
equipment for improvements of the nation's economic infrastructure and, nearly
equally important, the potential shortage of skilled manpower for the
development of an electronics subsector. United Nations' and bilateral
agencies providing aid to Viet Nam have also become increasingly aware of the
weaknesses in the country's manufacturing system caused by the severe limits
in the supply of electric machinery and electronic equipment.

Policy sugge_ions: Any government action has to be based on reliable and
up-to-date assessments of the situation in the electronics subsector of the
Viet..amese industry and of the current use of information technology in both
government and industry. Also, it is advisable that basic statistics is
gathered and processed on the actual "computerization" of the most important
agencies, institutions, companies and other organizations.

A complete statistical picture is not needed in support of medium-term
planning and policy-decisions, but -- using samples of data or other
time-saving survey techniques -- a representative view of the situation ought
to be constructed.

For key subsectors o_ industry or for certain government areas, more
detailed evaluations might be needed for developing limited and specific
information technology policies to speed up the diffusion of existing computer
applications and experiences. Such evaluations can be performed by Vietnamese
specialists, using expert advise from other countries.

2. MICROELECTRONICS AND INFORMATION TECHNOLOGY: ISSUES AT STAKE

With the dramatic growth of the information industries in the newly
industrialized countries of Asia, the applications of microelectronics has
come to the attention of industrial policy-makers in Viet Nam. The examples
set by Taiwan Province of China, Republic of Korea, Hong Kong, Singapore,
Malaysia, and Thailand (to follow the order of magnitude of their information
industries' markets) has forced the Vietnamese to re-think some of their
methods for creating new industries and for the rehabilitation of existing

industrial plants. One illustration only: there is now a much bigger role to play for the foreign investor as well as for the local entrepreneur or innovator.

The dynamics of the information industries in the neighboring countries has put a whole range of complicated issues on the Vietnamese policy agenda: more systematic use of computers in existing industry and in government administration, the assessment of the benefits of new, expensive communications equipment for the economic infrastructure, the demand for better information services, the multitude of available computer software, etc. Some of the issues have been coupled with discussions on import substitution strategies, export-oriented industrialization, and procurement policies by the government.

All this has strengthened the high tech component of the general deliberations on the composition of the industrial sector in Viet Nam. But solving the problem on how to best enter this dynamic market is causing policy controversies.

It is a general impression by information technology professionals in Viet Nam that some previous ideological restrictions among government planners and politicians to the government's promotion of the information industries have been overcome. Computer software "products" for exports are being discussed along with traditional, manufactured products. Computer specialists and other technical and scientific personnel are not seen any more as "unproductive labor."

Until now, these deliberations are more academic than real. The diversity of products and marketable services from the emerging information industries in Viet Nam is very limited, as will be shown in Chapter 4. As an introduction and for the sake of clarification of the text below, the diversity will be summarized in the following product"service segments:

- Computer hardware, which can be divided into several types, such as mainframe computers, minicomputers, and personal computers or PCs.

- Peripheral computer equipment.

- Hardware repair and maintenance.

- Office products and related electric appliances.

- Products for industrial design and process control plus related supplies.

- Computer software, which includes both applications and systems utilities. (The company structure in Viet Nam cannot be grouped according to these two types of software. Some firms specialize in modifying foreign software to meet specific customer needs or Vietnamese rules, regulations and other standards. Others provide software support and information services in relation to a specific hardware investment. A third category, which is much smaller in size, tries to develop specific software for the Vietnamese market, for example Vietnamese fonts for desk-top publishing procedures of the main newspapers in Hanoi. A handful of other companies are starting to develop software for exports.)

- Communications equipment, which includes several types of equipment,
  now supported by microprocessors and their programmes, e.g. for voice
  communication (telephones), network switching and transmission
  equipment, and (which is just emerging as part of the new satellite
  communication system) equipment for data and text"image communications.

The diversity and great variety of these and other interrelated technical
products and processes for information activities put great pressure on the
innovative capabilities of the information industries. The capabilities of
the whole system for research and experimental development (R&D), including
the ways and means of diffusion of technology and know-how, are brought into
the center of attention. However, the technological base for industrial
expansion is relatively weak. Despite significant government efforts, the
national R&D system is far from being well-functioning. Most other developing
countries with a similar economic structure as Viet Nam have bigger, more
advanced and more coherent R&D systems, although their national economies
might be smaller in size. Viet Nam has large numbers of highly specialized
researchers, but far from all of them are engaged in scientific and
technological activities, and the government spends comparatively little on
its R&D system.

As a consequence, the prime source for new and appropriate technology for
industrial applications is not endogenous R&D, but transfer of technology from
abroad. Most technologies and related know-how have to be imported. Moreover,
R&D related services, such as industrial quality control, metrology, and
standardization of products and processes, are not functioning as expected.
Legal and organizational changes are being made with the purpose of
integrating R&D activities with industrial production. It is a fact, however,
that only a quarter of the total R&D manpower in Viet Nam is in some way
connected to industry and agriculture. The great majority of researchers and
other R&D personnel is not.

With this background it would be easy to just accept the fact that the
technological base within the country for industrial innovation is too weak.
The conclusion is correct, but only in part. In specific fields of science
and technology, Vietnamese R&D laboratories have a relatively strong
standing. In scientific disciplines such as mathematics and theoretical
physics Vietnamese researchers are contributing to the international
scientific discoveries. Similarly, in high technology, Vietnamese engineers
are interacting with world specialists in areas such as telecommunications and
artificial intelligence.

Like in many other countries, microelectronics (especially as components
in popular consumer products) represents progress and modernity for large
segments of the population. In discussions the contemporary "technological
culture" of Viet Nam is expressed in the density and daily use of electronic
equipment. Information technology is apprehended as a key technology for the
ongoing industrial rehabilitation and for the coming economic expansion.

Microelectronics more than all other contemporary technologies has become
much of a symbol for what science and technology could do for the economic and
social life of Viet Nam. It is no exaggeration to claim that this kind of
industrial technology is now an integrated part of the country's cultural
discourse.

In the mass media, especially in the daily papers of the metropolitan areas, the wider, though still very limited use of microelectronics is reflected in numerous invitations to introductory courses to computer work as well as in computer programming. The sudden growth in this field of study of generally available, privately organized and often very expensive courses is remarkable and does not correspond to a similar growth in the actual numbers of computers in Viet Nam. It is not uncommon with just one PC for 30 participants in an expensive evening class in Hanoi. And there have been courses with many participants, but with no equipment at all.

The already high and still growing numbers of interested course participants from the Hanoi and Ho Chi Minh City areas, everyone willing to pay the fees and other costs by themselves, are even more remarkable since the skills acquired through such courses can not always be used in the work situation. For the ordinary citizen a course represents an economic sacrifice but also a personal investment in the industrial future of Viet Nam, while the typical industrial work-place cannot yet afford to install any computers or related peripheral equipment. The popularization by way of mass media coverage of information technology implies a better access to information technology, which is yet to appear.

It remains to be seen if the mass media will also be the principle conveyor of an emerging public debate on the control of information technology, of its particular applications in industry and elsewhere, and of the rate and direction of its diffusion.

In many other developing countries, which have experienced rapid technological changes and sudden growth of the industrial sector, resentments among marginalized groups tend to follow in the wake of modernization. In the case of Viet Nam, much will depend on how science and technology is worked into the ordinary curriculum of the basic and secondary education. But much will also depend on how a more general consensus on issues of technological and social change is being built among broader strata of the population than among the youth. It seems as if the young population in the cities, with its orientation towards western consumption patterns, is already extremely positive to technical change. Ultimately, the rate and direction of the introduction of information technology to Viet Nam will be a matter of public influence and participation.

Policy suggestions. Any policy-action in relation to information technology should take at least two issues into account: How to compensate for a relatively weak technological base for industrial expansion beyond the home market and, yet, how to best exploit a strong, general mobilization of interest for technological modernization among groups in industry?

It seems as if Viet Nam's educational system is fostering a positive interest in technology, which might very well reflect a positive general attitude towards higher education and specialized training among large strata of the population. While, in many developing countries, the educational system is biased towards other skills than technical, the choice of technical and related natural science specialties among young Vietnamese seems to be easy. This advantage could be another incentive to more systematic government action in strengthening specialized higher education in areas such as informatics and computer science.

Following the expansion of the manufacturing sector in Viet Nam, the transition in industry from a "single-skilled" work-force to a more "multi-skilled" (which may include some training in the use of computers and other information technology) could be made a central element of the training programmes at the company level. The generally positive attitude towards technical change could lead to an involvement in issues of technical change by large groups of the employees.

3. THE NEW MACRO-ECONOMIC CONTEXT: A WIDER POLICY FRAMEWORK?

Looking back on the last fifteen years, Viet Nam's economy has not adjusted very successfully to the changing world economy. Capital mobilization for industrial development has been slow, agrarian reforms have come late, exports of manufacturing products have not been promoted according to its immediate potential, the diversification of industrial and related activities have not been improved according to the plans, the economic infrastructure has not been developed according to the needs of industry, important manpower training issues have been neglected in the educational planning, etc.[1]

While Viet Nam is moving towards peaceful coexistence with all its neighbors, the general conditions for the economy of the country is changing rapidly. At the highest political level, foreign trade has been given priority.

The trade with the highly industrialized countries is now seen as an important stimulus to the technological modernization. Exports are being promoted through new means. As peace is being restored, the regional trade issues have been placed high up on the economic-political agenda. The opening of the national boarders for regional trade is expected to stimulate the Vietnamese domestic economy and to provide incentives for new kinds of product development and for greater efficiency in manufacturing companies.

The broadening and strengthening of Viet Nam's economic linkages with both the regional and world markets is being strongly supported at the highest level of government. There are long-ranging ambitions to catch up with the industrial development in other countries. By lending private industry a helping hand in the combination of foreign trade and industrial development, the government of Viet Nam is trying to contribute to a new and more dynamic entrepreneurial spirit.

The country's producers of industrial goods and services would like to benefit better from the strategic location in the growing markets of the Asia"Pacific region. With more emphasis on its industrial expansion, Vietnamese companies need a variety of machine tools and new machinery. The growth of exports should help finance imports of capital goods so as to modernize existing production facilities and expand and raise the quality of the total industrial output.

Consequently, the transfer of technology from abroad through capital goods and related know-how has been made easier through a special ordinance by

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[1] See further the UNIDO-report Viet Nam's industrial development - an assessmebt" of 24 August 1989 (PPD/R.28).

the State Council.$^{1/}$ However, it is too early to say if this government action, taken in late 1988, will actually promote the swift transfer of new technology to Vietnamese industry or, on the contrary, make it more complicated for foreign companies to operate with their own patents, licenses and products on the Vietnamese market.

Apart from the trade issues, a Vietnamese "open door policy" of the late 1980s has been designed and implemented for the purpose of attracting much more investment capital from abroad. The new foreign investment law$^{2/}$ is now being used for the promotion of the country as an attractive site for low-wage industrial production. There are nigh expectations that many foreign investors will soon find their way to both southern and northern Viet Nam. Not only are direct investments invited, but all forms and combinations of foreign investments are permitted -- even industrial plants fully owned and controlled by one single foreign company. Joint ventures with investors from Thailand are just recent signs of the new pattern of international economic co-operation.

In the past few years, there is a growing concern among policy-makers that the technical standard of the country's industry is lagging too far behind that of many other developing countries. The general level of maintenance of existing machinery in Vietnamese industrial firms is considered to be relatively low and the development of new products and processes in industry at large does not reach acceptable rates. With this background, the country's need for investment capital can hardly be underestimated.

The growing concern with a the slow technological modernization of industry is related with changes in the basic attitudes towards the country's overall strategy for economic development.

A basic element in the national economic development strategy is the concept of industrialization. During recent years, three development strategies for Viet Nam can be identified. All three have proponents among government officials in today's Viet Nam.

- The most dominant of these strategies for development has its roots in the idea of one -- or just a few -- key industrial subsectors, where, e.g., the steel industry or the machine-tool industry are seen as crucial for the long-term dynamics of industrial production in the country. By way of promoting heavy industry and related infrastructure Viet Nam would soon attain a more coherent and varied industrial system. This "basic industries approach" is very much inspired by the former Soviet and east European industrial development model.

$^{1/}$ State Council of the Socialist Republic of Viet Nam: "Ordinance on transfer of foreign technology to Viet Nam", Technology transfer and foreign investment, Hanoi: CONCETTI, 1989, pp 67-73.

$^{2/}$ Council of Ministers: "Decree of the Council of Ministers on implementing regulations of foreign investment law", Technology transfer and foreign investment, Hanoi: CONCETTI, 1989, pp 47-57.

- The second type can be abbreviated as a "resource-based strategy" for
  industrialization.   The pursuance of this strategy aims at the optimum
  exploitation of the domestic natural resources drawn from mining,
  agriculture, fishery and forestry.   It is expected that the creation
  and further improvements of industrial processing of these available
  resources will lead to many more Vietnamese products on the domestic
  market and, eventually, to strong positions on foreign markets as
  well.   The "resource-based strategy" is firmly rooted in the Vietnamese
  political culture, where the political leaders are from agricultural
  areas and derive some of their perceptions of industrial development
  from agricultural processing.

- The third type of strategy for industrialization, which is not very
  well represented among macro-economic decision-makers, looks into the
  expanding markets for industrial products -- at home and abroad --
  while identifying the the needs and possibilities as well as the
  necessary means for indigenous industrial production capabilities.
  Following this approach, there is no ambition to create a coherent
  industrial system, but to find growth poles, or dynamic industrial
  subsectors, where old and new products and processes could be further
  exploited commercially.   One such possible priority for technical
  change, as discussed within this policy-framework, is the electronics
  subsector of Viet Nam.

The original model of a centrally planned economy, as applied in Viet
Nam, has been weakened considerably in the course of implementing the economic
reforms.   Decentralization of economic decision-making has become an important
policy issue, which is already leading to changes in the structure and the
ownership of industry.   Now, the market is seen as the single most important
environmental factor for any macro-economic planning.   Or, as it was told by a
senior Vietnamese official, we cannot afford to manage the economy simply by
political-administrative means; we have to rely much more on decisions by the
managers of industrial enterprises.

Policy suggestions.   Relevant government agencies, which are able to
influence the industrial development strategies or the developments of
economically important industrial subsectors should look into the
effectiveness of the existing channels and mechanisms for the diffusion of
information technology.   Laws and other regulations of the transfer of
technology and related know-how from abroad should be evaluated with the same
objective in mind.

National and provincial institutions providing infrastructural support,
such as the Central Institute for Scientific and Technical Information and its
subdivisions, should be given better functional linkages to industry and the
professional staff of these institutions should be made more aware of the
shifts in emphasis in the nation's strategy for further industrialization.

4.   ELEMENTS OF A NATIONAL INNOVATION POLICY FRAMEWORK

Like in other developing countries, the government in Viet Nam has
pursued its own policies for science and technology.   At the national level,
various initiatives have been taken, especially in attempts to create new and
strengthen existing capacities for research and experimental development (R&D)

in different scientific fields and technological areas. In the last few years, particular government attention has been paid to high technology areas such as satellite-based telecommunications, microelectronics and other information technology. But, until today, there is no supporting government policy in Viet Nam for the industrial or commercial exploitation of the outputs from the national system for research and experimental development.

Mechanisms for the elaboration of industrial needs into constructive policy responses by the government agencies are few. Government officials and industrial managers are further apart than in many other developing countries. The functional co-ordination of actions between the different government sectors -- by departments and agencies within the government machinery itself -- is generally weak, although there are structures and procedures for the very purpose of cross-sectoral policy-implementation.

Unfortunately, this general characterization of government policy-making and planning for industrial change also fits well into descriptions of Vietnamese policies towards electronics and other information technology in the late 1980s, although this picture has many shades of meaning. Moreover, in 1989, the information technology policy passes through a stage of transition with many informal deliberations on the medium-term development of such technology.

For national policy-making in the area of science, technology and innovation there is an elaborate and rather complicated structure of agencies and consultative bodies. At the legislative level, in the National Assembly, the Commission for Science and Technology has supported several initiatives concerning high technology taken by the Council of Ministers and its advisory body, the Subcommission for Science and Technology Strategy. Starting in 1986, with the creation by the Council of Ministers of an ad hoc planning structure, a number of ideas to strengthen high tech in Viet Nam, including computer science and other information technology, has been brought into the national decision-making machinery. A few of these more than two dozen ad hoc planning groups, with members appointed according to their formal ranking as well as their personal competence and experience, have continued to meet regularly for nearly three years. Since the group members were brought in from different government sectors and from industry, they could add a more informal and functional dimension to the hierarchies of state planning. Probably, it was during these cross-sectoral strategy discussion that the views on how to improve the general conditions for information technology were expounded and systematized.

At the executive level of government, two State Commissions (or, better, "cross-sectoral ministries" under the Council of Ministers) are now more directly involved in policy-making and long-term planning of information technology. The State Commission for Planning, primarily through the Ministry of Mechanics and Metallurgy, looks more carefully at the strengthening of the industrial capacities in information technology as well as the accompanying professional training and manpower issues. Similarly, the State Commission for Science and Technology, primarily through the National Center for Scientific Research, the National Institute of Technology, and the Ministry for Higher Education, supervises the research and academically oriented training of specialists in computer science and information technology.

During the first half of 1989, following changes in the government organization, it has become clear that the industrial orientation of the build-up of Vietnamese electronics, computer science and other information technology has become the main focal point. It is already clear that this industrial bias in the government policy has been translated into several short- and medium-term actions by both State Commissions. But a functional co-ordination between the two commissions in order to attain common government objectives for information technology is still to be carried out.

Thus a weakness in co-ordination has led to unnecessary misunderstandings of the responsibilities for, e.g., the education of computer professionals (including special schools of informatics and computer technology), for the continuous training of engineers and other specialists, and for training options for other users of modern information technology. Which ministry in the government -- industry, science, or higher education -- should take the lead and what kind of functional co-ordination is necessary in a situation where very scarce technical resources limits duplications of course offerings?.

While entering the 1990s, there are three types of centers in Vietnamese microelectronics and information technology. These centers have all been able to influence decision-making at the national level. They are, in different degrees, responsible for the current state of affairs in the emerging Vietnamese information industries. As such they can be grouped into three clusters of major interests.

One such cluster consists of the industrial interests and are, to a large extent, co-ordinated by the Ministry of Mechanics and Metallurgy in Hanoi.

The second cluster of major interests in this area is represented by the major research institutions, with their most important facilities in Hanoi and Ho Chi Minh City.

The third cluster comprises several scores of institutions in the higher education sector. The biggest and most important in this field of science and technology are also located to the two big metropolitan areas.

Below, these clusters of major interests will be treated separately, but briefly, in order to show the complicated nature of co-ordination of planning in the field of information technology.

The industrial interest grouping. One year ago, in order to strengthen the position in government of the planning and policy-making for the industrial applications of microelectronics and information technology, the Ministry of Mechanics and Metallurgy was given the co-ordinating responsibilities. Within this ministry, and organized as a government-controlled branch association of industrial companies, the Union of Enterprises for Electronics and Informatics of Viet Nam has the prime executive tasks. Until 1988, they were under the responsibility of a separate ministry. The Union's main goal is to co-ordinate and centralize industrial activities in Viet Nam in relation to information technology and, for the same purpose, to influence professional training programmes in electronics, computer science and informatics.

In the 1988 reshuffle, the Ministry of Informatics and Electronics Industries was dissolved, and its functions were brought over to the Ministry of Mechanics and Metallurgy and its new "subdivision", the Union of

Enterprises for Electronics and Informatics, lead by a high-ranking ministerial secretary and operating as one legal entity. The idea was to substitute a formal ministerial structure, considered to be too bureaucratic, with a more functional organization, permitting radical, even drastic improvements in this high technology area of the industrial policy.

Thus, in fact, there is a formal c 'ter within government for major decisions concerning the information industries. But, by mid-1989, it was too early to say if this center will become the much-wanted, streamlined, functional body for the promotion of the industrial applications of microelectronics and for policy co-ordination between the sectors of government. Within its industrial field, the Union has the executive power to implement national industry policy decisions and could easily relate to companies outside of the Union -- in neighboring branches of industry and to other kinds of companies such as combinate factories (with various production units) and larger co-operative or private industries.

The Union of Enterprises for Electronics and Informatics could also act constructively in accordance with provincial and local planning initiatives for information technology. Such joint work with agencies at other administrative levels of government are necessary for any efficient industrial policy move. To use just one illustration: the Ho Chi Minh City administration or, formally, the People's Committee of Ho Chi Minh City, is in control of 140 different factories through its Industrial Service Department and is now actively promoting information industries, including the best equipped computer service company of the whole country. (Cf. the presentation of COSIS in section 4.1.)

In a situation, where the strong orientation by the centralized planning system towards large-scale projects is being reviewed and reconsidered, it is difficult to predict the future degree of central government intervention in the diffusion of information technology for industrial purposes.

The more than two dozen companies in Viet Nam producing goods and services under the auspices of the Union of Enterprises for Electronics and Informatics within the Ministry of Mechanics and Metallurgy are not described in any detail in this report. Rather, following each of the "functional areas" discussed below, it is the type of production they are engaged in which is brought into focus. So, for example, the Hanoi-based Viet Nam Informatics Company (VIETINFOR) will be presented through its major activities in sections 4.1., 4.3., and 4.4.. Moreover, the case-study method used as a basis for this report, does not allow for a complete survey of all the state-owned companies in the emerging Vietnamese information industry.

The research interest grouping. Two major scientific institutions, the National Center for Scientific Research and the National Institute of Technology, belong to the key actors in the promotion of research and experimental development in informatics and computer science.

The National Science Center with most of its resources in the Hanoi area, but with a large branch in Ho Chi Minh City, is the most important of the two. The best-equipped research teams in informatics belong to institutes under the National Science Center; in section 4.5., the the most prominent of these institutes, the Institute of Computer Science and Cybernetics, is presented in detail. Policy-wise, there are close links between the State Commission for Science and Technology, and the National Science Center.

The Ho Chi Minh City branch of the National Science Center is developing its research activities with closer links to industry than the Hanoi branch. The Ho Chi Minh City administration, especially its Industrial Service Department and its Committee for Science and Technology, provides relatively large funds for the Center's research and signs development contracts with the Center's institutes. Still, the Ho Chi Minh City branch of the National Science Center should be seen as part of a national research organization, performing both applied and fundamental research along with its experimental development work for the local and provincial industry.

The National Institute of Technology, located in the neighborhood of the Hanoi Polytechnic University, is still comparatively small and in a phase of construction. It was created only two years ago. In the spring of 1989, it had about 60 researchers in four major fields of specialization: solid state physics, optics, electronics, and telecommunications. It is better equipped than the Polytechnic University, and has very little teaching responsibilities.

The higher education interest grouping is based in a much more diverse set of institutions. The Ministry for Higher Education sets guidelines and develops plans, but it is deliberately playing less important roles in relation to the big academic institutions than it did only some years ago. There is little co-ordination between the different higher education institutions.

Informatics and computer science in Viet Nam is expanding and has already developed into an academic sub-field with a growing number of researchers. In some areas of scientific specialty, Vietnamese computer science has reached international standards.

More details on the current performance in informatics and computer science by the major higher education institutions in Viet Nam are given in the text which follows, especially in section 4.4.

Each of the three clusters of major interests, based in industry, science, and higher education respectively, tends to set different priorities for Viet Nam's information technology. The reason for this is obvious: they perform their activities for different objectives within different socio-economic settings. At the same time, however, their activities are influenced by interlocking interests. For specific purposes, the collaboration between them might be quite intense, e.g. in the diffusion of technology and know-how.

There are no special means developed for the systematic transfer of scientific and technological results from the national laboratories or from the universities to industrial production. Indirectly, however, some new rules and regulations make it easier for technical and other specialists to move between sectors and functions. One illustration only: state employed researchers and other specialists can now do consultancy work outside of their work-place practically without restrictions. This may very well imply that strong linkages are being created between the R&D institutions of the country and particular industrial firms.

Policy suggestions. For both medium-term and long-term actions by the Vietnamese government and by foreign aid agencies operating in the field of information technology, the three interest groupings, presented above, will

have to be treated separately; their development strategies are very
different. Following this, the central government will also have to take on a
co-ordinating role in long-term matters, where conflicts of interest may
hamper the general development of the emerging information industries.

The recent streamlining of the government machinery for industrial
policy-making in this subsector should be monitored and assessed while new
foreign and Vietnamese companies are being established. The information
industries may become very dynamic elements in the economy and this may force
new responsibilities on government regarding finance, international marketing,
R&D support, and other services.

The varying intensity and diversity of action in support of information
technology by the many provincial and local administrations could be seen as
separate and supplementary elements in a collective learning process. When
necessary, agencies of the central government should not hesitate to support
the most promising experiments in the introduction and further development of
information technology. It should also take some responsibility for the
diffusion of knowledge about these experiences to institutions and industries
in other parts of the country. One illustration only: positive and negative
experiences of business development in the Ho Chi Minh City electronics sector
should be made better known to the relevant companies and investors in
Haiphong, Da Nang and the other industrial centers.

4.1. Applications of information technology in governmental and other services

By any international standards the level of computerization in the
government sector of Viet Nam is low. It cannot be compared with that of
today's Thailand and Singapore, who have more advanced applications in use.
Yet, minicomputers and microcomputers for administrative and planning purposes
are very much needed in Viet Nam.

In the short-term, it would be easy to list a whole range of application
areas, where the government administration at the national, provincial and
local levels could function much better, should computerized support systems
become available. For persons involved in the preparations for the national
population census, important issues of administrative modernization have been
raised. Since computers and other technical support are already available,
immediate action has been taken for the local use of population statistics in
housing, education, etc.

More general steps to improve the use of specific information technology
for the promotion of the government services are put on the agenda by
consultants to the government. On the list of priorities are, for example:

- Local, computer-supported networks (within a ministry or among its
  agencies).

- Multi-user systems.

- Administrative workstations.

- Desk-top publishing equipment.

- Machine-translations or other computerized solutions to the heavy demands for foreign-language translation, resulting from increasing international communication.

- Database managing systems, using a minicomputer.

For further illustration, a closer look may be taken at one of the administrative support systems, organized by government for the nation's trade with other countries. A whole range of actors in industrial and other economic affairs are involved and while government does not play a strong co-ordinating role, it wants to monitor and promote some of the activities and, if necessary, change its policy according to the new circumstances. Thus, step by step, as part of an "open door" policy, the trade policy of Viet Nam is changing. Generally, the Vietnamese government is now promoting exports more vigorously than before and, with the same objectives, its Ministry of Foreign Economic Relations is trying hard to create more stable and long-term relations with foreign partners willing to buy products from Viet Nam. By May 1989, 120 companies and other units had been granted permission to work directly with foreign customers. Many more will be able to follow.

In order to monitor the expanding trade in industrial and other products, the Ministry is continuously collecting basic statistics and other data from the 120 trading units as well as from the customs offices at the 64 boarder points of the country. For the monthly processing of this data within the Ministry, there is a Center for Trade Information, equipped with a GDR-made Robotron (A6402 with 256 KB internal memory; magnetic tape plus 4 hard disks); three older computers (one Daron and two Robotrons) and one PC XT donated by Singapore. Also, the Center shares two PC AT and one PC XT with the Research Institute for Foreign Economic Relations, which has just started to use computers for its research and experimental activities.

The most striking weakness in the current performance of the Center for Trade Information is not insufficient or inadequate equipment to process very large quantities of information, but functional deficiencies caused by the poor state of the technical infrastructure in the country. The telecommunications is not always reliable for the transfer of data, even by telephone or telex; mail service is slow. The Ministry for Foreign Economic Relations is not satisfied with the basic function of its Center for Trade Information, since the monthly statistics can seldom be properly updated.

The nine professionals of the Center (three programmers with different specialties, two technicians or engineers for the maintenance and development of the equipment, three operators, and one manager) are trying hard to compensate for this situation also by developing an information structure with regional centers, which can collect and process data in a standardized way.

At the same time, the qualitative requirements are growing for trade intelligence, or information processed for immediate practical use. The list of 120 companies and agencies in direct contact with foreign trading partners is being extended. The government is encouraging other firms to market their products abroad. With an expanding foreign trade, more systematic information is needed from other countries on prices and other market changes, financing and credits in different commodity areas, trade regulations, standardization and harmonization, safety standards for consumer goods, etc.

To the intelligence needed for foreign trade policy-making belongs information on Vietnamese trading customers and counterparts as well as on potential partners and investors from a growing number of countries. Also, there is a need to know more about changes in production processes and locations, storage, maintenance, ways and means of distribution, etc.

Even though serious attempts have been made, all of this cannot be processed by computers in a specialized and separate unit of a ministry, but rather has to be integrated into the daily administration of a company involved in foreign trade or a functional unit of a government agency. But the Center for Trade Information of the Ministry of Foreign Economic Relations can be extremely helpful in providing partially processed or "raw" trade intelligence for the benefit of Vietnamese export companies and for policy-makers in both central and regional government agencies.

From an intelligence point of view, the Center is not just a producer of relevant trade statistics, which is an important objective by itself, but also a node in a national network for swift distribution of necessary information to decision-makers. It has started to develop a system for exchange of data between colleagues in seven east and southeast Asian countries, including a regional data base, although it will take a lot of time and effort to get accustomed to different statistical and institutional traditions. Experts of the International Monetary Fund, on missions in Viet Nam, use the services of the Center.

In the international as well as the national networking activities, new demands will be made upon both the existing computer hardware and the programming skills of the personnel of the Center. There is a need for appropriate and technically more sophisticated equipment as well as for software assistance, e.g. by way of consultants or special training options outside of the country.

No doubt, the demand for accurate and timely information on Vietnamese trade has grown dramatically. Hence, the Center should not only meet the requirements of its ministry. All the users in industry and at different levels in the government, including major province governments, have to be taken into consideration while collecting, processing and distributing data. The lack of experience in organizing a streamlined intelligence system with a multitude of functions, using computer-supported data base techniques, may cause problems in the acquisition of the relevant information technology. For this some external training assistance may be needed.

The Ministry for Foreign Economic Relations is a relatively advanced user. In many other Hanoi ministries, the ambitions are lower and the user experiences have not materialized into special applications like in the Center for Trade Information. But all other ministries have formulated some medium-term plans for their use of the new information technology.

One of the firms, which try hard to explore the growing market for computer services in the government sector, is the Viet Nam Informatics Company (VIETINFOR). It was founded in Hanoi already in 1976, but was remodelled two years ago to become a more functional and streamlined organization. Among its staff members are some 20 engineers with software skills and four persons with a Phd or equivalent degree. The company has four divisions or centers. The center for education and for applications of

informatics is presented in section 4.4. One division specializes in
maintenance and related services, another in assembling small batches of
consumer electronics, primarily television sets, radios and tape-recorders.
Here, while looking into the applications of information technology in
governmental and other services, the fourth division, the Center for Data
Processing, is the most relevant.

Like others among the growing number of computer service companies,
VIETINFOR has developed a capability to master the technical side of
administrative routines based on PC XT, PC AT and some eastern European
computers (primarily early versions of Robotron, which are now being
substituted). Under contract, the Center for Data Processing takes the
technical responsibility for such existing routines, including maintenance and
further development. Having a service organization with a national network,
VIETINFOR represents the GDR producer of Robotron computers. It is willing to
take on similar duties from other foreign companies. Also, the Center for
Data Processing provides technical services to government agencies and
industrial firms, who are planning to use information technology in support of
their daily activities. To the extent possible, it rents or leases equipment
to those customers, who prefer not to buy their own computers. Short
user-specific training courses are offered as package-deals with other
services.

The technically most advanced service center is located to the southern
part of Viet Nam, where there are many more users of computers than in the
northern provinces. On a more systematic basis, the Ho Chi Minh City
administration started to use computers (primarily PC XT) in the mid-'80s.
The administrative uses were both for the local government agencies and for
the economic records etc. of some of the many companies, owned by the City.
In September of 1988, after a year of preparations, the City administration
brought together several of its administrative and statistical services to one
unit, a separate company. The Company of Services in Informatics and
Statistics (COSIS).

COSIS was originally financed and is still owned by the City, but runs
independently as if it was a private firm. At present, it has about 30
programmers (trained at the School of Economics, the University of Ho Chi Minh
City, the Polytechnic University, etc.), ten technicians for maintenance, and
a quickly growing number of operators (soon to work in two shifts). The
salaries of the most skilled personnel are presently three times the normal
and is expected to raise to nearly five times of what a university-employed
programmer would receive.

The directors of COSIS have been granted a large room of maneuver in the
emerging Vietnamese information industry. The company can do business in the
whole country, accumulate its own profits (also in foreign currencies) and
trade with partners overseas.

The real "take off" for the COSIS activities coincided with the
preparations for the national population census, which was started in 1988 and
is being performed in 1989. Through the UNDP and the UNFPA, a minicomputer
(Bull DPS 700) with 22 terminals and 2 microcomputers have been installed in
the Ho Chi Minh City building of COSIS, which is providing the technical and
some of the administrative support to the census project. At the time, COSIS
was already well-furnished with Italian-made Olivetti PCs (of which 3 with 100

megabyte harddisks), PS2 (model 80; 150 megabyte). at least 10 Thompson additional monitors for the PCs, and scores of IBM PC clones from Hong Kong, Singapore, and Taiwan Province of China.

The abundance of modern equipment is partly explained by the imports by COSIS for the national Vietnamese PC market. Some 200 computers have been imported and sold to Vietnamese customers during the past 10 months. Here, COSIS competes with nearly 15 other commercial trading houses in Ho Chi Minh City, specializing in computers and related equipment. There are also a number of other channels for importation.

Among COSIS' customers are several Hanoi electronics companies (including VIETINFOR), the State Commission for Science and Technology, and the national Center for Scientific and Technical Information. To them and to others, COSIS can provide not only hardware and related maintenance, but also a range of applications programmes and relevant training courses for the end-users. To the many activities of the Ho Chi Minh City administration, COSIS contributes with statistical calculations for the local and regional population census, data on real estate management, statistics on tourism, and electronic processing of a variety of accounting routines. For customers in Hanoi, including central government offices, COSIS produces statistics and support to administrative routines.

COSIS aims at becoming a center for the transfer of information technology to Viet Nam and commercialize this service to the local industry. Skills in advanced programming are being developed (e.g. using Unix system V"386 and Xenix 2 operating systems; and applying dBase 4 and Oracle). COSIS is sending staff members abroad (two to Federal Germany, and three to Thailand in 1989) to attain special qualifications, and it has already developed its network to Vietnamese informatics professionals living permanently in other countries, who, for instance, can provide latest journals in the field of informatics and computer science only a few weeks after publication. The main restriction to the expansion of the commercial activities is the current lack of experienced manpower, while the recruitment of persons with only high formal qualifications in the field is much less difficult.

In VIETINFOR and among some of the other Vietnamese companies providing computer services to the government sector, there are clear ambitions to attain a higher degree of standardization. The idea behind is to reach economies of scale (primarily for the service functions), to be able to move computer programmes from one application area to another, and to exchange different kinds of data. But in many other countries, the tendency towards technical standardization is not as clear and does not have the same technical focal points. New standards in computer software are developed primarily for the purpose of having computer networks and other parts of a specific information system to interact. But the interface between different computers (and operating systems) are now much more developed than just a few years ago.

From a functional point of view, it is less important to be able to move specific computer applications from one area (or computer) to another, if there are no restrictions to move text and other data to be processed by others. Today, microcomputers made by, e.g., IBM can interact much better with most other computers, even with machine based on different operating systems. It is not insuperable to move a computer edited document or other text files, nor an intermediate spread-sheet summary, from a computer using

MS-DOS to one using Unix. Harmonization and standardization in this and other areas of information technology makes the work easier, but the technology itself is catching up with the growing needs for better data communication between the different software and equipment.

Policy suggestions. In support of the industrial development of Viet Nam, there is a great need to develop a well-functioning public adminstrative and service sector. Relatively inexpensive, international available information technology as well as locally developed software packages for administrative and other purposes could speed up the government administration and quickly raise the level of service to its citizens and companies. Several examples of recent improvements, while applying information technology, have been summarized in the text above.

The central government — and also the biggest provincial administrations — should systematize these and other experiences so as to detect important functional weaknesses in the administrative and planning machinery and, hereby, identify areas in which information technology could make procedures both faster and simpler and decisions more qualified.

It is advisable that Vietnamese computer scientists and other specialists in information technology are consulted by government agencies on a more regular basis than today in matters of modernization of the public sector.

New types of applications in this field of technology may sometimes seem extremely attractive to the end-user. But the options at hand may soon turn out to be less relevant to the particular government agency. Hence, it is advisable that local information technology expertise are drawn into decision-making on new investments and that they are treated as partners in a dialogue on the optimal use of these investments.

Such professional relations may not only lead to a better use of available information technology, but may also inspire to new applications and further development of information technology. In the medium-term and long-term perspectives, close and constructive relations between users and producers of information technology applications often provide a basis for new processes and products.

4.2. Information technology and the economic infrastructure

In January 1989, Hanoi launched a direct satellite link with the outside world through a 4.5 meter antenna on an interim earth station. Ho Chi Minh City had already been connected with international direct dial and, moreover, in the south of Viet Nam, technically stable fax-links are available to any customer. The small earth station in Hanoi, like the one on in Ho Chi Minh City from 1987, which provides services for transit traffic from many other countries as well, was developed with the assistance of the Australian Ministry for Telecommunications (OTC International). Earlier, some telecommunications relying on USSR satellite connections have been in use. Digitalized data, using methods developed at the Hanoi Polytechnic University, will be transmitted on an Intercosmos satellite.

Today, it is sometimes quicker and more convenient to pick up a phone in Hanoi for calls to Australia than to a medium-sized city in Viet Nam.

Above, in section 4.1., attention has been drawn to the negative impact of the weaknesses in the Vietnamese economic infrastructure on the Center for Trade Information in the Ministry for Foreign Economic Relations, which cannot provide much-wanted economic intelligence to decision-makers in government and industry. The mail service, the present alternative to computerized data from the 64 official boarder points and the 120 or more companies and agencies directly engaged in foreign trade has severe limitations.

For international trade, and for benefit of the industrial development of the whole country, national and provincial efforts should be made to improve this situation without delay. Probably, by using modern electronics and computerized telecommunications equipment, short-cuts and immediate improvements can be reached within a very short period of time.

Apart from the Ministry for Foreign Economic Relations, there are already a number of potential customers in both government and industry waiting for the possibility of transferring data through telecommunications for computer processing. One such grouping of eager customers is represented by the national bank.

The State Bank of Viet Nam belongs to the country's early users of computers for administrative purposes. Before switching to IBM-compatible microcomputers in 1986, the Bank used computers made in the USSR and other eastern European countries (e.g. Robotron of GDR). In the southern part of the country, the computers were most often originating from the USA.

Today, within the whole State Bank structure, which includes the two major branch offices in Hanoi and Ho Chi Minh City respectively, about 250 PC AT (or, less frequently, PC XT) with hard disk memories of 30-40 megabytes are in use all over the country. The bulk of these machines, primarily used for the daily, weekly and monthly accounting, are made in the USA, Japan and Singapore. The maintenance is organized and performed by the Bank's own technicians.

With a few exceptions, all software used by the State Bank for economic statistics and for the Bank's reports, account management, calculations of interests for individual accounts, etc. has been developed by program specialists within the Bank itself, trained in Viet Nam or in the USSR and the eastern European countries. Both development and routine work is organized within a special informatics department, the Center for Calculation and Statistics.

The Center's most challenging tasks remain to be done: the development of local and regional networks for the computerized accounting and the completion of a national network with similar functions. In 1989, a regional system with a computer unit of the State Bank in each Vietnamese province will be in operation. But there are still no computerized data communication links between the regional units and the local bank offices. For the systems development and the actual programming, more specialized training of the Bank's personnel is needed, and more operators and hardware specialists will have to be recruited.

The frequent changes of the rules and regulations for the banking and credit system of the country has forced the Center for Calculation and Statistics to create a capacity for change of its computer programmes as a

matter of (a relatively speedy) routine. But, on the other side, there is not enough money to buy one or several large enough mini-computers to manage and control the accounts and economic activities of the bank at the national level. Plans to establish a management information system, using available information technology, have been put aside for the same budgetary reasons. The fiscal restraints permit few economic incentives to a professional attitude to work among the computer personnel. Although the management generally wants a better performance by its highly skilled personnel, it actually encourages everyone to seek extra jobs outside of the State Bank to compensate for the low salary level. This may have negative secondary effects on job relations during the difficult transition from manual clerical work to computer-aided operations, where the new work specialization and division of labor become very different.

Being a pioneer of information technology among the banks in Viet Nam, the State Bank has some external responsibilities towards the specialized banks and the provincial banks. According to its instructions, the Center for Calculation and Statistics should take some responsibility for the diffusion of know-how and technology from the State Bank to other Vietnamese banks and credit institutions.

Another type of national data network, to be supported by modern computers and telecommunications, is currently being planned in detail in Hanoi and will be implemented in the next few years, if the fiscal restraints are lifted. it is the scientific and technical information network developed by the Central Institute for Scientific and Technical Information. This national network will be linked together with several already existing international networks and it will be promoting local and regional networks with similar ambitions.

Today, the Central Institute is equipped with only eight Olivetti PCs (four with hard disks) and a number of printers, including a laser printer for its publications. Technically, however, the Institute can already establish on-line access to library and documentary database in the USSR and eastern Europe, Thailand and Australia, but this service is considered to be far too expensive. After the creation of a link to the USSR for six months in 1988, the limited government funding forced the Institute to close the service during the first four months of 1989. More customers in industry and among research institutions will have to be mobilized for the service to continue.

Not just more money, but also, more specifically, a minicomputer and expensive peripheral equipment will be needed if the next stages of the experimental plan to provide Vietnamese users with similar quick and reliable information services as researchers and technicians receive in the industrial countries. Book abstracts, selected references, scientific articles grouped according to key words, patent descriptions, etc. are useful tools in the transfer of knowledge and technology to a country with a relatively small R&D system.

As a national institution linked to the major libraries and documentation centers, he Central Institute for Scientific and Technical Information should manage and develop information to ministries, companies, and ind vidual customers. It should also collect scientific and technical information in the country for distribution to potential users in Viet Nam. Traditionally, these services are carried out through bibliographies, photocopying of abstracts,

offset printing of review articles, microfiche techniques, etc. The current emphasis on computerization of the bulk of these services stems from the idea that the services could be much faster and more timely and hence directly relevant for innovative activities. Until now, the limitations in the transfer through telecommunications are blocking the development and makes Vietnamese researchers, technicians and other personnel relatively isolated.

Theoretically, with proper funding, it would only be a matter of months before Viet Nam could be connected with the other Asian countries (via Bangkok), the socialist countries (via Moscow and directly to eastern Europe), the French-speaking community and the English-speaking world. These links have been tested and, in most cases, the personnel to become involved are already trained and prepared. At present, routines are now being developed and the combination between traditional and new means for the transfer of technical information are tried out on relevant customers. Still, the demand is limited and is not expected to raise substantially before the industrialization gains speed.

Policy suggestions. The economic infrastructure, presented only in part above, will have to be substantially improved within the next few years. For the benefit of the industrial development, government efforts to develop telecommunications generally and to provide other services in this area should be made without much delay. By using available information technology and adapting it to local circumstances, substantial improvements could be attained within a very short time.

The experiences gained from the more advanced national users, such as the State Bank of Viet Nam, should be channeled into other economic sectors. Available expertise should be stimulated to work as consultants to different types of agencies, responsible for services to manufacturing industry.

4.3. The microprocessor in manufacturing industry

The on-going attempts to rehabilitate and modernize existing industrial plants and to create new companies in different industrial subsectors and product fields are hampered by the lack of foreign exchange. Necessary spare parts and some of the most relevant new machinery cannot always be bought abroad. But, also, company internal factors do hold back changes in industry.

A low degree of specialization within the typical industrial firm often prevents the relatively few technicians, foremen and other middlemen from working at the shop floor according to their qualifications and job functions. Ineffectiveness in the use of technicians may cause serious disturbances in the basic operations of the production system. There are also initiations in the continuous up-dating of machinery or, to phrase it differently, the system does not stimulate incremental technical change, which is often crucial to industrial innovation.

In the past few years, these and other deficiencies have lead to a fast-growing market in Vietnamese industry for technical and organizational consultancy services. In both metropolitan areas, Hanoi and Ho Chi Minh City, engineers and economists have created small firms to offer these kinds of consulting services to industrial companies.

Some of these firms are just part-time operations by one or a few state employees. Since many of them are primarily selling equipment and basic instructions on how to use it, they snould not be called consultancy agencies. They are not providing a proper service function. The concern is not to improve the functional organization of production, but, simply, to raise the technical level in the company. Expert advise is seldom provided on how to best combine organizational change with technical change.

Other firms such as CONCETTI (the Consultancy Center for Technology Transfer and Investment) with bureaus in Hanoi, Vung Tao and soon also in Haiphong, and TEDCO (the Technology Development Company) of Ho Chi Minh City are medium-sized, diversified operations with a number of specialists available on a full-time or part-time basis. They are interesting new examples of professionally run consulting firms with a broad range of expertise from different fields of technology.

Both CONCETTI and TEDCO have received government support, although they both function as independent consulting agencies. CONCETTI was originally created by the State Commission for Science and Technology and still shares some of its core personnel with one of the institutes under the Commission. TEDCO has received both its basic funding and important industrial contracts through the Ho Chi Minh City administration. Their main customers are found in industry, but there are recent examples of contracts for organizational and technological change with the government's administrative agencies and even with the secretariat of the National Assembly, who wants its administrative and other routines scrutinized and improved (also by the provision of relevant computer programmes).

Not only these two, but several others of the new consultancy agencies in Viet Nam are operating together with foreign partners. One of the reasons for developing such international partnerships, or fostering business links with firms outside of Viet Nam, is the potential for a much more efficient transfer of know-how and technology. Another reason is a possible adaption to management styles and skills developed in relation to technologically very specific production processes.

Beside the quickly emerging consultancy services, there is a tendency among modernizing industrial firms in Viet Nam to try to apply microelectronics and other information technology by themselves. In all branches of Vietnamese industry, there are only few joint efforts to computerize and, typically, there is little diffusion of experiences of information technology between companies. "Every business enterprise is trying its own way first", says one of the two directors of VESCO II, an electronics company in Ho Chi Minh City, specializing in technical support to industry. And, he continues, "for many reasons, so much duplication is unnecessary."

VESCO II or, to use its full name, the Electronics Service Company No. 2 is one of the electronics firms under the Ministry of Mechanics and Metallurgy, which has been granted a high degree of freedom in its operations. It functions as if it was a private, independent company; the only formal requirement by the Ministry is an annual progress report.

VESCO II began repairing, maintaining and assembling electronics products for Vietnamese companies in 1983. It now provides turn-key computer hardware and software applications to a variety of firms: a soap factory, a textile firm, dairy producers, etc. For food production it delivers electronic sensors such as pH monitors, for factory halls it installs automatic fire extinguishers, and for the general consumer market it assembles, in small batches only, radios, tape-recorders, television sets and electronic calculators.

The currently high demand for computers and related electronic equipment from Vietnamese firms cannot be met by small and medium-sized electronics firms such as VESCO II. For the next few years, before an electronics industry is developed in the country, there will have to be bigger and more efficient channels for high tech product distribution. The major bottleneck for companies like VESCO II is the current lack of foreign currency. At present, VESCO II's income in hard currency is derived primarily from technical service contracts to foreign companies operating in Viet Nam, including those in the special economic zone of Vung Tau (Agip, Denimex, Olivetti and others).

Like VIETINFOR (see section 4.1.), VESCO II can accumulate its own profits, and like COSIS (see also section 4.1.), it can trade directly with foreign companies. Of the ten professionals employed, two are engineers from the polytechnic university with a computer science specialization; eight are hardware and software specialists, several with training in Japan (one of whom received a postgraduate degree). The Japanese linkages, primarily with the Nippon Electrical Company (NEC), are the technical backbones of the VESCO II activities in Vietnamese industry. Appropriate electronic equipment is received without delay. NEC provides three-months credits, which makes importation of even expensive computers possible.

VESCO II would like to create a joint venture with a foreign partner to intensify its international trade and to establish production of computers and peripherals in the country. The directors are critical to the low degree of interaction between the Vietnamese research institutions, developing either software or hardware, and the electronic firms.

In this context, Sakyno Ltd, another type of company under the industrial service department of the Ho Chi Minh City administration, should be mentioned. Sakyno is not a company within the emerging microelectronics industry, but should be seen as an example of those manufacturing firms, which have started to move along with the diffusion of information technology to Vietnamese industry.

Sakyno is a multi-divisional firm producing and selling engines, a small harvester, equipment for food storage, spraying machinery and other farming equipment. It is now entering the electronics sector with the ambition to step by step update its products and production facilities through microelectronics. It is seeking ways and methods to combine some high technology inputs with the existing technical solutions, thereby raising the quality of its products.

The growing demand for new information technology, both hardware and software products, has tempted the directors of Sakyno to do business with foreign electronics companies (foremost a company from Singapore, which is

producing its own PC XT clone). But the emphasis by Sakyno is on specialized training, not on selling computers; and it has no maintenance or service facilities in this field of technology. There are unfinished plans on how to develop new software applications for industrial firms in the Ho Chi Minh City area. Software development might become a future business activity.

An educational department has been set up within Sakyno and this department is oriented towards management applications of computer software. A newly recruited university professor and a team of part-time educators are developing a six months' course for industrial employees, typically technicians with a secondary school certificate and a few years of work experience. Other courses, specifically for industrial employees, are to be developed later.

With the educational initiative, the Sakyno company wants to fill in gaps between the academic education in informatics and the many other short-term course options currently available. It is hoping for a co-ordinating function in this field of training between the Ho Chi Minh City administration and other companies of the different branches of industry.

The Ho Chi Minh City Committee for Science and Technology, which takes on some responsibilities for the local and provincial diffusion of computer applications, has been concerned with the training of another category of personnel, the computer operators. To expand their numbers, and to offer supplementary training, evening classes have been arranged for operators by various institutions in Ho Chi Minh City.

While bringing together individuals from different institutions and companies for courses and similar activities, it is expected that some transfer of know-how between different enterprises and agencies will take place. Networking among specialists is being stimulated and could, in the short run, compensate for the underutilization of some specialists and their equipment.

Another way of diffusing information technology is to arrange for development work in a specific industrial firm and invite other firms to learn from the experiences. Although not arranged as industrial "demonstration sites," limited government supported has been given to specific firms for computerized design of textiles and clothing, carpets and other woven fabrics. The Ho Chi Minh City administration is hoping that these experiments eventually will involve many other companies in these product areas.

For the mechanical industry of the Ho Chi Minh City area it has been estimated that substantial unused or under-utilized machinery (equivalent to "at least one million in horse power") could be put back into production, if the electrical components were repaired. Lacking spare parts, maintenance and repair has to be improvised according to what is available. Hence, in a typical industrial firm, machinery and other production equipment is far from full capacity-utilization.

Consequently, establishment of facilities to develop and produce spare parts for electronics is given high priority. The reliability of existing equipment has to be maintained. The distribution of available spare parts has to be become more efficient and timely. Such actions are contained in an informatics applications program of the Ho Chi Minh City Committee for Science

and Technology, which deals also with "mechanization and electronics."
In this setting, an important manpower restriction, which concerns the
technological contents in the formal training of engineers, should be
mentioned. As will be shown in the next section (4.4.), until recently, the
technical universities of Vietnam have put no special emphasis on computer
science within the education of engineers. The situation is now changing.
All graduates from the the polytechnics and other technical universities will
have to have some programming skills and practical experience of computers.

But for those engineers which have already graduated several years ago,
some institutions, like the Computer Science Center of the University of Ho
Chi Minh City, offer supplementary courses in programming, systems design
etc. Each year, fifteen engineers are offered this kind of training at the
Center. After the course, most of them return to their companies to work in
other technical functions.

This kind of supplementary training in computer science and related
information technology can also be looked at in the light of the general
underutilization of technical and engineering personnel in manufacturing
industry. Foreign observers often assert that engineers in Vietnamese
manufacturing industry are drawn into routine production, while they more
seldom get chances to develop their skills in advanced maintenance work or
innovative activities. Extending and up-dating their skills to include
computer science and offering them insights into new applications of
microelectronics, might lead to better ways of utilizing experienced engineers
in industry.

Policy suggestions. Both for the rehabilitation and modernization of the
existing manufacturing enterprises and for the creating of new production
capabilities in industry, the diffusion of microelectronics should be seen as
an important tool. For a limited set of Vietnamese industrial firms, it is
recommended that experiments are designed and performed to try out different
ways to use information technology in order to speed up production and improve
the quality of products.

Such government supported experiments in industry, limited in number and
in types of firms involved, could become part of a future "awareness campaign"
to stimulate whole subsectors of industry or even industrial branches to
benefit from information technology in production and related services. At
the same time, Vietnamese engineering consultancy firms could get involved in
designing and implementing techniques for the transfer of information
technology and know-how between firms and between R&D laboratories and
industry.

The experiments may also be used as proving grounds for Vietnamese
adaptions of foreign software and electronics products and, even, serve the
purpose of developing information industry products and services within Viet
Nam.

Companies, like VESCO II, who are already importing and adapting foreign
information technology to the most advanced Vietnamese users, should be
encouraged and, if possible, financially assisted by government agencies to
further develop their capabilities in design and development of computer
software and hardware, thereby creating potential microelectronic growth poles
around which other companies can be developing.

4.4. Manpower issues and migration of highly skilled personnel

Four years ago, in southern Viet Nam, there were not sufficient job opportunities for academically trained computer scientists such as program specialists. Today, higher education institutions like the Computer Science Center of the University of Ho Chi Minh City cannot meet the rising demand -- neither from the private companies wanting to hire programmers, nor from students wanting to study informatics and computer science. For the spring semester of 1989 there were five qualified applicants for each student place. Efforts are made to accept many more students, "since we have to adapt to the future demand," says one of the deputy directors of the Center.

The Computer Science Center, created two years ago and functioning as a semi-independent unit of the university, receives no money from the university budget apart from the salaries to its 12 teachers of which three hold doctoral degrees. The Center is located in the university's building complex in the center of the city. Apart from one microcomputer provided by the Ministry of Higher Education, all necessary equipment, including books and special documents, has had to be acquired through the extra income from consultancy services, offered by the Centre's staff members. Until today they have managed to buy and install ten extra microcomputers with related equipment worth nearly US $20,000 to be used for both research and course activities. Since there are no microcomputers, including related services, at the other departments of the University of Ho Chi Minh City, these machines have to be used also by researchers from all over the university.

The most pressing issues at the Computer Science Center are lack of relevant equipment (first and foremost more computers for teaching purposes), the limited supply of relatively expensive special publications and documents, and the very small number of highly qualified teachers. The small number of teachers in computer science is considered to be the most difficult problem to solve in a situation of necessary educational expansion. Previously, help has been received from abroad, but, in the future, teachers with training only from Vietnamese institutions will be in clear majority. Half of the current staff at the Computer Science Center has received specialized training abroad, or, to be more precise, in the USSR, Czechoslovakia, Poland, Switzerland and France. The low salaries in the public sector will make future recruitment of university staff members even more difficult as private industry already offers salaries which can be up to three times higher than the university's.

The sister institution at the University of Hanoi, the Department of Applied Mathematics and Informatics, has similar problems of staff recruitment, but tries to use more of part-time personnel as well. The staff of the Department has close contacts with the Institute for Computer Science and Cybernetics of the Hanoi branch of the National Center for Scientific Research. This informal arrangement allows for specializing university students in informatics to use some of the facilities at the Institute.

About 30 students at the Department of Applied Mathematics and Informatics have been accepted for specialized course work in computer science and informatics. Many of them have been promoted because of their exceptional mathematical and natural science performance already in secondary school. Until this year, they are the only students at this level and degree of specialization at the University of Hanoi. In fact, this is the first attempt by the University to develop a high level course program in informatics.

Indirectly, the French government has provided an important incentive to pursue this course development by way of a donation of a dozen educational computers (Thompson 7).

The Hanoi Polytechnic University is one of the major institutions in the country in the research on computer hardware and in informatics. In computer software, research and experimental development has been performed in areas such as databases, programmes for use in natural scientific experiments, and management applications of informatics. Research and development of electronics applications have been performed in a large number of areas, most of which have been relying on foreign microcomputers and other components, also from Japan, Republic of Korea and the south east Asian countries.

There is no special informatics or computer science department at the Hanoi Polytechnic. Specialists in the are all work in several different departments. The Electronic Information Department has some 150 students at present; the only limiting factor is the lack of computers. All in all, there is only 30 PCs and some older Soviet and east European computers available for the whole institution, which has a total of 3000 students. In electronics and telecommunications the number of students is smaller, but increasing.

For the last two years, the government has given the Polytechnic the freedom of choice in setting the numbers for student places available. More students are recruited and more PhD candidates have started their research training. The requirements from industry have become a more important criterion for a more detailed educational planning than before. It is already clear that student specialization in electronics and informatics and computer science will be awarded.

The sister institution in the south, the Polytechnic University of Ho Chi Minh City, has been better equipped by computers during most of the 1970s and 1980s. It has also more foreign funding that could be used for this purpose and for the training of its staff at overseas institutions. Previously, the staff has actually built some small computers ("we needed new machines, but had no funds, so we had to find a solution by ourselves, especially since most foreign markets were closed to us"). After this experience, the Polytechnic was given an assignment to assemble microcomputers for other research institutions in Viet Nam.

For its own needs, since a few years, the Polytechnic is relying on foreign-made computers only; some of these have been donated by Vietnamese living abroad. The earlier experimental work fostered a high level of technical skills, which has been exploited in the teaching of computer science.

In May, 1989, 15 microcomputers (five IBM AT; ten XT) are available to the students enrolled; and there is a "hardware room" for student practises. Apart from these machines, a number of other machines are used for research and other activities by the staff members. The Computer Center has 25 members, three of which (soon to become eight) have foreign PhD degrees. Apart from their teaching and research assignments, they have a service function to the other departments of the university.

Each year, 40 students of the new engineering students are accepted to a five-year long computer science specialization, which includes both the software and hardware sides of information technology. (In most other

technical universities in Viet Nam "hardware orientation" in electronics is a matter for electrical engineering; informatics, including computer programming, is taught in the basic sciences such as physics or in mathematics.)

The schools of economics in Hanoi and Ho Chi Minh City are much weaker in informatics than the universities and polytechnics. One reason for this is a slow adaption to the changing needs at the labor market; another, which is more important, is the absence of a strong research tradition within these institutions in support of teaching in informatics. Research in this area at the Ho Chi Minh City school is performed in two sections, one for cybernetics and the other for economic modelling; only between 10 and 20 students are enrolled each year in courses related to informatics.

In Hanoi, at the National University of Economics, as the name is officially transcribed, it is possible for a student to specialize in, say, mathematical modelling, credit and banking, or accounting and, along with the specialization, develop skills in computer usage. Apart from this, there is no special training in informatics.

The sudden rise in demand for high skills in computing and other information technology at the Vietnamese labor market, has caught government higher education planners by surprise. The planners had expected that a rise would come, but rather slowly. They did not predict that both industry and government would be so eager to recruit personnel with these kinds of skills. Because of this, bottleneck problems will probably appear, especially in the economically dynamic Ho Chi Minh City area but also in the northern part of the country.

In Viet Nam, computer science has not been introduced as a new field of study at the secondary school level. Recently, in the Ho Chi Minh City area, experiments have started to introduce computer science as a study dimension within the normal curriculum at the 10th, 11th, and 12th grades of high school. The City Committee for Science and Technology has endorsed such experiments in three high schools; seven more will follow.

At the major technical universities of the country, it is easy to find skeptics among senior staff members, who claim that the current growth in demand for computer engineers is either temporary or, at least, not as significant as the figures for applications to the limited number of study places shows. However, this group of academics seem to be diminishing; it is a more common belief that the educational opportunities in this area will have to be multiplied within the next few years.

The situation at the higher education institutions, as described above, is probably representative for most of the other higher education institutions in the country. Both in the short-term and in the long-term, any central or local actions have to be directed towards the solution of three key problems: Computers and related equipment for course activities and student assignments are insufficient in number, the training of teachers and assistant teachers has to be improved, and books and other documents necessary for efficient course work are lacking or cannot be made available to the extent wanted.

A first step in the solution of these problems would simply be to provide
new resources or redirect already available resources. This can be done in
co-operation between institutions at the local and central levels of
government, where the initiative rests with the educational establishments.
But the qualitative aspects of any policy-measure, which are equally
important, has to be based on analyses of how the labor market for this highly
specialized work-force will develop in the near future. Such a type of
planning is rather complex and difficult to perform and may have to include an
analysis of the local and regional differences within Vietnam; priorities and
planning objectives should not simply be transferred from technically more
advanced countries. Interest groups outside of the government sector have to
be involved in the setting of priorities.

All this implies that the actual training of specialists cannot be
restricted to the already existing universities and other scientific
institutions, but has to become the responsibility of other bodies as well,
including industrial firms.

What is likely to happen on the Vietnamese labor market, in relation to
the diffusion of information technology, is a rather quick diversification of
skills among specialists. Like in the technically more advanced countries,
the job structure will develop according to this further specialization. And,
as a necessary consequence, the training will have to be organized differently
for the different categories of the highly-skilled manpower. Obviously, there
are special requirements in the skill formation for programmers, systems
analysts, operators of mini-computers and computer networks, engineers and
technicians for hardware maintenance, etc. Furthermore, new skills are needed
for new types of programming tasks and other software developments.
The typical time for the training of such a specialist would be 4-5 years for
a programmer and 2-3 years for a skilled operator. In order to quickly expand
the total stock of skilled manpower in this area, there are surely many
unexplored possibilities to establish short and intensive, but still effective
course programmes for engineers, mathematicians, and similar groups of the
already trained and experienced Vietnamese workforce.

For the many new users of computers and other information technology, in
the government sector as well as in industry and related services, there is a
surge of course opportunities. It is very tempting for public institutions
and private companies to exploit the acute needs for training and offer short
courses for the eager candidates. During the spring months of 1989, the daily
papers in both Hanoi and Ho Chi Minh City ran advertisements in nearly every
issue to recruit course participants. In relative terms, all of these
privately organized courses proved to be very expensive for the individual
participant.

One of the larger companies in this area of teaching is the Viet Nam
Informatics Company (VIETINFOR), based in Hanoi and briefly presented in
section 4.1 above. Its educational division or Center for the Application of
Informatics arranges several training courses for a single customer or groups
of customers in industry and government, compiles and translates relevant
course books and study material into Vietnamese (also from the English
language), offers supplementary training and related services, etc.

Still comparatively small with only six full-time teaching specialists,
VIETINFOR tries hard to become one of the leading institutions in the

metropolitan area of Hanoi for user-related training in informatics. During
the last few years the company has offered courses for the staff of several
ministries, the Institute of Geology, and several private and state
companies. In 1989, it is collaborating with teachers and other specialists
of the UNFPA for further training of the Vietnamese personnel engaged in the
on-going national population census.

     Among the competitors to VIETINFOR on the expanding and lucrative market
for both introductory and more advanced courses in informatics are the
universities in the Hanoi area and the Institute of Computer Science and
Cybernetics of the National Center for Scientific Research, which is just
establishing a training center.

     To speed up the training of instructors and other teachers in informatics
and computer science, experimental courses have been arranged outside of the
higher education sector in Viet Nam. In 1989, just as an example, one such
course was arranged in Hanoi over a period of six months with nearly 20
specialized teachers, each involved for 2-4 weeks; some of the teachers were
brought over from France. All 50 participants had jobs in industry as
engineers, experienced technicians, administrators etc. and they were paid by
their employers while joining the course activities during 20-30 weekly
hours. Course expenses were covered by the Vietnamese industry.

     Formally, among computer scientists and engineers, there are surprisingly
few collaboration schemes between the north and the south. Among the
scientific institutions the difference goes between the more applied and
practically oriented Southerners and the more theoretically, "basic science"
oriented Northerners. The style of work in relation to industry follows a
similar pattern.

     Observers claim that those national institutions which are located to the
north of the country function more as regional centers than as national
resources, and that this has speeded up a similar, already existing and even
stronger regional bias of the national institutions in the south. Regional
networking is more important than the contribution to any of the national
activities.

     A situation with a generally better equipment in the south for production
and administration as well as for experimental work and other innovative
activities has added fuel to the north"south dualism. For the development of
information technology, the Ho Chi Minh City area and the other southern
provinces have benefitted from the informal foreign assistance, which is
larger in the south than in the north.

     Most, if not all higher education institutions offering courses in
informatics have just a small number of microcomputers available for their
students. The typical machines are either PC XT or AT or an equivalent.
Nearly all courses are adapted to these microcomputers, which means that the
skill formation is biased toward the IBM standards. Should different or more
sophisticated information technology be introduced in Viet Nam, e.g.
operating systems based on Unix, the qualifications and experiences among
teachers will have to be improved.

     For the individual computer specialist, regardless if he or she is
working in the north or in the south of the country, the situation could be
quite different from the general. At the level of the research group or the

individual, the informal contacts between the north and the south are, in
particular cases, intense and highly productive. Although transportation and
costs for telecommunications might be a severe restriction, the mobility of
professionals working in both parts of the country has grown in recent years.
Also, their international collaboration has been extended significantly.

In the Ho Chi Minh City area, plans have been discussed for the creation
of an international institute in computer science for the advanced training of
promising students. Some of the teaching should be performed by visiting
foreign specialists on short-term or long-term assignments. Part, if not all
of the teaching might be offered in English or another foreign language.
There has also been economic reasons for these deliberations; advanced
training at home is expected to be cheaper than abroad.

Already, the Ho Chi Minh City Committee for Science and Technology has
received 200,000 French Francs to employ foreign teachers and instructors in
experimental nine-months courses in informatics. The first course in this
collaborative program started in the beginning of 1989.

However, a more permanent international institution would not fully
substitute training and related research work by Vietnamese students in other
countries. It would certainly help in expanding the options available to the
most able students and young graduates. If the same institution could provide
some services in the field of informatics and initiate research with
international linkages, it might possibly even become self-financing within
just a few years.

Until now, the most ambitious of all experiments in collaboration with
foreign scholars is the creation of the first private university in Viet Nam,
the Thang Long University Center, Hanoi. With financial help from former
Vietnamese citizens, now living abroad, and from France (CNRS), along with
some local support, Thang Long University recruited its first 65 students in
January of 1989. About half of them will be specializing in "mathematics and
information science." The university president emphasizes the high quality
aspects in the education. Thang Long, she says, wants to be compared with a
university in any country. To the extent possible, it will draw upon visiting
professors from other countries. It has already managed to employ
highly-qualified professors from the Polytechnic University and the University
of Hanoi. The Ministry of Higher Education has agreed to grant those who
complete their five years of study certificates equivalent to similar degrees
at the state universities. Thang Long University strives to recruit
nationally, while keeping its financial independence of the government through
student tuition fees and more private sponsors. It expects foreign assistance
in finding better equipment for its students and staff, while creating more
departments and courses in order to become a fully-fledged university.

A similar, but more specialized undertaking is "l'Universitò Francophone
d'Informatique," (UFI), to be organized as a joint effort by the University of
Nice (France) and the Polytechnic University of Hanoi. This new
French-speaking university, which is still in the process of being planned in
its details by working parties of the two universities, is aiming for a
similar role in south east Asian academic and professional training as the
English-speaking Asian Institute of Technology (AIT) in Bangkok. During the
first phase of activity, it will have an international staff drawn from
different French, Vietnamese and other universities. It will be

well-connected to one of the best-equipped universities in Viet Nam; the president of Hanoi Polytechnic University will function also as UFI's first director.

UFI's educational programmes follows the French higher education structure of academic courses and degrees up to and including the doctoral degree. Final examinations should guarantee a level of quality similar to the best universities in France ("ingénieurs en informatique de gestion -- du niveau des grandes écoles francaises"). However, the contents and orientation of the specific courses are oriented towards the specific needs in a developing country. UFI wants to recruit not just Vietnamese students specializing in informatics and computer science, but also students with similar interests from countries like Laos and Cambodia with French language training in the secondary schools.

Supported since 1989 by the government of France, UFI can be seen as an institutional response to the frequent and now more regular contacts between French and Vietnamese scholars in science and technology. As such UFI could become a permanent meeting point between French-speaking scientists and technologists from several countries. Research co-operation could be extended beyond the scientific and technological areas defined by its educational specialization.

There are clear signals from the Vietnamese labor market that the quality of the training of computer specialists will have to be improved. From industry, there is critique of the bias in the design of informatics courses on issues in research and experimental development, not on issues in production. Some of the new consultancy agencies and the existing electronics firms have moved in to exploit this situation while offering some more general training in informatics to interested customers.

Policy suggestions. Courses should be offered in Viet Nam emphasizing a broader range of available analytical tools, alternative methodologies for systems work and, more generally, the logics, language theory and other analytical foundations of computer science. In the current educational planning more attention should also be given to the major areas for practical applications of information technology, certainly so for industrial application areas, but also for others. Such specialization will have to be related to more advanced and coherent training programmes.

A medium-term solution to the lack of highly qualified manpower in the field of computer science and informatics would be to set up separate schools for informatics in the major cities. This would permit a specialization in areas of application discussed before. But it would not have to imply that the existing universities and other higher education institutions will have to put limits to their current teaching activities in the field. Instead, more opportunities would be left open to young students for a high-level education in the field, to raise the quality of teaching by introducing an element of competition, to economize the use of computers for educational purposes, and to broaden the range of options of specialization of the skills.

The current pressures on education and further training in this area from future employers as well as from potential course participants will have to speed up the implementation of existing educational plans. Viet Nam should better adapt to the willingness of young engineers and other professionals to receive training in computer science and other information technology.

A negative effect of the relative shortage of computer specialists in Viet Nam, as well as of engineers in general, is the geographical immobility. Engineers and other specialists can pick challenging jobs among several options, and, so it seems, they are unwilling to leave the metropolitan areas, where they have received their long academic training. In both Hanoi and Ho Chi Minh City they face an abundant supply of professional opportunities. It has been difficult for, e.g., the Polytechnic University of Hanoi to assign their young graduates to important tasks in the other provinces, where they are very much needed. The new engineers refuse to go there for personal reasons.

As a consequence, a technically advanced cement factory, located several hours drive from Hanoi, has not been able to attract qualified engineers and computer specialists. Instead, two scientific institutes of the National Center for Scientific Research has been forced to take on the necessary maintenances and repair work of the high technology installations of the plant.

Other examples of local and regional imbalances in the distribution of the most qualified technical experts in Viet Nam are easy to find. Educational planners should be more aware of the geographical dimension of their planning, thereby helping all the major regions in providing facilities for training of computer and informatics specialists.

To improve the manpower situation and to help the many different institutions involved, there is a strong need for the central government to set quantitative targets for the education and training of highly qualified personnel in the field of informatics and computer science. The priorities of the higher education institutions will have to be altered to accommodate the need of the emerging information industries in Viet Nam. But this is not enough.

The government will have to take action in order to provide additional funds for the universities to train more computer scientists and other informatics specialists, especially at the undergraduate level. To make it easier for United Nations and other multilateral and bilateral agencies to provide long-term support to the manpower development, it may be relevant to work out medium-term priorities for this type of education and specialized training.

4.5. Software production for the national and regional markets

The ambitions are growing in Viet Nam to create a broader and more coherent base for its future information industries, both for the hardware or computer equipment and for the software. The problems and prospects for the emerging electronics industry are discussed in the next section (4.6.). Here, the softer sides of information technology will be brought into focus.

There are many reasons for taking a closer look at the potential in Viet Nam for marketable software development. The most important reason is the expanding international market: projections show that worldwide software production could surpass US $200,000 million in the next few years. Given the fact that the global market is very dynamic and provides many niches for newcomers, it could be attractive to those young Vietnamese software companies already operating on the local or domestic market, who would try out new specializations on the regional or even the international market.

"Software differs from conventional, 'hard' products made from interchangeable components and constructed through a sequential assembly process; it is primarily an iterative process of design, coding, testing and redesign. There are only a few industry-wide standards for product features, tools, or project-management techniques." In other words, there are few formal approaches to programming of computers and related development activities. Among the most industrialized countries in the world the harmonization and standardization of software production has become an important lever for the swift diffusion software applications in their economies.

In most developing countries, however, factory-type, mass-production methods of production of software are still rare. Centralization, standardization, reusability and similar criteria for mass-production are not easily applied to computer software production. Software is often seen simply as an unstandardized good, composed of complex knowledge for still-evolving markets. But mass-production techniques and modern management practices have been moving into the information technology of many developing countries as well.

Even though software may be dependent on the specific characteristics of the hardware, several of Viet Nam's neighbors have been able to transform parts of its software production from an unstructured service to an internationally marketed product with a guaranteed level of quality. By creating families of software parts and standardized routines as building blocks for programmes to be run on different computers, they have been able to raise the productivity and further standardize design and verification.

In a recent issue of the IEEE Software, one of the international journals on computer software, the editors noted that "Software has been one of the fastest growing industries in most Far Eastern countries in the last few years. — Most Far Eastern countries now recognize that they must keep abreast with advanced software technology to compete." And they continued: ""We have also" found that cultural differences and language barriers have forced each Far Eastern country to approach the problem differently. On the one hand, most have imported and integrated modern technology from the West and made it available to software professionals through some very effective national initiatives. On the other hand, some countries have invented unique techniques to serve the needs of their peculiar software market. — "T"he effort to industrialize software is likely to be made through a national, government-directed, and publicly funded initiative."

While other countries in the region like Singapore, Malaysia and Taiwan Province of China try hard to develop their "software factory systems," Viet Nam still lacks the necessary means to move from a very labor-intensive production to a more knowledge-intensive. To industrialize software development and production -- i.e. to produce software through less expensive manufacturing techniques instead of through more expensive manual labor -- it will be necessary not just to concentrate large numbers of programmers and other computer engineers into one well-equipped plant and speed up production. It will also be necessary to to use computerized development facilities and rely on well-functioning regional and even national communication networks.

At present, there are no economic incentives in Viet Nam to make software much cheaper than today; the computers and other hardware are still much more expensive than the already available programmes in use. The home market is not as rich with customers and demand is not as big and diversified as in the neighboring countries. But, and this should be underlined, although still very small the software market of Viet Nam is now expanding exponentially. As a consequence, Viet Nam of today is far from any standardization of software design, which is a precondition for a "software factory" system. Almost all users in the country simply rely on the skills and experience of each individual engineer available to them. In the relatively few software development projects in Viet Nam, the design is made for an individual customer without other customers in view or with any assessment of a potential larger market.

This situation may soon change. At least a handful of export-oriented software development projects are under way (two of which rely on contracts with foreign firms based in France and Republic of Korea respectively). Other export-oriented software projects are being planned. These experiments may serve a pioneering function for software businesses in Viet Nam. Should the current mobilization of resources continue, Viet Nam would soon follow the software examples set by Taiwan Province of China, Singapore, Hong Kong and most recently, China.

A feature of the R&D system of Viet Nam is the informal linkages between, on the one hand, the researchers and other experts in the centers of science, technology and higher education and, on the other hand, the engineers and technicians of manufacturing industry. In recent years, some of these contacts have been further developed and even formalized through the emergence of consulting firms run by researchers.

The creation of these small business operations, organized as private or co-operative firms, have been stimulated by the low wages and limited careers within the public sector. A quick overview, reveals that there is a wide variety of consultancy services offered by university staff and other researchers in Viet Nam. Following three specific cases from the University of Ho Chi Minh City, where the staff of the Computer Science Center provides systems design facilities and implements computer software, many illustrate this:

- An advanced program package has been developed in co-operation with individual customers for efficient handling of data for telex communication. Through the program, the microcomputer manages the telex operations, feeds the machine and arranges the data. This software package will also be marketed abroad.

- Programs have been developed for better use of optical scanning in text character recognition.

- An information system based on geographic data, has been developed using a data base with images.

At present, the equipment available for consultancy work in information technology is only at a minimum level. The diffusion of more up-to-date equipment will considerably improve the quality of the computer programmes.

The migration of skilled persons between the sectors of the economy and between different types of functions (as researchers, consultants, course leaders or teachers, entrepreneurs, etc.) has promoted the transfer of skills, know-how and technology. The informatics community of Viet Nam is relatively transparent. Experiences among one group of Vietnamese experts is rather easily transferred to another group, even though their primary base of work could be geographically or functionally far away from one another.

The most important reason for the transparency is the limited size of the information technology community in Viet Nam. Surely, both the openness and accessibility will be difficult to uphold with the growth, specialization and commercialization of Vietnamese information technology. Any industrial or government action should try to benefit from the current situation and promote the catalytic effects of the broad range of skills and experiences potentially available for development work.

A precondition for advanced consultancy work in a dynamic field of high technology is a broad and firm research base within the country and"or good access to the most advanced foreign technology and know-how. At present, Viet Nam has neither.

The strongest among many research groups in information technology can be found at the Institute of Computer Science and Cybernetics. This Institute is formally part of the National Center for Scientific Research and will soon move all its research and development activities to a new building complex at the same location as the National Center, in the outskirts of Hanoi.

The Institute's staff includes 180 persons (with administrative personnel) of which 8 are full professors and at least 45 have acquired PhD or equivalent degrees. Each year, some 20 staff members work abroad for longer or shorter periods; nearly all of these trips are financed through invitations. Frequently, the Institute receives foreign scholars as part of this international exchange. Its prime contacts abroad are with research institutions in the USSR and eastern Europe, but contacts are well-established with institutes and individual researchers in France, the Federal Republic of Germany, USA and Belgium. About 30 post-graduate fellows from universities in the northern provinces are attached to the Institute for their PhD project work; some of them earn their income as staff members.

As in many other scientific institutions in the country, the general lack of relevant scientific instruments and other research equipment has made the daily scientific work unnecessary difficult. Four years ago, the Institute did not have access to any microcomputers; only some "second generation Russian computers" were available. Now, in the summer of 1989, it will install a "super-mini computer" and has already six microcomputers of its own and several more at its disposal. The French Embassy has donated four of these, the government budget to the National Center for Scientific Research has permitted some acquisitions and, not the least, substantial new technical investments are being made through a large-scale support project by the United Nations Development Program, which is just beginning. The equipment is furnished for educational and other training purposes, but the prime function will certainly be research and experimental development.

Through informal contacts in the computer science community, electronic equipment provided by United Nations agencies for other government purposes has been, from time to time, temporarily installed at the Institute, which have made a number of special R&D projects possible to accomplish, e.g. for the development of fonts and keyboards with Vietnamese characters, pattern recognition, desk-top publishing, etc. In January of 1989, as the new private university in Hanoi was inaugurated, the Institute of Computer Science and Cybernetics could, for the first time, provide a similar service to a sister institution by letting two of its microcomputers be available to the young students of computer science.

With the current, energetic strengthening of the technological resources at the Institute of Computer Science and Cybernetics pressures are put on the staff to provide more significant research results and practical applications. The level of quality in its software products and services is expected to become positively correlated with the higher quality of the equipment.

The Institute is not only a research institution. The director describes its main activities as if research and applications cannot be treated separately: "Computer science is always applied". Himself being av specialist in artificial intelligence (primarily "pattern recognition"), he directs a 14 members unit working on "image processing" and so-called expert systems, some of which are designed for use in planning and decision-making. Most of the other R&D performed at the Institute relates directly to practical problems for software engineering: applied statistics, systems analysis, management support programmes and office automation, computerized control of industrial processes, computer applications for medical treatment, etc. In academic terms, the research orientation is summarized in three categories, namely artificial intelligence, theory of programming and numerical analysis, and database handling.

With a broad range of expertise in informatics and computer science this national institution has been forced to accept a role as a local and regional service center. One illustration only: When the microprocessor used for of a modern cement plant, made in Denmark and located far outside of Hanoi, malfunctioned and caused an explosion, two highly-qualified experts from the Institute of Computer Science and Cybernetics had to spend weeks repairing and testing the electronic equipment for production. But not only that; they and other colleagues at the National Center for Scientific Research have had to get involved in the maintenance and in establishing new technical routines, since the plant is permanently understaffed with own technical specialists.

The experts from the Institute of Computer Science and Cybernetics gained some industrial experience, but the Institute temporarily lost staff time, which was very much needed for the build-up of other technological capabilities. This and similar projects has placed the Institute in a dilemma, which is not uncommon among other Vietnamese research institutes and university departments. With relatively little support from a government suffering under the current fiscal crisis, these institutions have to find a substantial share of their income elsewhere, if they would like to keep up with their normal activities and, certainly so, if they would prefer even a modest expansion. This particular institute has found the United Nations agencies operating in Viet Nam, e.g. UNICEF, UNFPA, UN High Commissioner for Refugees, to be the most important external source of funds, paid under contracts for computer services.

At present, the Institute of Computer Science and Cybernetics plays no central role in the training of computer specialists. However, it provides support to PhD projects in computer science, but would like to extend its teaching to the creation of a Master degree in the same field of study. There are plans, now materializing with financial support from the United Nations, to create its own training center and attach it to its main function as a national R&D institution.

The embryo to this training center consists of three kinds of services. Scientists and other staff members of the other institutes within the National Center for Scientific Research are provided with continuous assistance. Secondly, professors and university teachers in the Hanoi area are frequently seeking advise and introductions to the use of computers and related equipment. And, thirdly, new user groups such as managers, engineers, and secretaries as well as others are offered brief introductory courses through the staff of the Institute. However, with the current growth of course offers at the universities and with an expanding private sector for teaching in informatics and computer science, the future of the training organized by the Institute has to be closely monitored.

The Ho Chi Minh City branch of the National Center for Scientific Research is not engaged in teaching of informatics to the same extent as the Hanoi branch. One reason for this is the limited number of computers available for educational purposes. Another is the many other course options by the local universities and companies. But two of the institutes in the Ho Chi Minh City branch are engaged in advanced software development: one for "image processing" in relation to remote sensing technology, the other for mathematical modelling.

Using a minicomputer and some microcomputers at the Center for Space Physics and Remote Sensing, twelve persons are developing new and existing software for "image processing," based on data drawn from airplanes and satellites such as Landsat, Spot, and Soyus. Results are traded with data and experiences from the Asian Institute of Technology (Bangkok), Indonesia and the USSR. The practical applications are directed towards geological surveys, hydrology, forestry and agriculture.

Techniques for mathematical modelling has been developed in another institute of the Ho Chi Minh City branch of the National Science Center. In one section development work is done on software for hydrology models. In another section experiments with economic models for planning and decision-making is made under two contracts with the Ho Chi Minh City administration. In a third group macro-economic models from other countries are tried out and applied to the Vietnamese economy

More practical software products are developed for handling problems of logistics in large industrial production system, involving several thousand employees. For the methodological work in this area, exchange of specialists with a French university (CNAM in Paris) is well underway. After further work, it is expected that some of these systems might become interesting for customers in other countries as well.

Since a few years, all institutes at the Ho Chi Minh City branch of the National Science Center are expected to bring in substantial funds from contracts with companies and institutions in order to compensate for the low basic income from the state. The government's fiscal crisis has become an important lever for the commodification and commercialization of R&D at this and other national institutes.

The opening of an industrial or, broader, a private market for information technology has affected both the quality and orientation of software development in Viet Nam. Until just two or three years ago, almost all applications of computer technology was designed for specific use in the government sector or in the scientific and higher education institutions. Most, but not all software developments could be described as local adaptions of existing program packages, transferred to Viet Nam with the hardware itself.

As has already been implied, this picture has been changing. The development of software in Vietnamese scientific institutions has come closer to the state-of-the-art in programming and the areas of practical applications of computer technology have expanded into manufacturing industry and related services. It is not an exaggeration to say that almost all areas of computer applications — from the most advanced, e.g. automatic "pattern recognition" and "image processing", to computerized data processing of simple administrative routines — are well-known to Vietnamese computer analysts as a group, and in specific areas the individual qualifications and personal experiences of these specialists can be compared with those of their colleagues in the industrial countries.

One of the best and most experienced groups of programmers in Viet Nam is working at the computer department of the Ministry of Forestry in Hanoi. The Center for Informatics at the Ministry of Forestry, which was founded in the '60s, has two minicomputers and more than twenty PC XT and AT, connected in a local network. Its main function is to study the development of Vietnamese forests with the help of digitalized maps. Foreign observers have recognized the software produced at the Center to be of international standards; the interface between the computers and the program users are praised. Programmers of the Centres, have developed software to be launched at the international market, such as self-instructing programmes in geography for secondary school children.

The weaknesses in the current situation for software developers are hampering their activities. First of all, the technical and other resources for experimental work are limited. In general, the equipment is comparatively old, not of a high quality and seldom the most relevant for the task. Locally as well as nationally, the specialists in each field are relatively few in numbers and they work in small groups, exposed to a limited set of technical alternatives and professional experiences. With more technical resources and a better organizational structure the same groups of highly qualified personnel would be able to do much more in their respective fields of specialization.

Interesting attempts to make better use of sophisticated consumer demand for more appropriate and technically advanced solutions to current deficiencies in the printing industry of Viet Nam are made by the Institute for Printing Research in Ho Chi Minh City. Similarly, the Center for Information Technology, owned by one of the city companies, is also developing

new software for computerized printing and publishing. TEDCO, the Technology Development Company of Ho Chi Minh City, who is publishing the journal "Science and Development" (Khoa Hoc và Phát Trien) with a current circulation of 3 500 copies, wants to become the first regular user of desk top publishing techniques, both for its journal (now in its ninth year of publication) and for a newsletter on business developments in Viet Nam.

In both the south and the north of Viet Nam, attempts are being made to closely connect Vietnamese computer science with that of the western industrialized countries. Among companies in the southern provinces, there are many such commercially motivated links established with the help of overseas Vietnamese. Initially, the new channels to the western markets are primarily used for imports of computers and electronic equipment.

However, in several cases, exports are now slowly starting up. In early 1989, co-operation was formalized and a contract signed with a company from the Republic of Korea for the joint development in Ho Chi Minh City of computer software and its subsequent export. A software package, developed in the north for international marketing to schools, is currently being tested in France. There are many other examples of a growing interest among Vietnamese programmers and computer specialists for the international market.

The most obvious reason to look for export options of computer software is the relatively small national market, which is divided — primarily — into two regional markets, that of Ho Chi Minh City in the south and that of metropolitan Hanoi. Although these two markets have just started to grow exponentially, they are still small in money-terms and the purchasing power of each customer is not big enough to allow for specific investments in development work. According to consultants in the two main cities of the country, the level of customer qualifications to buy more sophisticated computer software for use in production or administration has just started to raise above the minimum. Almost all purchasers still regard software as only an accessory. In most cases, the user"producer relations have to be developed as a joint learning process. While improving such relations, the concept of software as a commercially interesting commodity by itself might be established.

Policy suggestions. In both government and industry, there is an acute need for a group of specialists to bridge the gap between, on the one hand, the technical requirements of computerization and the introduction of new information technology in the work-place and, on the other hand, the accompanying organization change. Systems analysts, as they are usually called, knowledgeable in computer science and with some experience in organization reform, could help push the experimental applications of information technology to a stage of routine use. This is especially important for the office automation in the government sector, where computers will soon be brought in in larger quantities. Moreover, some of the new consultancy firms, operating in industrial firms, have started to develop a specialized function for organizational change, which is coupled with systems analysis.

The experiences of systems analysts, who may have good access to the changing technical know-how, should also be integrated into experimental work, so that, e.g., important program packages could be unpacked and redesigned for specific use in a Vietnamese industrial company or government agency. The

economic efficiency of computer applications are usually determined by their general fitness and specific adaptability to the local circumstances.

The general weaknesses, which might be understood as barriers for the future development of a software industry in Viet Nam, are summarized in the following points: There is a general lack of standardized design and verification tools, which makes it difficult to accumulate (and diffuse) experiences from different projects. Similarly, the capacities to reuse software components from the many application areas are still underdeveloped. Due to limited experiences of large software development projects, computer specialists in Viet Nam tend to follow non-standardized approaches to design and implementation of new programmes; and often, for the same reason, there are difficulties in specifying performance requirements before the detailed design and coding.

Learning from the past experience of other east Asian countries, including Japan of the '60s and '70s, there is a special urgency to improve productivity in software design and production in Viet Nam, to raise the level of quality in software production, maintenance and other related services, and to try out new management techniques better suited to a situation of potential growth and rapid expansion on larger markets than today's.

Any change in government policy would have to offset the shortage of skilled programmers and the lack of standardized software packages for the Vietnamese market, and to accommodate the rise in demand for a greater variety of applications programmes. In a situation with limited resources, national priorities will have to be set in order to combine the needs to customize software — be it imported or developed within the country — with more standardized software for the international market as a basis for a growing software industry in Viet Nam.

Due to the current changes of Viet Nam's industry and trade policies, there will soon be a need for setting some national priorities concerning the most relevant types of software development. Many functionally important questions will have to be answered in a new context. For general applications development, should the emphasis be on some specific industrial applications? For the new informatics needs in the government sector, what should be the most immediate targets for applications developments? For software engineering, which minimum standards should be reached within a specific time period? For scientific applications, which focal points should be given extra resources?

III. Prospective future development of the microelectronics and information technology

1. AN EMERGING MICROELECTRONICS INDUSTRY

In the world of high technology, Viet Nam cannot afford to stand alone. To be able to develop its information industries, the country will have to communicate much more actively than today with the technologically more developed countries. Vietnamese industry will have to find its own ways of co-operation with leading business companies and research organizations. The many mechanisms for the transfer of technology and know-how to Viet Nam must be developed and streamlined to fit the particular needs of individual Vietnamese firms.

Before giving further details, it is important to underline that the Vietnamese information industries are in their infancy. There is no production of computers in Viet Nam and the small electronics industry is dominated by companies assembling foreign products in relatively small batches.

At the same time, it is quite clear that an information industry is in the making. Both the rate and direction of the development reflect strong ambitions by Vietnamese entrepreneurs and foreign investors to create production facilities. The emerging national market is becoming more interesting to exploit. And the growth and dynamics of the regional and international markets for products containing microelectronics is a further stimulus.

Earlier, a handful of recent examples have been presented of industrial activities in Viet Nam aimed at creating modern industrial production facilities, using information technology. In this section, attention will focus on the prospects of further development in relation to current problems. Since this brief study has not been based on a systematic survey of all industrially relevant activities, the text can not provide an analytical platform for action. Instead, the observations and evaluations made, following a case-study method, should better be used as sources of inspiration to further elaborate the main policy issues.

A good indicator of the dynamics of recent Vietnamese entrepreneurship in this subsector of industry is the experimental development of new products within a small high technology oriented company, linked to the Polytechnic University of Hanoi. The Oscar Company, as it is called since 1988, is developing its products through the inventiveness of the staff members of the technical University, and has been permitted to use its laboratories and instruments for experiments and testing. Oscar is paying the University for this service.

For its product development, a small number of specialized workshops have been built in the vicinity of the university buildings as in a research park. In each of these workshops staff members and other qualified personnel are developing new products, adapting existing products to new technical requirements and testing new industrial production methods. Production is performed in other locations, as subcontracting and according to a putting-out system.

The original capital behind the Oscar Company was provided by the Youth Union, but the investments in R&D and production has been paid by private investors (now board members) and through inexpensive loans from the State Bank of Viet Nam. Most of the profits from its business operations are re-invested in the company; some of the profits is given as royalties to the inventors.

The business idea guiding the expansion of the Oscar Company is to combine the high tech edge of its development work with cheap and handy products for the Vietnamese and south east Asian mass markets. Its management tries to respond to specific market demands by continuously launching new products or by refining existing products. It operates as a multi-divisional firm in product areas such as porcelain and ceramics, furniture, medical products, essence oil (e.g. a garlic oil for the food industry), construction materials (e.g. inexpensive brick production), arts-and-crafts products, etc.

Using electronics it has developed an extremely small hydroelectric turbine (200 W; for family use), a wind turbine (250 W), a dynamo-driven lamp (invented in the south of Viet Nam, but further developed by Oscar), a television broadcaster (maximum range of 30 kilometers) for remote, hilly areas, a small high-quality beer brewery, etc. The television broadcaster is now produced for exports other developing countries as well (at a unit price of about US$ 3000); the only restriction for further expansion on the international market is the limited supply of microprocessors from Japanese companies.

The Oscar Company is devoted to an original business strategy with its high technology orientation and its innovation workshop, but it is not a unique construction among the new industrial firms in Viet Nam. Many other small companies have emerged out private initiatives by local entrepreneurs and innovators. Should the open industrial environment in today's Viet Nam be maintained over a number of years, it is likely that some of these small private or co-operative companies, all emphasizing the high technological components of their products and in their production processes, will become major players on the Vietnamese market.

Among the state-owned industrial firms, there are some two dozen companies, which easily would qualify in becoming full members of Viet Nam's information industries. Some of them have been mentioned earlier.

Formally owned by the Union of Enterprises for Electronics and Informatics within the Ministry of Mechanics and Metallurgy, VIETINFOR (presented in sections 4.1. and 4.4. above) functions as an independent, de facto private company trying out a long-term commercial strategy in both computer services and related training. At the same time, VIETINFOR is slowly developing a capacity for production of electronics, based on its daily experiences in maintenance work as well as from its limited production of spare parts. Already, it is assembling and testing small batches of color television sets and tape-recorders. VIETINFOR is one of several computer service companies in the country, which under favorable circumstances could become a producer of computer hardware.

VIETINFOR has not been searching actively for a foreign partner to start production in the field of microelectronics, but it is preparing itself for some kind of joint venture, should the opportunity arise. It has applied for,

but has not yet been granted permission to conduct and control its own import
and export activities.

The government has encouraged some Vietnamese companies to explore ways
and means of assembling personal computers of both the XT and AT types. The
general response from industry has been positive. However, given the level of
sophistication of available technology, the precondition for production is a
firm and functional relationship with a technologically strong foreign
partner, who is willing to furnish additional expertise and know-how. Other
limiting factors are the lack of special production machinery, testing
equipment, microelectronics components, and, last but not least, managerial
experiences.

Still, attempts to assemble and produce computers are already being made
in the southern part of the country. And, in 1988 and 1989, potential
investors from Taiwan Province of China, Singapore and Republic of Korea have
looked closely into the possibilities of production in the northern provinces
as well. One reason for their reluctance to enter into a joint venture, or to
make direct investments on their own, has been the still relatively small
Vietnamese market. These foreign companies are waiting for the domestic
demand to raise a little further and, moreover, to see how actively Viet Nam
will link up to the markets outside of the centrally planned economies. This
will determine their attitude in using Vietnamese labor as producers of
electronics products primarily for exports.

One pioneering factory, constructed specifically for assembling French
microcomputers (Bull Micral-45), was created in 1988 as part of a joint
venture between Vietnamese and French capital. Its name is Genpacific and its
major private share-holder is a Vietnamese-born French citizen. The factory
is located to the Ho Chi Minh City area and is expected to have a total
assembling capacity of 20 000 machines annually by the end of 1989. (In
August, when this is written, nothing is known about the realism of this
planning objective.)

Genpacific's second, but still important ambition is to construct and
produce software for Bull computers aimed specifically for the Vietnamese and
eastern markets.

To speed up the marketing of its hardware and software products,
Genpacific wants to establish separate training courses for high officials in
Viet Nam. For this purpose it seeks collaboration with French university
teachers in informatics. However, in the spring of 1989, organizational and
related problems have ocurred, which have slowed down the activities of the
company.

The unclear rules and regulations of intellectual property produced
within public research institutions in Viet Nam may cause problems in the
co-operation between the single research institution and the industrial firm.
Already, there are examples of companies trying to run away with an invention,
produced by specialists in a university department of other institution. The
Institute of Computer Science and Cybernetics within the National Center for
Scientific Research is not satisfied with the current situation. To launch
some new products, it has looked at foreign markets, where the rules are more
clear and transparent.

Policy suggestions. At this stage of the development of the electronics industry in Viet Nam, general recommendations for an industrial strategy by government are difficult to formulate. Most of the information industries in the country are young and inexperienced. Lessons from outside of the country seem to be more relevant. Vietnamese business leaders and government planners should study the track record of the industrial assembling and production of products containing microelectronics in the neighboring countries and learn from both the positive and the negative experiences. And, especially, consider the high costs of entering the production of electronics, should no foreign company provide all the means.

The continuous changes in the world market for specific microelectronics products must be a special parameter in any industrial policy planning and programming.

2. NATIONAL OBJECTIVES OF THE INDUSTRIAL REHABILITATION - AND MICROELECTRONICS

In highly industrialized countries, modern technology is seen as an important lever for economic growth. Without continuous technical change affecting both products and processes, industry will soon suffer from stagnation.

Many government agencies in these countries, in close co-operation with industry, now play important roles to improve the general conditions for industrial innovation. For specific technologies, such as information technology, government support for industrial technology is often directed towards systematic improvements of the international competitiveness. During the 1980s, both western and eastern industrial countries have established so-called "national programmes" for microelectronics or other information technology in support of the development and diffusion of new applications.

For the newly industrialized countries, such as the Republic of Korea and Taiwan Province of China, the same kind of close collaboration for technical change between government and industry has become a strong feature of their economic success. In the development of a high technology industry, government has been an active partner while supporting individual firm strategies and making them more coherent by way of a selective technology policy. The government spending on technology and science has also been relatively high in these countries, and, as a consequence, the industrial firms have been tempted to chose "technology push" strategies.

To sum up the lesson in one simplified sentence: Internationally successful microelectronics companies have been very much dependent on government interventions during different stages of their development.

In the Republic of Korea, to take just one example, the government has played at least two roles in the industrial software development. State agencies have performed basic software technology R&D that could not be performed by single private companies, because of the big investments needed and, following from this, the great risks to be taken if the results could not be exploited commercially. In this specific technical field, the government has also tried to link its R&D system more systematically with the product developments in industry.

Which are the social carriers of this kind of industrial development? How can innovative capabilities be developed? Which are the preconditions for a revitalization of Vietnamese industry with the help of information technology? - Generally, in the Vietnamese setting, three groups have to become more involved to make the economic system work better.

- The first important group consists of politicians at both the central and local levels. In order to stimulate favorable conditions for industrial restructuring and technological change, much more attention to key factors in the economic environment has to be shown by political decision-makers. It is a general phenomenon that industrial managers, born and trained in the northern part of Viet Nam, function much better in the south than in the north. Some of the most successful business firms in the south of Viet Nam have managers from the northern provinces. This difference in behavior is attributed largely to differences in both the previous industrial experience and the degree and types of government intervention. State and local regulations and rules for business should make industrial production easy and permit a larger variety of business firms to be created and developed. With such and other measures, much more could be done to foster an industrial spirit.

- The second group, functioning as a social carrier of industrial change, consists of engineers, technicians and, also, industrial researchers employed by industry or working in Vietnamese laboratories. Their special skills have to be better integrated into all industrial development activities. Generally, highly skilled personnel has to be used much more effectively in areas for which they are trained. It is a misuse of human resources, when — as is often the case in Viet Nam — engineers are engaged by industrial companies merely as skilled production workers, not as specialists on maintenance, standardization, production control and experimental development.

In January of 1989, some 600 of these researchers, engineers, technicians and other specialists in information technology gathered at Tran Hung Dao, Hanoi, to form a national (non-government) association of Vietnamese informatics professionals. Apart from being a trade union, protecting the interests of its members, the association should organize professional training courses and seminars, improve contacts with colleagues in other countries, and bring together key "workers in the information sector". In short, this is the first attempt in Viet Nam to create a national community of computer specialists. As such, this newly organized community could become a highly-qualified actor on the national and provincial policy arenas.

- The third group of social carriers of industrial change are the industrial entrepreneurs, which could be individuals or groupings of individuals and, even, institutions. Contrary to the earlier phases in the Vietnamese industrial development since 1975, entrepreneurs are now given a much larger room of maneuver. Their activities are seen, also by the Vietnamese government, as highly beneficial to industry and the country's economic development. The general view has been that entrepreneurs are in scarcity in Viet Nam, but this impression is quickly being changed along with the government's deregulation of the industrial sector.

Most likely, it is only when the three groups are working together — or are systematically adjusting their behavior to the others -- that the preconditions for industrial development become the most favorable. At present, the three groups are relatively small in actual numbers, which would make national co-ordination easier and the implementation of any joint effort administratively simpler.

For an illustration, let us look a little bit closer at one of the "functional areas", the software industry, presented in section 4.5. above. If Viet Nam should be able to develop its existing manpower to create its own software industry, all three social carriers of technological modernization have to become involved in fostering a better software development environment. It will not be sufficient to provide individual entrepreneurs with more capital and better access to advanced technical equipment. Learning from the experience of other east Asian countries, what is needed for the establishment an advanced software industry are good conditions for the software-industry infrastructure, bridging the gaps — at the national and the regional levels — between the research institutions, government agencies and the programmers and systems analysts at the usually small or medium-sized software firms.

By way of joint initiatives, the three groups can provide the most important inputs to the necessary government-directed and publicly funded support programmes. Through the acceptance of an active partnership in a national effort in support of a new subsector of the Vietnamese information industries, the government should "seek to "develop and" consolidate state-of-the-art software techniques into an advanced state-of-the-practice environment and thus improve the productivity and quality".

All this implies a more functional approach to planning and national policy-making in Vietnamese industrial affairs. At the national level, the linkages between current government policy areas are generally weak or even non-existing. Typically, macro-economic policy-making in Viet Nam is not closely related with policies for science and technology.

Within the macro-economic policy framework technology policy and innovation policy are not seen as essential components. Planners and decision-makers operate in their traditional areas as if they did belong to separate political cultures with no social or economic functions in common. And the industrial firms tend to receive contradictory signals depending on which type of public institution they approach.

If state planning should not be a restricting factor to industrial change, more co-ordination and coherence are needed at the policy-making level both nationally and in the provinces, but especially at the level of the firm or industrial subsector. Strategy formulation has to be based on a multitude of factors and not just on traditional macro-economic deliberations. Methods and means for creating better policy coherence could be drawn from abroad, but should be adapted to Viet Nam's special conditions before being implemented.

Such broader factors to be included in the national policy-deliberations could be illustrated by the following questions, all related to a national policy framework for microelectronics and information technology in Viet Nam. They are inspired by the experiences by the Republic of Korea and some other newly industrialized developing countries.

° Is there a need to create more R&D projects to pave the way for the
  further development of the Vietnamese information industries?

° Which policy-generated methods are the most efficient in support of the
  use of information technology in government and industry?

° What could be done to boost joint projects with foreign companies
  involved in advanced development of information technology?

° Which means are the most efficient in the development of systems
  software and other software?

° What could be done to stimulate more educational courses in order to
  improve the training of information technology specialists and to
  improve "computer literacy" among employees in manufacturing industry?

° Which economic circumstances would mobilize more resources for
  information technology development in Viet Nam and what would best
  stimulate diversified and decentralized programmes for new computer
  applications in specific sectors of the economy?

° At the provincial and local levels: How can the diffusion of
  information technology and a more active use of computing resources be
  stimulated?

° Which international collaboration program or mutual scheme of
  development activities would be the most efficient for the further
  development of Vietnamese information technology?

All these questions are difficult to answer and there is no obvious
policy-conclusion. Probably, to elaborate on the last question only, the
future of Vietnamese information industries lies in the way co-operation with
foreign partners will be developed. At present, the contacts are primarily
with the eastern countries, especially with the USSR.

The Council of Mutual Economic Assistance (CMEA) has implemented a common
program called PIDA (Program of Informatics Development and Application) among
its member states that seeks to develop and diffuse electronics and
information technology. Being one of the CMEA members, Viet Nam has joined
these networking activities and established several national contact points or
collaborating centers. One of the Vietnamese contact points is the Center for
Trade Information at the Ministry of Foreign Economic Relations; another is
the VIETINFOR, Viet Nam Informatics Company.

The overall PIDA program in 1986-90 is divided into five general groups
of activities:

° Large-scale MIS (management information systems) applications for
  government agencies,

° Development of MIS for small- and medium-scale application enterprises,

° Research related to appropriate computer hardware,

° Development of computer software packages,

° Training of computer specialists as well as user groups.

It is too early to assess the full impact of PIDA on electronics and information technology in Viet Nam. But there is frustration among some of the Vietnamese participants that very little, if any information technology has been transferred to Viet Nam as part of the PIDA activities. However, possible openings to the consumer electronics markets in the Soviet Union and eastern Europe should be noted: Vietnamese firms are assembling an electronic calculator for school children. In the near future, through PIDA, Vietnamese specialists might be engaged in development work of a computer for use in secondary schools in the CMEA member states.

According to the Vietnamese participants, the PIDA collaborating centers should pay more attention to international quality standards and to the current changes in the global market of information technology. The Vietnamese have had little influence on the framework of co-operation and the design of the joint PIDA projects. They would have liked to have more systematic information on not only technical matters, but also on related application areas. Moreover, the orientation of most PIDA projects to the current USSR standards and its own industrial needs provide no incentives to advanced technical development work in a country like Viet Nam.

For the next few years, the regional co-operation perspective might look promising for Vietnamese information industries.

Compared with Taiwan Province of China and other neighboring countries, Viet Nam will be able to take a number of shortcuts while creating its information industries. With low labor costs, it will have a strong base for mass-production of products using microelectronics. Vietnamese firms will most probably be able to take over segments of existing sub-contracting electronic industries and create new, similar production through contracts with foreign firms. At the same time, with its -- in relative terms -- well-functioning educational system, Viet Nam can also take on more sophisticated information industries that rely less on low labor costs and more on value-added activities.

With a diversified strategy for its industrial development in this technological field, Viet Nam could be in the fortunate situation of modernizing and speeding up its industrial production by international sub-contracting, while promoting entrepreneurial activities in both hardware manufacturing and software and related service production.

3.   FOREIGN INVESTMENTS IN THE INFORMATION INDUSTRIES: WHAT'S AHEAD?

By the end of the 1980s Viet Nam is in a desperate need of investments in industrial production capacities. Foreign capital is needed for the rehabilitation and maintenance of existing machinery as well as for the installation of new machinery and its further improvements. Most observers agree that there is not enough capital accumulated within the country for the industrial investments planned for.

By doing a lot to attract foreign capital to its industrial sector, Vietnamese government decision-makers hope for the transfer also of appropriate modern technology. Foreign investors and innovators and companies from abroad are expected to transfer technology and know-how as part and parcel of their commercial investments.

In May 1989, 36 joint ventures had been formed with foreign companies wanting to invest in Viet Nam. Some of these are in the service sector (e.g. Swiss tourism, Thai hotels); most are industrial development projects. One example from the latter category was mentioned: the Genpacific company, based in Ho Chi Minh City but also with an office in the nation's capital city. Genpacific was founded in 1988 and set up to assemble microcomputers for the Vietnamese and eastern markets. In full operation by the end of 1989, the company should also have its own capacity to produce software for the French-owned electronics company Bull.

Many more similar arrangements with foreign-owned high technology companies are expected in the near future. Moreover, direct investments, with 100 per cent foreign ownership, have already been permitted by law. If the internationalizing of investments are developing as in 1988 and the first half of 1989, it is likely that the foreign influence on business developments in Viet Nam will be very important within just another few years. Still, it is difficult to judge upon the speed of which foreign investments will contribute significantly to the economic development of the country.

Given these new macro-economic conditions, a foreign-controlled computer software industry would be a likely candidate for moving into Viet Nam. Not just on paper, a software industry is well-suited to Viet Nam. Highly qualified manpower is available. The industry consumes little energy, can lead to a high value added, causes no pollution, and, last but not least, does not require large and expensive facilities.

Probably, it would be easy for the government to find ways to attract overseas companies to set up software development centers in Viet Nam. The conditions for such investments would look so favorable that foreign investors would not have to be awarded pioneer status or attain specific benefits.

4.   FURTHER INVESTIGATORY WORK REQUIRED

There is no immediate need for a detailed national survey on the computer and electronics industry subsector in Viet Nam. The information industries of Viet Nam are in their infancy and most relevant facts and figures are already available. For the specialists, it will be relatively easy to complement the existing picture with more relevant technical and economic intelligence.

To create a sound, factual basis for medium-term policy-making and for long-term planning purposes there is no particular reason for a national survey. What is needed is a better systematization of already existing knowledge, organized for the purpose of both medium-term and long-term decision-making.

The structure of this report, should help identify important policy issues and provide ideas for medium-term action by the government and by foreign aid agencies, including those of the United Nations. It is important that important potential new linkages between sectors and subsectors by way of using microelectronics and other information technology are identified.

For these purposes, in a possible second phase of this study, it will be useful to extend the overview of the main types of available computer resources to different administrative levels within the government, e.g. at the central, provincial and local levels. An analysis of the goals and means of decentralization and centralization, using the new information technology, could lead to new and simpler administrative practises and procedures.

Such types of a functionally oriented surveys -- cf. Chapter II.4 above -- focused on the integration of computer technology in the current activities of the government administration, should be limited to a small number of carefully selected departments, agencies, enterprises and other units. These more qualitative surveys do not necessarily have to be performed by outside experts, but could be conducted by a team of Vietnamese information technology specialists or administrative experts. In other countries such limited surveys of their information technology resources are organized also for the purpose of administrative and other reform.

The diffusion of computer applications into non-government services and manufacturing is now even more significant than in the government sector. In a situation where barriers to international trade in technology are lifted, information technology will probably spread much faster in manufacturing industry than in government. This implies that the needs for specific policy measures in relation to information technology in industry should not be taken for granted. Without government co-ordination and other regulation there will certainly be a lot of duplication and, at least temporarily, waste of resources, but among the gains are a much more experimental and innovative environment for the applications of this new technology.

The United Nations and foreign aid agencies can, in a very early stage of the national policy-making process in relation to information technology, help the government to identify and scrutinize the weaknesses in the diffusion and development of information technology and widen the bottlenecks for the technical development in this high technology application area such as:

° Tertiary (and possibly also secondary) education in the field of informatics and computer science.

° The minimum size, quality and future direction of research and experimental development in informatics and computer science to stimulate industrial exploitation.

° The telecommunications development in relation to the on-going improvements of the economic infrastructure.

° The optimal use, in selected high priority industrial development projects, of computing facilities.

° The development of marketing techniques for newly created software products by Vietnamese firms or research groups.