

Meske, Werner (Ed.); Thinh, Dang Duy (Ed.)

Working Paper

Vietnam's research and development system in the 1990s: Structural and functional change. Research report

WZB Discussion Paper, No. P 00-401

Provided in Cooperation with:

WZB Berlin Social Science Center

Suggested Citation: Meske, Werner (Ed.); Thinh, Dang Duy (Ed.) (2000) : Vietnam's research and development system in the 1990s: Structural and functional change. Research report, WZB Discussion Paper, No. P 00-401, Wissenschaftszentrum Berlin für Sozialforschung (WZB), Berlin

This Version is available at:

<https://hdl.handle.net/10419/50920>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

**Veröffentlichungsreihe der Arbeitsgruppe Wissenschaftstransformation
des Wissenschaftszentrums Berlin für Sozialforschung
- Research Report -**

P 00-401

**VIETNAM'S RESEARCH & DEVELOPMENT SYSTEM
IN THE 1990s**

**- Structural and Functional Change -
Research Report**

compiled under the direction of
Werner Meske¹ and Dang Duy Think²

This project was funded by a grant from the Volkswagen Foundation,
Section "Transformation of Economic, Political and Social Systems",
1996 to 2000.

Berlin, December 2000

¹ **Wissenschaftszentrum Berlin für Sozialforschung gGmbH (WZB)**
Reichpietschufer 50, 10785 Berlin
Tel.: ++49-30/ 25491-591
Fax: ++49-30/ 25491-684
E-mail: meske@medea.wz-berlin.de

² **National Institute for Science and Technology Policy and Strategy Studies (NISTPASS)**
38 Ngo Quyen, Hanoi, Vietnam
Tel. (+844) 826-5451
Fax (+844) 825-2873
E-mail: dangduythinh@hn.vnn.vn

Das vorliegende Dokument ist die pdf-Version zu einem Discussion Paper des WZB. Obwohl es inhaltlich identisch zur Druckversion ist, können unter Umständen Verschiebungen/Abweichungen im Bereich des Layouts auftreten (z.B. bei Zeilenumbrüchen, Schriftformaten und –größen u.ä.).

Diese Effekte sind softwarebedingt und entstehen bei der Erzeugung der pdf-Datei.

Sie sollten daher, um allen Missverständnissen vorzubeugen, aus diesem Dokument in der folgenden Weise zitieren:

Meske, Werner (Hrsg.); Thinh, Dang Duy (Hrsg.): Vietnam's research and development system in the 1990s. Structural and functional change. Research report.

Discussion Paper P 00-401. Berlin : Wissenschaftszentrum, Berlin 2000.

URL: <http://bibliothek.wz-berlin.de/pdf/2000/p00-401.pdf>

Abstract

Under the ca. 15 years of *doi moi* (renovation) policy, Vietnam's development has been taking place in the two different but overlapping contexts of transformation and swift economic development. These contexts correspond to two different scenarios for the country's future: One scenario of transformation is the Eastern European pattern; the other is the "Tiger Scenario", with increasing industrialisation and rapid economic growth.

The research and development (R&D) potential created during the period of planned economy could assume a key role in these processes. In the 1990s the R&D system was restructured, with the aim of solving the financial problems that had arisen during transformation, while at the same time seeking to better achieve a functional integration of R&D into innovation processes in the economy. A joint research project carried out by the 'Working Group Transformation of Science Systems (WZB) and the NISTPASS, Hanoi conducted macrostructural research and in-depth case studies in selected industrial sectors and R&D institutions to clarify how this is taking place, which organisational forms are created by it, and how the new structures affect the functions of R&D.

This report presents the results of this research. The impact of *doi moi* policy in the area of S&T must be described as ambiguous: There is an incongruity between successful structural changes and their functional effects, in particular regarding increased innovation activities - which have so far not or only partially been achieved. Some serious problems in the science system, in industrial enterprises as targets of innovations and in infrastructural prerequisites for innovation diminish Vietnam's current and future potential to utilise R&D for economic growth and social welfare.

Zusammenfassung

Die Entwicklung Vietnams verläuft seit etwa 15 Jahren unter der *doi moi* (Erneuerungs-) Politik in zwei verschiedenen, einander überlagernden Kontexten der Transformation und der raschen Wirtschaftsentwicklung. Diesen beiden Kontexten entsprechen unterschiedliche Szenarien für die künftige Entwicklung: Ein Transformationsszenario nach osteuropäischem Muster und ein ‚Tigerszenario‘ mit zunehmender Industrialisierung und einem raschen Wirtschaftswachstum.

Dem in der planwirtschaftlichen Periode geschaffenen Forschungs- und Entwicklungs- (FuE) Potential könnte eine Schlüsselrolle in der künftigen Entwicklung zukommen. In den 90er Jahren erfolgte eine Umstrukturierung des FuE-Systems, die das Ziel verfolgt, die im Zusammenhang mit der Transformation entstandenen Finanzierungsprobleme zu lösen und gleichzeitig seine funktionelle Einbindung in das Innovationsgeschehen in der Wirtschaft zu erreichen. Wie dies geschieht, welche Organisationsformen dabei entstehen und wie die neuen Strukturen die Funktionen der FuE beeinflussen, wurde durch ein gemeinsames Projekt der Arbeitsgruppe Wissenschaftstransformation des WZB und des NISTPASS untersucht.

In diesem Heft werden Ergebnisse dieses Projekts vorgestellt. Die Auswirkungen der *doi moi* Politik auf Wissenschaft und Technik müssen als zwiespältig charakterisiert werden: Es gibt ein Missverhältnis zwischen erfolgreichen Strukturveränderungen und deren funktionellen Auswirkungen, insbesondere hinsichtlich verstärkter Innovationsaktivitäten, die bisher nicht oder nur teilweise erreicht worden sind. Einige ernsthafte Probleme innerhalb der Wissenschaft, in den Industriebetrieben, die Ziel der Innovationen sind, und in der relevanten Infrastruktur vermindern Vietnams aktuelle wie künftige Möglichkeiten, FuE für Wirtschaftswachstum und Wohlstand nutzbar zu machen.

Abbreviations

ASEAN	Association of South-East Asian Nations
CMEA	Council for Mutual Economic Assistance (or COMECON)
CPV	Communist Party of Vietnam
DOSTE	Department of Science, Technology and Environment (in provincial authorities)
FDI	foreign direct investment
FTE	full time equivalents
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
ISM	Institute for Science Management (now NISTPASS)
MOF	Ministry of Finance
MOHI	Ministry of Heavy Industry
MOI	Ministry of Industry
MOSTE	Ministry of Science, Technology and Environment
MPI	Ministry of Planning and Investment
NCNST	National Centre for Natural Sciences and Technology
NIE	newly industrialised economy
NISTPASS	National Institute for Science and Technology Policy and Strategy Studies
ODA	official development assistance
PPP	purchasing power parity
R&D	research and development
S&T	science and technology
SCCI	State Committee for Cooperation and Investment
SME	small and medium-sized enterprise(s)
SOE	state-owned enterprise(s)
SRV	Socialist Republic of Vietnam
STS	science and technology system(s)
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organisation
USD	United States dollar (currency)
VAT	value added tax
VND	Vietnamese dong (currency)
WTO	World Trade Organisation

terms:

self-accounting:

This term is used to characterise the duty or ability of the enterprises and other units to come up with at least a balance of costs and sales (income) – in contrast to the situation in the centrally planned economy where the differences between costs and sales were earned or paid by the budget.

Executive Summary

Under the ca. 15 years of *doi moi* (renovation) policy, Vietnam's development has been taking place in the two different but overlapping contexts of transformation and swift economic development. These contexts correspond to two different scenarios for the country's future: One scenario of transformation is the Eastern European pattern; the other is the "Tiger Scenario", with increasing industrialisation and rapid economic growth. The R&D potential created during the period of planned economy could assume a key role in these processes. In the 1990s the R&D system was restructured, with the aim of solving the financial problems that had arisen during transformation, while at the same time seeking to better achieve a functional integration of R&D into innovation processes in the economy.

A joint research project carried out by the WZB (Berlin) and the NISTPASS (Hanoi) conducted macrostructural research and in-depth case studies in selected industrial sectors and R&D institutions to clarify how this is taking place, which organisational forms are created by it, and how the new structures affect the functions of R&D.

Even under *doi moi* policy, Vietnam followed a path that characterised all former socialist countries: Research was linked more and more closely to the economy and in particular to industry by state regulation. *Doi moi* added economic pressure to the political pressure already being exerted on science. Both the organisational restructuring of S&T and the introduction of economic relations led to significant changes in the Vietnamese research and innovation landscape: In a *first transformation phase (1988 to 1991)*, the government reduced its direct influence on relations between research and industry and increasingly left it up to the "market" to regulate them. Reduced financial means and limited demand led to a decline in state R&D. At the same time so many new research facilities were being founded that the government lost track of what was going on and then sought to regain control of the system's development. In a *second phase (1992 to 1995)*, this led to concepts being devised for the restructuring of the whole R&D system. Since it proved difficult to even draw up principles for the reorganisation of the R&D system, these could only be implemented to a very limited extent in this phase. Thus, the *period from 1996* onward can be called a *third phase* in Vietnam's new S&T policy; one involving the establishment and initial consolidation of a new R&D system that should be better adapted to market conditions in Vietnam. But, as our analysis has shown, this process has so far only really begun – also due to the weak demand for R&D results in industry. During all these phases, major emphasis was placed on improved *utilisation* of the available scientific potential. This fundamental policy orientation in favour of putting S&T to use for 'industrialisation and modernisation' purposes is maintained in the 'Law on Science and Technology' passed by parliament in June of 2000. In contrast, during the 1990s there had been a dearth of political orientations and measures aimed at maintaining and developing science as such, i.e. towards improving working and living conditions of scientists and relating to the content and quality of the research work done at scientific institutes.

The politically initiated process of restructuring the Vietnamese S&T system has led to important changes that provide a new basis for further policy. With regard to S&T financing, the main aim was to diminish the state's share and to increase the funding provided by industry. Both aims have been achieved to a significant extent. However, since the industrial financing could not compensate for the decrease in state funding, two obviously unintended processes have been initiated: A decrease in S&T personnel occurred that is similar to the transformation scenarios in Eastern European countries, and the share of R&D activities in the institutes has decreased because institutes compensated for the drop in state financing with various other activities. A second aim of science policy was to adapt institutes' organisational structures to the demands of industrial innovation. Many new, smaller and more specialised

units have been created, which can be assumed to adapt more easily to the demand for innovations. But it is doubtful whether these institutes now produce the innovations needed by their partners in industry: Institutes were described as not being adapted to user needs. On the other hand, our investigation indicated that there are obstacles to such an adaptation that cannot be overcome by increasing the pressure on research organisations.

The impact of *doi moi* policy in the area of S&T must be described as ambiguous. Although much has been achieved regarding the transformation of R&D institutes, the hoped-for consequences - in the form of increased innovation activities - have not yet occurred. Our study shows that the implemented political measures were suitable in that they produced some of the *necessary* conditions for more and stronger innovations. However, these conditions are not *sufficient* to facilitate innovations. There is an incongruity between successful structural changes and their functional effects, which have so far not or only partially been achieved. Our macrostructural analyses and case studies revealed some serious problems, located within the science system, in industrial enterprises as targets of innovations and in infrastructural prerequisites for innovation. They diminish Vietnam's current and future potential to utilise S&T for economic growth and social welfare.

The empirical investigations have led us to draw the following conclusions:

- 1) It is of the utmost importance to *enhance the innovation capacity of industrial (and, perhaps, agricultural) enterprises*. Enterprises' economic power must be raised to a level at which enterprises can establish in-house R&D and make the investments necessary for innovations.
- 2) On the supply side of innovation, the long-term stabilisation and qualitative *improvement of the personnel situation in R&D* institutes by attracting young scientists will become a main task. Additionally, without the *improvement of research institutes' technological basis*, it will not be possible to overcome this bottleneck in Vietnam's innovation systems.
- 3) Both limitations of enterprises' innovation capacity and evident tendencies towards business activities in research institutes suggest the *promotion of innovations by building new firms* around them. Research institutes should be permitted to implement their innovations if they cannot be transferred to industry. Thereby, organisational forms must be found that enable the commercialisation of innovations without preventing institutes from conducting R&D.
- 4) The political measures promoting innovation must be accompanied by measures that *ensure the personnel, technological and financial reproduction of the science system*. The new 'Law on Science and Technology' already included some measures in this direction.
- 5) Our study revealed some 'blind spots' in knowledge and therefore indicates that some *lines of future research* are particularly important for a better understanding of Vietnam's S&T system. Knowledge must be enhanced with regard to the reproduction of R&D potential, in particular personnel structure and technological equipment, with regard to conditions for and barriers to innovation in industrial and agricultural enterprises, with regard to the influence of FDI on technological change in Vietnam and with regard to the content of research contracts between institutes and enterprises.

Contents

Preface	1
Chapter 1 The Research Problem and the Project Approach	7
<i>Werner Meske / Jochen Gläser</i>	
1. Transformation Context	
2. Development Context	
3. Development Scenarios	
4. Project Approach	
Vietnam's S&T System in the Doi Moi Period	
Chapter 2 Doi Moi Policy in Vietnam since 1986: Objectives and Progress in the Reorganisation of Politics, the Economy, Science and Technology	23
<i>Dang Duy Thinh</i>	
1. Introduction	
2. Doi Moi Policy since 1986	
3. Science and Technology in Vietnam	
4. Conclusions	
Chapter 3 Foreign Investment and Technology Transfer	69
<i>Pham Huyen</i>	
1. Foreign Investment and Imported Technologies	
2. Foreign Investment and Domestic R&D	
3. Streams of Technology Importation	
4. Technology Transfer and Technology Assessment	
5. Conclusions	
Chapter 4 Dynamics of Vietnam's S&T Potential in Socio-Economic Context	87
<i>Werner Meske</i>	
1. Science and Technology Indicators	
2. Economic Structure and Innovation	
3. S&T Input Indicators	
4. R&D Output: Publication Activities and International Co-authorship	
Industrial R&D and Innovation in Vietnam	
Chapter 5 Development and Reorganisation of the R&D System in Industry	123
<i>Nguyen Thanh Thinh / Dao Duy Tinh</i>	
1. Industrial Development in Vietnam	
2. The Chemical Sector	
3. Formation and Development of R&D Institutions in Industry	
4. Functions and Financing of Industrial R&D	
5. Processes of Restructuring Industrial R&D Institutes	
6. Outlook	

Chapter 6 R&D in Enterprises' Innovation Activities - Results of Case Studies	145
<i>Tran Chi Duc</i>	
1. Chemical Industry	
2. Food Processing Industry	
3. Electronics and Electrical Industries	
4. Conclusions	
Chapter 7 Content and Organisational Forms of Innovations – Some Comments on the Case Studies	183
<i>Jochen Gläser</i>	
1. A Case for Case Studies	
2. Misunderstandings Suggested by Innovation Theory	
3. Organisational Forms of Innovation Processes	
4. Re-analysing the Case Studies	
5. Conclusions	
International Experiences of Relevance to Vietnam	
Chapter 8 Transformation of Science and Technology in European Economies in Transition - Basic Patterns, Sectoral and National Particularities	205
<i>Werner Meske</i>	
1. Dissolution and Fragmentation of the Socialist STS	
2. Institutional Changes in S&T in the CEEC – A Systematisation of Empirical Findings	
3. Discussion and Interpretation of the Empirical Findings: The "3-Phase-Model" of S&T Transformation	
4. Typical Problems of Strategic Importance	
Chapter 9 R&D in Southeast Asian Nations. The Example of South Korea	233
<i>Barbara Susec</i>	
1. Introduction	
2. Economic Development	
3. The Construction of a Network of State Research Institutes	
4. National R&D Programmes	
5. Promotion of Private Sector R&D	

Chapter 10 Summary and Conclusions	255
<i>Werner Meske / Dang Duy Thinh / Jochen Gläser</i>	
1. The Restructuring of Vietnamese S&T as a Contribution to Doi Moi Policy	
2. Impact of Doi Moi Policy: Achievements and Unsolved Problems	
3. Weighing Achievements and Problems	
4. Science Policy Implications	
List of Authors	269
Lists of Figures, Overviews, Tables	272

Preface

The specific situation faced by Vietnam is that of an underdeveloped country moving from a socialist planned economy to a free market economy (albeit as socially benign a free market as possible). The goal is to quickly catch up with the economic dynamics and standards of the particularly successful Southeast Asian "Tiger States" by accelerating economic growth and industrialisation. Vietnam must therefore achieve a "double transition from underdevelopment and from socialism" (Andreff 1993). Internationally, both the wider public and the scientific community paid little attention to these changes for a long time. Even after interest grew, as recently as the early 1990s, analyses of the changes occurring in Vietnam still largely concentrated on the political, legal and fiscal-economic preconditions for achieving a free market economy (cf. Tepper 1996; Wolff 1997). Problems associated with future technological change were only viewed as marginal or were not addressed at all. But they have, since the beginning of the 1990s, been paid more attention by Vietnamese scientists (see references), especially those in the Institute for Science Management (ISM, now the National Institute for Science and Technology Policy and Strategy Studies - NISTPASS) under the direction of the Ministry of Science, Technology and the Environment (MOSTE). This work was often done in international collaboration with other scientists, principally from Scandinavia (cf. Annerstedt et al. 1993, 1995), Canada, Australia, the Netherlands and Germany (NISTPASS 1998), Vietnam's membership of ASEAN (28 July, 1995) substantially strengthened collaboration with Southeast Asian neighbours.

In the middle of the 1990s ISM/NISTPASS scientists began to analyse structural and functional change in the transformation process of the Vietnamese research and development (R&D) system together with German colleagues from the Wissenschaftszentrum Berlin für Sozialforschung (WZB). For this purpose, in 1995 Dang Duy Think (ISM/NISTPASS, Hanoi) initiated a research project that he then designed together with Werner Meske (WZB). This project "The Interrelation of Structural and Functional Change in the Vietnamese R&D System - Investigated in Selected Industrial Branches" (Meske and Dang, 1995), the results of which are presented in this volume, could draw on these scientists' earlier work on the Vietnamese R&D system (Pham and Dang, 1990; Dang, 1995; Meske and Dang 1996) and first findings on its transformation.

Apart from this groundwork carried out by the participating institutes, discussions that took place in a workshop held at the WZB in 1995 were especially helpful for elaborating the

research proposal. In addition to the actual project members, further workshop participants were Markus Diehl from the Institut für Weltwirtschaft at the University of Kiel, Peter Wolff from the Deutsches Institut für Entwicklungspolitik, Berlin, Gerhard Becher from Prognos AG Basel and the Fridericiana University in Karlsruhe, Chung-Yang Kim from Yonsei University, Seoul, and other researchers in the WZB (WZB-Mitteilungen, 1995). The suggestions made in the (anonymous) experts' evaluation of the proposal submitted to the Volkswagen Foundation were also taken into account in the final draft of the research programme.

Following funding approval from the Volkswagen Foundation,¹ the research project was carried out from 1996 to 2000 by a joint project team from both participating institutes (NISTPASS, Hanoi, and WZB, Berlin). Experts from NISTPASS and MOSTE in Vietnam carried out most of the empirical and statistical work; experiences from the S&T transformation in Central and Eastern Europe – and to a limited extent from development in Southeast Asia – were contributed by colleagues in the WZB. Frequent reciprocal working visits and discussions of the results provided beneficial learning processes for all concerned and enabled WZB scientists to contribute 'commentaries' to Chapters 2 and 3. Workshops held in Hanoi (1997 and 2000, with participants from China, Malaysia, South Korea, Taiwan and Thailand) and in Berlin (1998 and 2000, with participants from Denmark, Germany, Hungary and the UK) also proved invaluable. They not only ensured continuity in the work, but also facilitated the development of a comprehensive understanding of the issues and the involvement of a wider circle of interested scientists with excellent knowledge and different points of view in the discussion.

We would like to take this opportunity to express our particular thanks to those who participated in these four workshops without being affiliated to either of the institutes. We are most grateful for their interest and the valuable input they made to our research. They were: Jan Annerstedt, Scandinavian Academy of Management studies, Copenhagen/Denmark, Jürgen Bitzer, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin/Germany, Wantanee Chongcum, National Science and Technology Development Agency, Bangkok/Thailand, Harvinder Kaur, Economic Planning Unit, Prime Minister's Department, Kuala Lumpur/Malaysia, Wong-Young Lee, Science & Technology Policy Institute (STEPI), Seoul/Korea, Jen-Fang Lee, National Chengchi University/Taiwan, Judith Mosoni-Fried, Institute for

¹ The grant was approved in 1996 by the Volkswagen Foundation's section 'The Transformation of Economic, Political and Social Systems'.

Research Organisation, Hungarian Academy of Sciences, Budapest/Hungary, Yang Qi Quan, National Research Center for S&T for Development, Beijing/China, Thomas G. Whiston, Roskilde University, Roskilde/Denmark. We also owe a special debt of gratitude to the many interview partners in Vietnamese enterprises, institutes and authorities for their willing and open cooperation.

This project investigated the *restructuring processes* of the Vietnamese R&D system. These processes can be described as radical structural change; particularly susceptible are the organisational forms, the allocation of and the degree of autonomy of the R&D facilities as well as their funding. In many cases the continuing existence of the facilities was and is open to question. The declared political objective of the restructuring of the R&D system is to achieve a *functional change* in the system, above all so that R&D facilities more intensively support innovation processes in industry and generally contribute more to technological change in Vietnam.

The *aim* of the project was to determine what the relationship is between structural and functional change in Vietnamese R&D. The political leadership and the actors in science and industry anticipate the necessary functionalisation of R&D for innovation and are making it the basis of their restructuring strategies. Accompanying macrostructural research and in-depth case studies in selected industrial branches and R&D facilities aimed to clarify how this occurs, which restructuring processes emerge, and whether and how the new structures influence the functions of R&D. In particular, the project aimed to extend knowledge of what has been happening to industrial R&D during the process of industrial restructuring and development and, more specifically, to look at the degree to which there are signs of the integration of R&D into the enterprise-based industrial innovation process.

A particular difficulty for designing the project lay in the fact that no suitable theoretical basis had been developed for this relatively complex task. Although countless analyses of transformation processes had previously been undertaken, no single, nor certainly more than one, theory has been formulated on which the study of the transformation of science and technology systems (STS) in the (formerly) socialist countries could be based. Our own experiences and analyses as well as the evaluation of relevant literature had enabled us to ascertain that the transformation of STS can only be understood when one also considers the changes that occur in their societal "environments", in particular in politics and the economy (Meske 1993; Webster 1996). This was the foundation upon which the *conceptional and methodological approach* to this project was developed (cf. Ch. 1 in this volume).

Parallel to this project, comparative research was conducted on the transformation the S&T systems in Central and East European countries. These studies provided us with further experiences and insight into the similarities and differences in the restructuring and transition of the science systems in these countries. The 'three-phase model' that was developed from this (Meske 2000; cf. Ch. 8 in this volume) could contribute to determining a standard for the concluding judgement/assessment of the changes in Vietnam; it was, however, not yet available when the conceptional framework of the project was being designed.

It was also only in the course of research and in the discussion of its results with international experts that the authors became fully aware of the problems arising from Vietnam's specific conditions, or rather of their considerable significance within the contextual and analytic setting of the project. This primarily concerns Vietnam's economic situation; it is characterised by a specific branch and enterprise size structure, with a weak industrial sector and a lack of experience with extensive technological change. The authors were aware from the start that only a limited segment of industrial reality could be examined, primarily due to the restricted capacities for empirical work in Vietnam and the associated lack of relevant experience on the part of their Vietnamese colleagues (who conducted almost all of this work). Despite this, case studies were to provide data on as wide a range of changes in industrial R&D as possible. The inclusion of branches such as food processing and fertiliser production served in particular to take the strong influence of the agricultural sector on industry into account; in contrast, the electronics branch was, for example, included so as to consider modern and internationally dynamic areas of production as well as younger enterprises. Macro and mesostructural analyses of the Vietnamese economy, its branch, enterprise size and socio-economic structures were then conducted. Until then the industrial sector and the associated restructuring of industrial R&D had been the focus of our investigations, since industrialisation stood at the political forefront. These studies revealed, however, that the industrial sector/industrial R&D did not in fact have the postulated significance and would not achieve it in the foreseeable future. In addition, the selection of various branches had not automatically led to the case studies being able to include even a portion of the array of enterprise types that was emerging in Vietnamese industry during the 1990s – from small family firms to state-owned enterprises of various sizes to newly founded corporations and enterprises with foreign capital investment. We must therefore here emphasise the exploratory nature of the analyses and case studies conducted in the industrial sector (cf. Ch. 6). On the other hand, in these circumstances, the combination of statistical

analyses and case studies we decided upon proved to be particularly stimulating and fruitful for considering the empirical findings in the context of the situation and developments as a whole as well as for identifying unresolved issues and developmental problems in Vietnam. The results of this project thus represent a basis for future research in two senses; on the one hand they present for the first time systemically acquired statistical and empirical findings on the R&D landscape in Vietnam and the changes that occurred in it during the 1990s; on the other hand, they draw attention to gaps in our knowledge and these open questions provide an impetus for further research. This appears to be a matter of some urgency, since our investigation also revealed structural problems in the innovation system that cannot be solved with the organisational reforms initiated to date.

In addition, during the period of investigation, the international environment has also rapidly changed and is confronting Vietnam with new challenges: The crisis in Southeast Asia retarded economic development in Vietnam, for example through the reduction in foreign investment; Vietnam's entry into ASEAN and the striven for full membership in the World Trade Organisation (WTO) and (in 2006) the Asian Free Trade Area (AFTA) and the associated further dismantling of trade barriers also represent considerable challenges. This signifies new opportunities for Vietnam, but also increasing international competition for investments, market, etc. and an only minimally protected domestic market. Globalisation is placing Vietnam under considerable time pressure to devise and implement reforms – a fact quite correctly emphasised in the S&T policy study conducted by an international expert commission parallel to this report (cf. Bezanson et al. 1999).² The focus of this group of experts was largely on science policy, also reflected in the conclusions drawn. In contrast, our report first and foremost presents the results of an empirical-statistical analysis of scientific and technological developments in Vietnam at the close of the 20th century. The differences in the objectives and the approaches of the two studies thus provide complementary perspectives on the S&T system and S&T policy in Vietnam. We are convinced that these studies on the Vietnamese S&T system could and will support the (further) design of a long-term strategy for S&T and contribute to its successful implementation in the interests of Vietnam's further socio-economic development.

² We are especially grateful to Jan Annerstedt, who was a member of this commission and presented the approach taken and the results of its work in the workshop held in Berlin in November 2000.

We are in particular indebted to both our institutes (NISTPASS and WZB) for their support of our research, as well as to the Volkswagen Foundation, without whose support this project could never have been carried out. A special thanks goes to Dr. Alfred Schmidt from the Volkswagen Foundation for his many years of uncomplicated and understanding handling of project sponsorship.

Dang Duy Thinh
NISTPASS/Hanoi

Werner Meske
WZB/Berlin

References

- Andreff, Wladimir, 1993: The Double Transition From Underdevelopment and From Socialism in Vietnam. In: *Journal of Contemporary Asia*, Vol. 23 (4): 515-531.
- Annerstedt, Jan and Nguyen Thanh Ha, 1993: Demolishing the ivory tower: The drive to commercialize research and experimental development in today's Vietnam. Pp. 109-130 in Vu Cao Dam (ed.): *Science, Technology and Society in Vietnam*. Institute for Science Management: Hanoi.
- Annerstedt, Jan, Vu Cao Dam and Nguyen Thanh Ha, 1995: Saigon High-Tech Industrial Park. Report to Ho Chi Minh City People's Committee and Schmidt Vietnam Co. Ltd. (1994); edited 1995.
- Bezanson, K., J. Annerstedt, K. Chung, D. Hopper, G. Oldham, and F. Sagasti, 1999: Viet Nam at the Crossroads. The Role of Science and Technology, International Development Research Centre, Ottawa, ON, Canada K1G 3H9.
- Dang Duy Thinh, 1995: Vietnam - ein Land im Aufbruch. Prozesse, Perspektiven, Probleme. Unpubl. lecture held in a WZB colloquium, Berlin, 16. Mai 1995.
- Meske, Werner, 1993: The restructuring of the East German research system – a Provisional Appraisal. in: *Science and Public Policy*, Guildford/England, Vol. 20, No. 5, October 1993, pp. 298-312.
- Meske, Werner and Dang Duy Thinh, 1995: Der Zusammenhang von Struktur- und Funktionswandel des vietnamesischen Forschungs- und Entwicklungs-Systems - untersucht in ausgewählten Wirtschaftszweigen. Projektantrag an die VW-Stiftung im Schwerpunkt "Transformation von Wirtschaftssystemen", Berlin.
- Meske, Werner and Dang Duy Thinh (eds.), 1996: Zur Situation und den Veränderungen des FuE-Systems in Vietnam, unter besonderer Berücksichtigung der Schwerindustrie. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 96-401, Berlin.
- Meske, Werner, 2000: Changes in the innovation system in economies in transition: basic patterns, sectoral and national particularities, in: *Science and Public Policy*, Vol. 27, No. 4, pp. 253-264.
- NISTPASS, 1998: Annual Report, NISTPASS, Hanoi.
- Pham Huyen and Dang Duy Thinh, 1990: Zum wissenschaftlich-technischen Potential der SRV, in W. Meske (ed.): *Wissenschaft der RGW-Länder. Studien und Forschungsberichte*, H. 30. Institut für Theorie, Geschichte und Organisation der Wissenschaft: Berlin, pp. 222-238.
- Tepper, Sibylle, 1996: Transformation von Wissenschaftssystemen – Vietnam; Literaturstudie, in Werner Meske and Dang Duy Thinh (eds), op. cit., pp. 77-94.
- Webster, Andrew (ed.), 1996: Building New Bases for Innovation – The Transformation of the R&D System in Post-Socialist States, Anglia Polytechnic University, Cambridge/UK.
- Wolff, Peter, 1997: Vietnam – Die unvollendete Transformation. Schriftenreihe des deutschen Instituts für Entwicklungspolitik. Band 113. Weltforum-Verlag: Köln.
- WZB-Mitteilungen, 1995: WZB, Heft 69, September 1995, Berlin, pp. 33-34.

Chapter 1: The Research Problem and the Project Approach

Werner Meske / Jochen Gläser

When we began work on this project in 1995 Vietnam's development was proceeding in two different overlapping contexts. The *transformation context* (1) was determined by the gradual transition from the socialist planned economy to a free market economy. This economic development was being centrally directed by the political leadership. Vietnam's development fits into the general pattern of transformation in formerly socialist countries, but the transformation processes undergone differ from most of those found in other countries in that they are centrally steered by the Communist Party and the government. In terms of its *development context* (2), Vietnam appears to be a developing country with good prerequisites for moving from being one of the world's most economically backward countries, to being a fast-developing nation that may well follow in the path of the so-called "Tiger States" of Southeast Asia. These contexts correspond to two different *scenarios* (3) for the future development of Vietnam: A transformation scenario along East European lines, in which the free market opening first of all led to massive setbacks in industrial production, and a "Tiger" scenario, involving increasing industrialisation and rapid economic growth.

Because the country has so far only partially opened up, despite the successes achieved in transformation to date, it remains completely unclear which of these development scenarios will actually come into effect, and to what extent. Equally unclear is which conditions this depends upon. The R&D potential created during the period of a planned economy could play a key role in future developments. As was the case in all socialist countries, science was held in high esteem in Vietnam. Along with socialist ideology, national traditions also contributed to this special reverence. As a result, an R&D potential was built up that lay well above the standards of other economically comparable developing countries.¹ However, on the other hand, it also exhibits the same deficient functional integration into the national innovation

¹ This essentially concerns the employment of qualified personnel in science, i.e. R&D. In 1985, with a total population of 60 million, approximately 37,500 scientists were engaged in R&D. This ratio is roughly four times higher than average in developing nations at that time (Pham Huyen and Dang Duy Thinh, 1990: 222). Even after first cutbacks had already taken place, about 30,000 scientists were still employed in R&D in 1993: This figure is equivalent to approximately 9 per 10,000 employees in the national workforce. In relative terms this is more than in Turkey and in Mexico (both ca. 8 per 10,000 employed in 1993), but only 10 % of the EU average (93 per 10,000 employees) in that year (cf. Ch. 2 in this report and OECD 2000:18, Tab. 9).

system and inadequate prerequisites for research work (material/technical equipment, information, financing, etc.) as is to be found in other socialist countries. Since the early 1990s a restructuring of the R&D system has been underway, aiming to solve the financial problems arising in connection with the transformation and to simultaneously improve the integration of R&D into industrial innovation activities. This development is also governed by the two contexts of transformation and development - R&D is deemed to be largely a cost factor in the former context, and in the latter context it is regarded more as an important potential. The project presented here aims to analyse the changes occurring in the Vietnamese R&D system in the 1990s in light of this complex situation (4).

1. Transformation Context

Since 1986 the Vietnamese government (and the ruling Communist Party) have been pursuing a policy of centrally organised and controlled transition to a free market economy, similar to that implemented in China. This policy has led to some first successes, especially since the beginning of the 1990s (Diehl 1993; Andreff 1993; Revilla Diez and Schätzl 1993; Bagoglu 1995; Dang Duy Think 1995). In the meantime important free market institutions have been established and legally secured. On a macroeconomic level, lending and fiscal policies have achieved a relative stabilisation; liberalisation has advanced due to the lifting of domestic price-fixing controls and a partial opening for foreign trade (Diehl 1995; Wolff 1997).

Vietnam thus represents a centrally controlled version of transformation that clearly differs from that found in Eastern Europe. It is more comparable with the transformation occurring in China (Shulin Gu 1999). So far it appears as if this version could avoid massive economic crises involving a considerable decline in the gross domestic product (GDP) as have occurred in Eastern Europe. "The transition out of Socialism seems to be rather efficient when handled by a Communist Party still in power but convinced of the benefits of a market economy at a time when, in Central Eastern Europe, economic transition is regarded as the twin sister of political democracy and its flourishing parliamentary debates." (Andreff 1993: 529). Shultz and Khai Le conclude from their exhaustive analysis of the political constellations that

"economic reforms will be encouraged while various forms of central and political repression continue, but political reforms and democratisation, as even conceded in party documents, will follow the economic reforms, regardless of the will of some conservatives. The pace of the overall reforms will depend mainly on the results of the economic reforms; ... It is likely that the reforms will go considerably further, enabling Vietnam to become one of the more prosperous nations in Southeast Asia, and perhaps propelling Vietnam towards democracy faster than its neighbouring countries moved in the past." (Shultz and Khai Le 1993: 193)

Similarly, from the analysis of transformation processes to date, Haddad draws the following conclusion:

"The 'Transforming State', as distinct from the 'Managing State' which comes at the end of the transitional process, must create the new institutions required by a market-oriented economy. The state must play a far more active and creative role than is commonly perceived by people writing on the economics of transition. ... Once more, China and Vietnam must resist the current fashion in Eastern Europe and elsewhere and focus on the more difficult problem of exploiting the complementary and reinforcing roles of the state and the market." (Haddad 1994: 455-456; cf. Nikolajew 1995: 55-56; Etzkowitz 1998)

However, the centrally steered transformations proceed more slowly than the spontaneous processes in Eastern Europe. The situation in Vietnam is viewed as being full of contradictions and as still not durably stable (Gates and Truong 1992: 38-39; Diehl 1993: 235-237; Andreff 1993: 527; Wolff 1997). For example, the country needs up to 20 billion US dollars for investments (ca. 60% from abroad) to implement the industrial stabilisation and development strategy devised by the Communist Party for the period from 1991 to 2000 (CPV 1991). Although considerable foreign direct investment has already been approved, the *actual amount* raised has remained far behind that required. In 1996 only 6.7 billion USD of the 22.9 billion USD FDI pledged to that time had actually been paid – only 23 % (Wolff 1997: 73; cf. also Diehl 1993: 228-229; Bagoglu 1995: 2-3; Dang Duy Thinh 1995; Pham Huyen, Ch. 4.1 in this volume). It is assumed that the low investment in equipment is already hindering the further intensification of agriculture, while, for instance, investments in the state textile industry and labour-intensive, mainly private light industry in South Vietnam are among the causes underlying the increase in productivity (Revilla Diez and Schätzl 1993: 543-544). These intrinsic limitations give rise to pressure to further open the country to the international community and to adapt the state enterprises to the free market economy more rapidly. Such compulsions will possibly result in similar developments to those observed in Eastern Europe. On the one hand, the political order has largely remained unchanged and, on the other hand, the prerequisites for both economic integration into Southeast Asia and the creation of a predominantly private sector export industry are only gradually being established. For these reasons Wolff speaks of the "uncompleted transformation" and anticipates that integration processes will intensify in future in the light of pressure to conform as exerted both from within and outside Vietnam (Wolff 1997: X).

2. Development Context

Most authors assume that Vietnam will develop in accordance with the role model provided by the successful "Tiger States" (Andreff 1993; Revilla Diez and Schätzl 1993; Hilpert 1994; Diehl 1994). Hilpert summarises the concept of industrial development in the Asian-Pacific region as follows:

"According to this model, the economic development of East and Southeast Asia occurs in several chronologically successive, overlapping waves, graphically described in the 'model of wild geese'. This represents a staggered process in which the NIEs (= newly industrialised economies, W.M./J.G.) follow Japan, the ASEAN nations follow the NIEs and China and Vietnam follow the ASEAN nations. The latest economy to join this dynamic development association was the People's Republic of China. Vietnam is generally expected to join the association in the 1990s ... The central notion of this model is its linking of the product cycle theory, in terms of sectoral specialisation patterns in the participating economies, with an intensive, complementary and competitive foreign trade obligation in the entire Asian-Pacific region. ... If a country has comparative advantages in the early phase of industrialisation, in particular in labour-intensive production, then as its economy matures industrially, its capital- and training-intensive sectors will become increasingly competitive and it will ultimately specialise in capital- and technology-intensive sectors. ... Because positions are not fixed in the dynamic process of catching up, the Asian-Pacific economies can integrate themselves in the international division of labour into those branches of industry in which they have (or achieve) competitive advantages by way of crowding-out competition" (Hilpert 1994: 619-620).

Its history has meant that Vietnam only got off to a late start and is handicapped by its low level of economic development. Its assigned starting position is thus at the end of the "skein of wild geese". The successes achieved to date in agriculture and the notable rate of economic growth in labour-intensive light industry, do, however, indicate that Vietnam has started in pursuit of the others (Diehl 1995; Wolff 1997). The process of catching up could be accelerated by the mobilisation and effective use of the present scientific potential in the interests of qualification (improving human capital) and technological change.

3. Development Scenarios

The two different development contexts correspond to differing scenarios for Vietnam's future. A transformation scenario based upon the necessity for a rapid and far-reaching opening of the country and an accelerated transition to a free market economy with rapid privatisation, oriented on East European patterns, will most likely involve massive setbacks in industrial production, at least in heavy industry. The "tiger" scenario involves accelerated advances leading to Vietnam becoming classified as a fast-developing nation and it catching up on the developments of other Asian states. This scenario, in contrast, involves an increase

in agricultural production and productivity, the rapid growth firstly of labour-intensive industry and then, based on the accumulation achieved here, also the growth of other capital- and technology-intensive branches. Experiences so far indicate that the central control of economic development, which resembles that exerted in China, does not represent a barrier to this: In Taiwan and South Korea the successful development was also steered by a dominant party and the proportion of state enterprises was also high in both cases (cf. Kim, 1993; Chi-Ming Hou/San Gee, 1993). In Vietnam the current situation is characterised by

- an economic development that has been successful so far, but also by
- a relatively slow transformation of industry to date, which has yet to take its most difficult and hazardous steps.

Given this situation, no definite prognosis can be made of which scenario will be realised. Vietnam's R&D could, however, play a key role in the country's future development since the experiences made in the Tiger States indicate that "industrial development is a process of acquiring technological capability in the course of continual technological change" (Pack and Westphal 1986: 106). In all East European countries undergoing transformations focussing on rapid free market opening there has been a rapid disintegration of R&D capacities, in particular in the industrial sector (Meske et al. 1998; Mayntz, Schimank and Weingart 1995).

In contrast, studies on the development of Taiwan (Wade 1990; Chi-Ming Hou and San Gee 1993) and South Korea (Linsu Kim 1993; STEPI 1994; Taeyoung Shin and Hoagy Kim 1994) show that their successes can largely be put down to successful technology development and R&D. Since the 1960s the South Korean government has been systematically implementing strategies to promote industrialisation, to develop technology and to increase the levels of qualified personnel. While in the 1960s such capacities were being built up from scratch, and in the 1970s the focus shifted to an orientation toward import and the adaptation of foreign technology, in the 1980s Korean politics began to focus on increasing competitiveness by way of technological innovation and product differentiation. In the 1990s, the "Long-range Plan of Science and Technology towards the 2000" aims to turn Korea into a developed nation (STEPI 1994). Setbacks in recent times show how complicated this phase is and how necessary it is to have balanced preconditions (cf. Outlook 1999: 38-39). Conversely, according to Moshi, in Tanzania the main reason for the lack of competitiveness of the state enterprises lies in the fact that their low level of research and innovation potential leads to poor quality products. None of the enterprises Moshi studied had its own research department. Such a department could serve to develop new production processes or to raise the quality of

the products. Underlying causes are technological dependence on the industrial nations and, above all, the fact that these enterprises hold a monopoly, which effectively eliminates technological competition (Moshi 1992: 198).

If we consider Vietnam's preconditions for achieving industrialisation on the basis of constant technological change, supported by the early utilisation of its own R&D potential, it can only be concluded that they are contradictory:

- On the one hand Vietnam has (had) a well developed education system (Jordan 1992) and an R&D potential that is considerable at least in quantitative terms, with some top-notch experts (Annerstedt and Ha 1993: 67),
- but, on the other hand, these resources have contributed little to innovation in production.

This contradiction is a typical structural feature of socialist countries in which, for various reasons, the development of science was given a high priority but where the potential of the national science system was not successfully tapped for industrial development (cf. Hanson and Pavitt 1987; Meske and Gläser 1996; Meske 1998; Nguyen Van Hieu 1998). The high status accorded science in socialist ideology was in contrast to its inadequate material resources and the inability of the planned economy to generate industrial innovation based on research results. This also holds true for Vietnam:

"There is practically no research and experimental development (R&D) performed in the business enterprise sector in Vietnam. Most modern technology is brought to production through the imports of machinery and other products from abroad, through joint ventures and foreign investments, through transfer of know-how in the form of licences, consultancy services, etc. Of course, some high-technology is generated locally, e.g. through the polytechnic universities and some of the other universities and through a few national R&D institutes. As Vietnamese R&D activities are not organised to easily and effectively support industrial firms operating in the modern market economy, most business enterprises do not rely on the R&D institutions as they try to develop products and new manufacturing processes. Or - in economic terms - the supply of research results is not in line with the demand, since there is only little interaction between scientific research and industrial technology." (Annerstedt and Sturgeon 1995: 6-7; 65-66; cf. Annerstedt and Ha 1993)

"At present, the weak links between R&D and industry are seen by many decision-makers in Vietnam as an obstacle to further industrial rehabilitation and modernisation. There is an awareness that institutions and firms which create and/or disseminate technology and related know-how are not modernised by the same speed - and maybe not even in the same direction - as the rest of society. Most R&D institutions are not yet fit to interact constructively with enterprising industrial firms." (Annerstedt, Dam and Ha 1995: Introduction).

This contradictory situation corresponds to the attempts made by the Vietnamese leadership in the *doi moi* ("renovation") policy to achieve a restructuring in R&D potential. This

restructuring follows two simultaneous objectives: Solving Vietnamese R&D's (state) financing problems and better functionally integrating R&D potential into a dynamic Vietnamese innovation system (some parts of which must yet be created), which can deal with the constant technological change in industry required by free market conditions.

4. Project Approach

The project presented here aimed to analyse which changes are occurring in the Vietnamese R&D system and whether and how they contribute to achieving these two objectives. It was assumed that structural and functional changes on the various levels of the science system manifest themselves in various forms:²

a) On the *macrostructural* level of the science system and its sectors, structural changes will be expressed primarily in terms of funding, organisational and personnel changes. These could affect the proportions of the three R&D sectors (industrial research; non-university, public/state research; university research) just as much as the size of the R&D system as a whole. Considerable reductions in R&D potential, as occur in Eastern European transformation processes, cannot be ruled out.

On this macrostructural level, the functional change of the R&D system will manifest itself primarily as changes in proportions in the R&D facilities' functional spectrum (on the basis of their main orientations toward basic research, applied research or the experimental development of products and technology). Changes in the functional spectrum could affect both the R&D system as a whole and also its individual sectors.

b) On the *mesolevel* far-reaching changes are to be expected in the continued existence and in the organisational forms of the R&D facilities. This applies in particular to the industrial R&D sector, which is also the main focus of the research project presented here. These changes could be initiated and negotiated for entire groups of facilities or for individual institutes. They range from the dissolution of institutes and the founding of new ones, to an organisational reassignment (e.g. to an enterprise) or a sweeping adjustment of financing, all the way to moderate changes in the size or structure of individual facilities. The founding of new facilities in connection with the growth of the private sector in industry and science could also play a role. All of these changes will, however, most probably be accompanied by an at

² This assumption is based on the findings of a preliminary study conducted for this project in 1994/95 (Meske and Dang 1996).

least partial shift in the functions of the facilities in the R&D system. In particular, it is conjectured that the structural change will result in a change from (applied) research that is not oriented toward the direct needs of industry, to R&D that is directly technologically relevant for industrial enterprises.

c) It was assumed that these changes will also have an impact on the *microlevel*, i.e. on the composition of individual research groups and the profiles of scientists. The interaction between the development of an organisation and the formation of its research profile, in terms of both content and function, touches upon a question as yet unanswered by the sociology of science (cf. Gläser 1997: 3-8). The formation of research profiles certainly involves longer-term processes that only follow organisational changes with some delay. This project was therefore only able to observe the first signs of changes on the microlevel.

The project was conceived of as accompanying research, nevertheless it had to consider the situation Vietnamese R&D found itself in the early 1990s as these were the initial conditions for its transition. The project therefore encompassed

- the consolidation of the (previously begun) ex-post analysis of the conditions at the outset of transformation in the early 1990s,
- accompanying research to ascertain changes from the mid-1990s onwards, and
- an evaluation of these changes, also by means of international comparisons to transformation processes in Eastern Europe and industrialisation processes in Southeast Asia.

The scientists from NISTPASS (i.e. formerly from the ISM) have been analysing Vietnam's R&D system since the 1980s. In addition they act as advisors on science policy for the government. Their knowledge in this field is thus extensive and wide-ranging. However, the "double transition" that lies ahead confronts them with new challenges and led to the search for new co-operation partners who may be able to support their work. The WZB working group 'Transformation of Science Systems' has gained considerable experience and insights into the restructuring of relations between science and production in its research on transformation processes in East Germany and Eastern Europe (cf. Meske 1994; Gläser et al. 1995; Meske et al. 1998; Meske 1998). These experiences in particular were to be evaluated and taken advantage of and the insights re-examined in terms of the specific situation in Vietnam.

Because the structural and functional changes manifest themselves differently on the various levels of the R&D system, a differentiated methodological approach is required for their analysis. For the macrolevel, changes in the organisational, personnel and financial structure must first be ascertained with the help of document analyses and (usually aggregated) statistical data from the sources available. The functional change can only be determined by way of the allocation of (dominant) functions to sectors or organisations and by recording the changes in their proportions in the R&D system. This could be supplemented by the redefinition of functions of individual organisations, which could also be done by way of qualitative interviews on the mesolevel.

On the mesolevel of (groups of or individual) R&D facilities one must identify

- changes in the type, scope and proportions of the individual R&D facilities, similarly to the macrolevel but supplemented by gathering data on the individual institutes, and
- organisational and above all functional changes in addition to the factors and actors that effect these changes. This can only be done by way of supplementary qualitative interviews. Because of the high expenditure of time and resources involved in such a procedure, it requires that the field of analysis be limited to selected areas and R&D facilities.

To analyse these restructuring processes with both representative breadth and the necessary depth, a two step methodology was decided upon. This involved

- a sample of industrial branches (namely: chemical industries, electronics, food processing), in which the interrelation of structural and functional changes in the R&D potentials working for them was to be examined in overview. Besides statistical and documentary analyses, qualitative interviews with representatives of these branches in science, industry and politics were also utilised.
- Within the selected branches, the changes in structures and functions of some R&D facilities of various types were investigated as case studies.

The case studies of institutes aim to longitudinally investigate the changes occurring in the facilities during the transformation processes. They can be considered a form of accompanying research. As experiences in East Germany and Eastern Europe have demonstrated, the transformation processes of R&D facilities, and above all their integration into an economic and scientific landscape that is itself in transition require much more time than originally envisaged (Gläser et al. 1995; Meske et al. 1998). Since these changes are only

now beginning in Vietnam and must be observed over an extended period of time, within the framework of this project it was only possible to provide an initial characterisation of the selected facilities and the changes that are beginning to occur there. To complement this international comparisons were necessary, not only as an indicator of the level achieved, but also as important methodological steps and instruments that suggest themselves for the analysis and assessment of processes of change themselves. Such international comparisons were thus integral elements of the entire research process, which, however, also made specific demands that were only able to be met in part by this project given the lack of experience in Vietnam and the limited resources available in Germany. Two key ways in which such comparison could be integrated into the project were the following:

- Significant changes in the organisational forms of R&D, in its funding, in its relations to industry, etc. were compared with corresponding changes in East Germany and Eastern Europe (cf. Ch. 8 in this volume).³ This served to ascertain similarities and differences early on and assisted in assessing the ensuing consequences for the further development of R&D in Vietnam.
- Parallel to gaining an overview of the R&D system in Vietnam and its macrostructural changes in the 1990s, the attempt was made to gather analogous data and statements for some comparable countries in Southeast Asia (in particular South Korea, Taiwan, Thailand, China). This comparative data was processed and additionally drawn upon to assess the changes occurring in Vietnam. This was facilitated by one workshop held in Hanoi (1997) with participants from the above-mentioned countries and a short analysis of the case of South Korea by B. Susec (cf. Ch. 9 in this volume).

The first findings of the studies on the economic and science policy changes introduced in Vietnam, on their effects on the R&D system as well as within individual research institutes and enterprises will be presented below. The account will on the whole follow the conception

³ The prerequisites for such a comparison were given in the WZB Working Group 'Transformation of Science Systems' on the basis of its analyses of the transformation of science systems in East Germany and Eastern Europe (see Meske and Nadiraschwili 1994, Malizkij and Nadiraschwili 1995, Meske 1996). This work was further intensified specifically from the point of view of comparative analyses in the context of the WZB Working Group's participation in the project "Restructuring and Reintegration of Science and Technology Systems in Economies in Transition". This international project was funded by the EU from 1996 to 1998 within the TSER Programme and was co-ordinated by the Science and Technology Policy Research Unit (SPRU) of the University of Sussex in Brighton (cf. Radosevic et al. 1995). Werner Meske was responsible for Part D: Institutional transformation of science and technology systems in the European economies in transition (cf. Meske 1998). In the interests of an exchange and comparison of experiences, Dang Duy Thinh (Vietnam) and Yang Qi Quan (China) participated in a workshop on the institutional transformation of S&T systems held in connection with the EU project in Budapest in 1997 (cf. Meske et al. 1998).

outlined above. The first part of this volume, "Vietnam's S&T System in the Doi Moi Period" (Ch. 2-4) positions changes occurring in the Vietnamese R&D system in the overall context of political and economic transformations. The second section, "Industrial R&D and Innovation in Vietnam" (Ch. 5-7) looks at the restructuring of industrial R&D in more depth (in particular the area of heavy industry) and at the role of domestic R&D in enterprise-based innovation activities - case studies conducted in enterprises and R&D institutes in selected industrial branches provide valuable insight here. In the third section, "International Experiences of Interest for Vietnam" (Ch. 8-9), experiences in the development of science and technology within the Central and East European transformation countries as well as in South Korea are presented and analysed. They enable us to draw comparisons to the situation in and tasks facing Vietnam. Finally, in Chapter 10 the most important findings and assessments are summarised and conclusions drawn about future possibilities and strategies for development as well as for further research.

References

- Andreff, Wladimir, 1993: The Double Transition From Underdevelopment and From Socialism in Vietnam. In: *Journal of Contemporary Asia*, Vol. 23 (4): 515-531.
- Annerstedt, Jan and Nguyen Thanh Ha, 1993: Demolishing the ivory tower: The drive to commercialize research and experimental development in today's Vietnam. Pp. 109-130 in Vu Cao Dam (ed.): *Science, Technology and Society in Vietnam*. Institute for Science Management: Hanoi.
- Annerstedt, Jan and Tim Sturgeon, 1995: Electronics and information technology in Vietnam. A report to the Ministry of Science, Technology and Environment, Hanoi 1994; reprinted 1995 by Nordic Center for Innovation: Lund/Sweden.
- Annerstedt, Jan, Vu Cao Dam and Nguyen Thanh Ha, 1995: Saigon High-Tech Industrial Park. Report to HoChiMinh City People's Committee and Schmidt Vietnam Co. Ltd. (1994); edited 1995.
- Bagoglu, Necip C., 1995: Vietnam. *Wirtschaftstrends zum Jahreswechsel 1994/95*. In: *bfai-Länderreport*: 1-12
- Chi-Ming Hou and San Gee, 1993: National Systems Supporting Technical Advance in Industry: The Case of Taiwan. Pp. 384-413 in Richard R. Nelson (ed.): *National Innovation Systems. A Comparative Analysis*. Oxford University Press: New York.
- CPV, 1991: Strategy to stabilise and develop the national economy by the year 2000. Document from the VII. party congress of the Communist Party of Vietnam (CPV), Hanoi.
- Dang Duy Thinh, 1995: Vietnam - ein Land im Aufbruch. Prozesse, Perspektiven, Probleme. Unpubl. lecture held in a WZB colloquium, Berlin, 16. Mai 1995.
- Diehl, Markus, 1993: Die Systemtransformation in Vietnam. In: *Die Weltwirtschaft*, Heft 2: 207-248

- Diehl, Markus, 1994: Real Adjustment in The Economic Transformation Process: The Industrial Sector of Vietnam 1986-1992. Kiel Working Paper No. 597. The Kiel Institute of World Economics: Kiel.
- Diehl, Markus, 1995: Hanoi startet leichter durch als Osteuropa. In: Die Welt, Weltreport 23. Mai.
- Etzkowitz, Henry, 1998: Science and Industrial Policy: Beyond the Endless Frontier. Pp. 57-66 in W. Meske, J. Mosoni-Fried, H. Etzkowitz and G. A. Nesvetailov (eds.): op. cit.
- Gates, Carolyn L. and David Truong, 1992: "Reform of a Centrally-Managed Developing Economy: the Vietnamese Perspective", in: NIAS Report No. 9 published by the Nordic Institute of Asian Studies: Copenhagen/Denmark. Pp. 1-39
- Gläser, J., G. Groß, M. Höppner, C. Melis and W. Meske, 1995: Die aufgeschobene Integration. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 95-404. Berlin.
- Gläser, Jochen, 1997: How do Research Institutes Learn? Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 97-401. Berlin.
- Haddad, L., 1994: The World Bank and the Process of Transition in Eastern Europe: Lessons for China and Vietnam, in: Journal of Contemporary Asia, Vol. 24 (4): 441-448.
- Hanson, Philip and Keith Pavitt, 1987: The Comparative Economics of Research Development and Innovation in East and West: A Survey. Harvard Academic Publishers: Chur/Switzerland.
- Hilpert, Hans Günther, 1994: Yen-Block in Asien? Die wirtschaftliche Verflechtung Japans mit der asiatisch-pazifischen Region, in: Geographische Rundschau 46 (11): 616-621.
- Jordan, Sigrid, 1992: Berufliche Bildung als Bestandteil der Bildungssysteme in den sozialistischen Länder Ost- und Südasiens. Mitteilungen des Instituts für Asienkunde Hamburg, Nr. 208.
- Linsu Kim, 1993: National System of Industrial Innovation: Dynamics of Capability Building in Korea. Pp. 357-383 in Richard R. Nelson (ed.), National Innovation Systems. A Comparative Analysis. Oxford University Press: Oxford, New York.
- Malizkij, Boris and Alexander Nadiraschwili, 1995: Die Umgestaltung des Wissenschaftssystems der Ukraine im Zuge der gesamtgesellschaftlichen transformation. Pp. 283-370 in R. Mayntz, U. Schimank and P. Weingart (ed.), op. cit.
- Mayntz, R., U. Schimank and P. Weingart (ed.), 1995: Transformation mittel- und osteuropäischer Wissenschaftssysteme. Länderberichte zu den institutionellen, personellen und finanziellen Veränderungen der Forschung. Verlag Leske & Budrich: Opladen.
- Meske, Werner, 1994: Veränderungen in den Verbindungen zwischen Wissenschaft und Produktion in Ostdeutschland. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 94-402. Berlin.
- Meske, Werner and Alexander Nadiraschwili, 1994: Umbruch der Wissenschaft in Mittel- und Osteuropa. Pp. 349-376 in: Wolfgang Zapf and Meinolf Dierkes (ed.), Institutionenvergleich und Institutionendynamik. WZB-Jahrbuch 1994. Ed. Sigma: Berlin.
- Meske, Werner and Dang Duy Thinh, 1995: Der Zusammenhang von Struktur- und Funktionswandel des vietnamesischen Forschungs- und Entwicklungs (FuE)-Systems - untersucht in ausgewählten Wirtschaftszweigen. Projektantrag an die VW-Stiftung im Schwerpunkt "Transformation von Wirtschaftssystemen". Berlin.
- Meske, Werner and Dang Duy Thinh (ed.), 1996: Zur Situation und den Veränderungen des FuE-Systems in Vietnam, unter besonderer Berücksichtigung der Schwerindustrie. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 96-401, Berlin.
- Meske, Werner and Jochen Gläser, 1996: Konzeptionelle Überlegungen zur Analyse des vietnamesischen FuE-Systems. In: Werner Meske and Dang Duy Thinh (eds.), Zur Situation und den Veränderungen des FuE-Systems in Vietnam, unter besonderer Berücksichtigung der Schwerindustrie, Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 96-401, Berlin, pp. 1-9.

- Meske, Werner, 1996: Academic-Industry Relations and East German Innovation. Pp. 41-50 in Andrew Webster (ed.), *Building New Bases For Innovation*. Anglia Polytechnic University: Cambridge.
- Meske, Werner, 1998: Institutional Transformation of S&T Systems in the European Economies in Transition. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des WZB, P 98-403, Berlin.
- Meske, Werner, Judith Mosoni-Fried, Henry Etzkowitz and Gennady A. Nesvetailov (eds.), 1998: *Transforming Science and Technology Systems - The Endless Transition?* NATO Science Series 4/23. IOS Press: Amsterdam.
- Moshi, Humphrey P. B., 1992: Zum Entwicklungsbeitrag staatlicher Unternehmen in den Entwicklungsländern: Dargestellt am Beitrag Tansanias. *Schriften zur öffentlichen Verwaltung und öffentlichen Wirtschaft*, Bd. 74. Nomos Verlagsgesellschaft: Baden-Baden.
- Nguyen Van Hieu, 1998: Development-oriented research in the basic sciences: the case of Vietnam In: Martha J. Garrett, Claes G. Granqvist (eds.), *Basic Sciences and Development*, Ashgate Publishing Limited, Aldershot, pp. 123-127
- Nikolajew, Vadim, 1995: Zu Möglichkeiten und Grenzen komparativer Transformationsforschung. In: *BISS public*, Jg. 5 (17): 55-62.
- OECD, 2000: *Main Science and Technology Indicators, 2000/1*, Paris, OECD/OCDE.
- Outlook on Science Policy*, Vol. 21 (4), April 1999 (Korea).
- Pack, Howard and Larry E. Westphal, 1986: Industrial Strategy and Technological Change. Theory versus Reality. In: *Journal of Development Economics* 22: 87-128.
- Pham Huyen and Dang Duy Thinh, 1990: Zum wissenschaftlich-technischen Potential der SRV. Pp. 222-238 in W. Meske (ed.): *Wissenschaft der RGW-Länder. Studien und Forschungsberichte*, H. 30, Institut für Theorie, Geschichte und Organisation der Wissenschaft: Berlin.
- Revilla Diez, Javier and Ludwig Schätzl, 1993: Industrieller Transformationsprozeß in Vietnam. In: *Geographische Rundschau*, Jg. 45 (9): 538-545.
- Radosevic, Slavo, D. Dyker, C. v. Hirschhausen, W. Meske and X. Richet, 1995: *Restructuring and Reintegration of Science and Technology Systems in Economies in Transition - Project Proposal - EC Framework Programme IV - TSER*. Science and Policy Research Unit, University of Sussex: Brighton.
- Shulin Gu, 1999: *China's Industrial Technology*, Routledge, London.
- Shultz, Clifford J., II and Khai Le, 1993: Vietnam's Inconsistencies Between Political Structure and Socio-economic Practice: Implications for the Nation's Future. In: *Contemporary Southeast Asia*, Vol. 20 (2): 179-194.
- STEPI, 1994: *Policy Incentives for the Commercialization of R&D Outputs*, Training Course, Science and Technology Policy Institute (STEPI): Seoul/South Korea.
- Taeyoung Shin and Hoagy Kim, 1994: Research Foresight Activities and technological Development in Korea. Science and Technology Policies in National R&D Programs. In: *Technological Forecasting and Social Change* 45: 31-45.
- Wade, Robert, 1990: *Politics Of Investment And Industrial Policy*. Pp. 256-296 in R. Wade: *Governing the Market. Economic Theory and the Role of Government in East Asian Industrialization*. Princeton University Press: Princeton/New Jersey.
- Wolff, Peter, 1997: *Vietnam – Die unvollendete Transformation*. Schriftenreihe des deutschen Instituts für Entwicklungspolitik. Band 113. Weltforum-Verlag: Köln.

Vietnam's S&T System in the Doi Moi Period

Chapter 2: Doi Moi Policy in Vietnam since 1986.

Objectives and Progress in the Reorganisation of Politics, the Economy, Science and Technology

Dang Duy Think

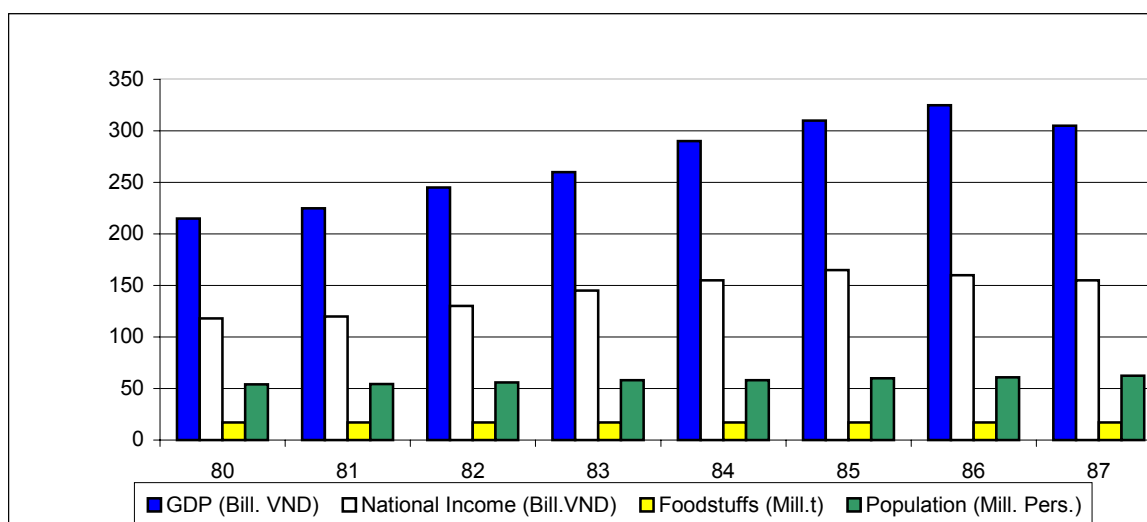
1. Introduction

Vietnam has a population of approximately 76 million (1999). With an area of ca. 330,000 km², the country is comparable with Germany in terms of its population and size.¹ There are however enormous differences between the two regarding their surface distribution and economic levels. Germany's northern and southernmost points lie 800 km apart whereas in Vietnam this distance is ca. 2,000 km, which approximates the distance from Denmark to central Italy (Rome) and involves considerable variation in climate and agricultural productivity. In addition, the traffic network is not highly developed. These are key reasons behind the significant economic differences that continue to exist between the north and south of the country. These differences were further intensified by the division of the country (1954 to 1975) and the differing political and economic systems in North and South Vietnam. Since reunification in 1975, attempts have been made to bridge these gaps. Economically Vietnam is characterised firstly by a dominant agricultural sector - currently still ca. 70% of the workforce and ca. 30% of the gross domestic product (GDP). Secondly, the country has low GDP per capita - in 1998 ca. 320 US dollars (USD) or 1,400 USD in purchasing power parity (PPP). In comparison, in 1998 GDP in Germany was ca. 25,000 USD/capita and agriculture represented less than 3% of GDP and the workforce. Whereas Germany belongs to the leading group of countries with regard to indicators such as GDP/capita and R&D intensity, Vietnam had a rather very low level in both indicators at the end of the 20th century – despite high GDP growth over the last decade.

¹ Germany has a population of ca. 80 million and an area of ca. 356,000 km².

In Vietnam the average annual increase in produced national income was only 0.4% in the period 1976-1980, but 6.4% in the period 1981-1985; In 1986 it rose again by 4.3%, but in 1987 it actually fell below the 1986 level due to a decrease in agricultural production. Agricultural gross production grew at the following average annual rates: 1976–1980 1.9%; 1981-1985 4.9%; 1986 1.4%. In 1987 food production did not reach the level of the previous year owing to adverse weather conditions. In the mid-1980s Vietnam was therefore only able to maintain subsistence levels and local means of accumulation and industrialisation were essentially lacking. When compared with a population growth of 2% per annum, the per capita food production actually declined (cf. Fig. 2.1).

Figure 2.1: Economic Development in Vietnam, 1980–1987



Source: Pham/Dang 1990, p. 232.

Since the late 1980s Vietnam has been engaged in a sweeping programme of economic transition to an internationally open market economy while at the same time retaining its political system. It is hoped that these economic reforms will accelerate industrialisation and boost the standard of living. There are still substantial differences between the economically advantaged south and the politically dominant north on the one hand, as well as between urban and rural populations on the other hand. Thus, for example, the per capita GDP in Ho Chi Minh City (912 USD in 1995; 982 USD in 1996) is not only far higher than the national average of 320 USD (1998), but is also higher than in Hanoi (619 USD in 1994; 695 USD in 1995) (Report 1998). In recent years the experiences gained in South Vietnam with private enterprises and the free market economy are therefore increasingly being acknowledged and evaluated, as are this region's relations with

capitalist countries, in particular through personal contacts ensuing from several earlier waves of migration. Some main features of the changes introduced in the late 1980s will be presented below to elucidate the background to the transformation of the R&D system in the 1990s.

2. Doi Moi Policy since 1986

In December 1986 the Communist Party of Vietnam (CPV) announced the *doi moi* ("renovation") policy of (CPV 1986). Since then Vietnam has consistently dismantled the centrally planned economic system and gradually introduced a market oriented system, whereby, however, the socialist political structure was maintained. The period from 1986 until 1989 was primarily characterised by the preparation for this "rethinking" and conveying the new orientations to all levels of the hierarchical management system so that the most significant reforms did not begin on a full scale until 1989. Reforms aimed at the active promotion of market mechanisms, increasing the efficiency of the administration, restructuring the state-owned enterprises (SOE) and the introduction of various ownership forms. Through this policy of international opening, Vietnam hoped to become a member of GATT and the WTO, and to simultaneously attract foreign investments in the country and eliminate the state monopoly in foreign trade. Investment in the economy was to be concentrated on agriculture, light industry and tourism. In the public sector, investment was to be primarily directed at infrastructure, in particular telecommunications, transport and the electricity supply. The finance system as a whole was also to be reformed.

Vietnam required a new legislative framework for this development strategy. Many new laws were necessary to regulate, for example, private firms, foreign and domestic investments, the role of the SOE, bankruptcy, international technology transfer, the state budget, property ownership, ore, oil and gas exploitation, environmental protection; employment, civil rights, etc. One fundamental problem resulted from the fact that such regulations had to be drawn up and passed parallel to the changes themselves. The legislation is thus in part lagging behind the changes it is to regulate - a problem also found in Eastern European economies in transition. In 1994, following a first period of transformation, a programme for the development of Vietnam's economy until the end of the century was determined (CPV 1994). The main objective of the economic reform was the increase of the per capita GDP to 400 USD by the year 2000. This required an average growth rate of approximately 9 to 10 percent per annum and represented double the 1994 level.

Industrialisation and the modernisation of the economy, in particular of agriculture, forestry and fisheries along with their respective processing industries, as well as the production of consumer and export goods were to be given priority. Enterprises involved in heavy industry were only to be expanded or founded if and when demand for their products was in fact given and other conditions met.

The industrialisation or modernisation of industry were to be intensified in the following areas:

i. Processing industries for agricultural, forestry and fisheries products

- Agriculture, forestry and fisheries were to contribute to swiftly covering domestic needs in conjunction with the (further) establishment of processing industries. This was to simultaneously contribute to the strengthening of export.
- Agriculture was supposed to concentrate on specialised and intensive cultivation, several production cycles, increasing the food yield, increasing the proportion of plants for industrial use and also on livestock breeding. These tasks were to be realised by the utilisation of fertilisers, strengthened pesticides and biotechnology.
- The forestry industry was to maintain the timber stand and forest land and to use it more economically. The fisheries industry was to further improve its fishing technology, breeding and stock management.
- Improved technologies for the treatment of rice after harvesting and for its further processing were to be implemented more intensively.

ii. Consumer and export goods industries

- The production of consumer and export goods was to be increased for both the domestic and the foreign markets by means of new technologies, in particular in the textile, ready-to-wear clothing, paper, medicine, electronic household appliances and handicrafts branches.
- Innovations in facilities and technologies were to improve the quality of these products and guarantee their competitiveness in export markets.

iii. Mechanical engineering, electronics and information technology, construction.

- Mechanical engineering was to be more intensively developed for agriculture, forestry and fisheries along with their respective processing industries, as well as for the mining industry, transport and services.
- Electronics and information technology were to directly contribute to modernisation. The capacity and technology of the construction industry were to be improved, also in order to realise foreign investment projects.

iv. Primary industry

- Those branches of primary industry were first developed that were deemed important for the production of consumer and export goods in agriculture, forestry and fisheries. Priority was given to increasing the production of energy, mineral oil, coal and other raw materials

(chemicals, fertiliser, pesticide, building materials, ferrous- and non-ferrous metals, iron ore, bauxite, rare soils).

v. Tourism and services were to be developed.

vi. Infrastructure and provincial structure

- The minimum infrastructure prerequisites for economic development were to be fulfilled by utilising the capacity of existing power stations, by improving the highways, other traffic networks and communications technology, by safeguarding the water supply and by building several provincial centres with universities for science and technology (S&T).
- Industrialisation was also to make a substantial contribution to the development of the cities and industry in the central provinces and the highlands as well as on the coast and to relieve congestion in the urban centres Ho Chi Minh City and Hanoi.

The development and implementation of the *R&D system* in Vietnam is closely connected with the solution of these fundamental economic problems. S&T must primarily contribute to the realisation of this economic strategy by indicating potential paths of development and by advancing production capacity. They should also, however, serve as instruments for administrative reform and for technological innovations, in particular through the modernisation of traditional branches and the building up of some high-tech branches (electronics, information technology, biotechnology, new materials, renewable energies).

The strengthening of the scientific-technical potential was steered by means of the allocation of funds. A particular emphasis was placed on the closer coordination of R&D facilities, educational institutions and universities with industry. Market mechanism were also carried through to the administration of scientific-technical activities. The organisation of S&T followed the following basic guidelines:

1. The importation of modern technologies is the central element. It is, however, simultaneously to be linked with the qualification of the local workforce, which should not only master these imported technologies, but also improve them. Technologies with high socio-economic effectiveness are to be developed in Vietnam by combining selected components of differing technological levels
2. Priority is given to information technology, biotechnology, technologies for the production of materials.

3. The promotion of applied research is to be prioritised, but a minimum of basic research is to be guaranteed.
4. Two high-tech parks were to be built in Hanoi and Ho Chi Minh City.
5. This strategy was to be implemented by means of research programmes.

The scientific-technological institutions were to be reorganised and the establishment of R&D departments in enterprises to be promoted, also by incorporating existing R&D facilities into enterprises. Certain R&D facilities were themselves to be transformed into enterprises, especially in high-tech fields. The R&D facilities in the higher education sector were to be strengthened and made the focal point of basic research. The reorganisation of the R&D system to conform with the restructuring of the economy was a matter of general concern, as was the transition of the system from a planned to a free market economy. A technology market was supposed to emerge in the country.

The expectations placed on the future development were strongly influenced by Vietnam's striving for high economic growth by continuing to implement reform policies. Vietnam was to remain attractive for foreign capital on the one hand, and, simultaneously, a further aim was to increase domestic savings since investments are the main problem. The investment rate was only 14% of GDP in 1993; it was to be raised to 30% by the year 2000. Due to the low income level and the weak initial situation, the accumulation rate was only 5% of GDP in 1993, a very low rate when compared to the other dynamic economies in Southeast Asia (cf. Tab. 2.1).

Table 2.1: Investment and Accumulation Rates in Selected Asian Countries (1993)

	Investment (% of GDP)	Accumulation (% of GDP)
China	37	36
Hong Kong	30	30
India	24	24
Indonesia	35	38
Korea	34	35
Malaysia	34	38
Philippines	24	15
Singapore	42	48
Taiwan	25	27
Thailand	44	37
Vietnam	14	5

Sources: Vietnam - Special Study, Deutsche Bank Research, Hanoi, October 1994
 Vietnam - Overview and Outlook, Merrill Lynch, Hanoi, July 1994

It was clear that the volume of investment required could not be attained solely through Vietnam's own revenue. To be able to achieve these objectives by the year 2000, the country would need approximately 48 to 50 billion USD. It was calculated that 20 billion could be mobilised from domestic revenue, still leaving 28 to 30 billion dollars that would have to come from abroad. The hope was that this may come in the form of official development aid from other states or international organisations or in the form of foreign direct investment (FDI), supported by measures to increase Vietnam's attractiveness and security for foreign investments.

At the same time, everything was to be done to increase accumulation in Vietnam. Increasing the number of workplaces and wages, stimulating saving and the investment of capital and in particular state accumulation via the budget and revenue from foreign trade were to contribute to this. The export structure was still dominated by mineral oil, rice and marine products. The construction of a refinery was to reduce the export of crude oil and the import of mineral oil products: The proportion of crude oil in total export volume was supposed to decline from ca. 30% in 1994 to 20% by 2000, and in turn, the proportion of manufactured products to rise from 30% to over 40%. With increasing exports it was presumed that there would be an equivalent but even stronger growth in imports since the scale of investments in particular but also consumption would grow rapidly. The widening gap between export and import was not expected to begin gradually reducing again until around the year 2000. Financial policy and the entire financial system were to be tightened in order to keep inflation under control and low under these conditions.

The drawing up and carrying through of the reform policy has in the meantime proven to be a continuous and not entirely consistent process (cf. Overview 2.1).

The first phase of reform, between 1988 and 1990, was characterised by a variety of controversial opinions and heated discussions about a potential democratisation of the country, including the possibility of political pluralism. Similar discussions were taking place in the Soviet Union at this time, under the leadership of Mikhail Gorbachov ("perestroika"), as well as in other socialist countries. These discussions, and in particular the differing views put forward by leaders in the former USSR and China respectively, exerted a very strong influence on debate in Vietnam. The impact of subsequent social changes in the Eastern European countries was keenly observed. The leadership of the Vietnamese Communist Party concluded that liberalisation and democratisation did not necessarily depend on the number of political parties within a country, but were in fact

rather related to the ability to respond flexibly and learn within the Party. The decisive factor was seen to be the processes of rethinking and the real changes occurring in the country.

Overview 2.1: Reform Measures in Vietnam (Chronological Overview)

1986	"Doi Moi" Policy (Renovation Policy)
1987	Law on Foreign Investment
1988	First Steps Toward Agricultural Liberalisation (Land Use)
1989	Reform of the Price System; Devaluation of the Dong (VND); Increased Autonomy for State-Owned Enterprises (SOE); Elimination of Export Subsidies; Changes in the Taxation System
1990	Bank Laws; Laws on Turnover, Profit and Excise Taxes (for SOE)
1991	Free Currency Exchange; Removal of the State Monopoly on Foreign Trade
1992	New Constitution
1993	Law on Land Use Law on Bankruptcy Privatisation of the first State-Owned Enterprises Removal of Import Quotas
1994	Formation of the State Corporations (Conglomerations by Enterprise Mergers)
1995	Laws on Domestic Investments Laws on Civil Rights
1996	Law on the National Budget Law on Cooperatives Law on Foreign Direct Investment (FDI)
1997	Law on Value Added Tax Law on Income Tax Law on Trade
1998	Law on Corporation
1999	Law on Education
2000	Law on Science and Technology

Source: Own compilation based on 'Co so du lieu Luat cua Van phong quoc hoi Viet nam' [Data Bank of Vietnamese Law from Vietnam's National Assembly] 7/2000

In the meantime almost fifteen relatively successful years have passed since the beginning of reforms. Life has markedly improved for Vietnam's 76 million inhabitants thanks to the policy of economic liberalisation. Per capita GDP reached 320 USD in 1998 - 160% of the 1994 figure and will reach about 375 USD in 2000 (in PPP the amount is much higher). Many people are now able to afford more than just very basic necessities. This development is primarily put down to the initiative and political orientation of the Communist Party leadership. It has thus come to be accepted that it is of utmost importance to ensure a continuity in the leadership of the country and in the economic transition to a free market. However, the more free market principles take hold, the more quickly the state can withdraw from economic control. Yet the process of transformation

itself still requires state leadership and, above all, coordination - in particular when social and other factors are taken into account.

This type of transition will, however, always result in particular problems for the workforce, especially middle and junior management, both within the Party and in industry. These leaders are generally reserved and tend to be conservative since they see their present positions and thus their futures as being under threat. Meanwhile, alongside the economic transition to a free market, a reform of the administration is underway, encompassing the transformation of, for example, not only economic institutions but also the ministries themselves.² It is foreseeable that this development will not leave the Communist Party apparatus untouched.

Vietnam's economy developed favourably during the 1990s, with annual growth rates of between 6 and 9%. Thus, it has been possible to both provide the growing population with a better supply of food and to achieve a substantial increase in employment (cf. Tab.s 2.2 and 2.3).

Table 2.2: Economic Development in Vietnam

Year	Population (thousand persons)	Change from Previous Year (%)				
		Economy in total	Agriculture	Industry (incl. Construction)	Export	Import
1991	67,774	5.8	2.2	7.7	-13.2	-15.1
1992	69,405	8.7	6.9	12.8	23.7	8.7
1993	71,205	8.1	3.3	12.6	15.7	54.4
1994	72,510	8.8	3.4	13.4	35.8	48.5
1995	73,962	9.5	4.8	13.6	34.4	40.0
1996	75,355	9.3	4.4	14.5	33.2	36.6
1997	76,715	8.2	4.3	12.6	26.6	4.0
1998	78,059	5.8	3.5	8.3	1.9	-0.8
1999	76,327	4.8	5.2	7.7	23.3	1.1

Sources: Nien giam Thong ke 1999 [Statistical Yearbook] 1999

Tap chi Nghien cuu Kinh te so [Economic Studies] No. 249 2/1999 & 263 4/2000)

Report by Prime Minister Phan Van Khai, Bao Nhan dan [The People's Paper], Hanoi, 9. 1. 1999

² The pilot study documented in this report also gave the Vietnamese scientists involved the opportunity to gain some insight into how the German Federal Ministry of Science, Education, Research and Technology works, and how the German R&D system is organised, in particular regarding the allocation of funds to research programmes in accordance with free market conditions. Such experiences and considerations can be of great value when adapting the administrative level in Vietnam to free market conditions. This must, however, be understood to be a long-term process of learning, whereby changes in the political and administrative leadership are closely linked with changes in the economy, in science and in other areas. There is great interest in studying corresponding experiences gained abroad.

Table 2.3: Employees (thousand persons)

Year	Total (wage-earners & salaried employees)	Material Production	of which		Non- material Production	of which	
			Agriculture*	Industry		Science**	Education
1990	30,286.0	28,320.4	21,889.0	3,392.0	1,965.6	52.5	802.6
1991	30,974.0	28,972.4	22,482.6	3,394.0	2,001.6	48.6	804.3
1992	31,815.2	29,779.1	23,208.3	3,450.0	2,036.1	48.3	825.2
1993	32,718.0	30,624.1	23,898.2	3,521.8	2,093.9	48.1	848.0
1994	33,663.9	31,509.5	24,510.5	3,603.7	2,154.4	49.5	872.6
1995	34,589.6	31,879.4	24,121.7	3,434.6	2,710.1	38.4	973.0
1996	35,791.9	32,936.3	24,775.3	3,500.6	2,855.6	39.2	994.3
1997	36,994.2	34,122.1	25,443.4	3,503.0	2,872.1	40.7	998.8

Source: Nien giam thong ke [Statistical Yearbook] 1995 and 1998

* Agriculture (including Forestry and Fishing)

** since 1995: Scientific Activities and Technology

The industrial and services sectors have both developed particularly swiftly, which has led to the contribution of the agricultural sector to GDP dropping from 40% to ca. 25% since 1990 (cf. Tab. 2.4 and 2.5).

Table 2.4: Growth in GDP per Annum by Sectors (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	2.3	7.7	12.8	12.6	13.4	13.6	14.5	12.6	8.3	7.7
Agriculture	1.0	2.2	6.9	3.3	3.4	4.8	4.4	4.3	3.5	5.2
Services	10.2	7.4	7.6	8.6	9.6	9.8	8.8	7.1	5.1	2.3

Source: Nien giam thong ke [Statistical Yearbook] 1999

Table 2.5: Contribution of the Sectors to GDP (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Industry	22.7	23.9	27.6	28.9	28.9	28.8	29.7	32.1	32.5	34.5
Agriculture	38.7	40.5	33.9	29.9	27.4	27.2	27.8	25.8	25.8	25.4
Services	38.6	35.7	38.8	41.2	43.7	44.1	42.5	42.2	41.7	40.1

Source: Nien giam thong ke [Statistical Yearbook] 1999

Agriculture

Even in the year 2000, agriculture is still the backbone of the Vietnamese economy, representing about 25% of GDP and employing about 65% of the workforce. The production of foodstuffs has risen from 17.5 mill. t in 1987 to 22 mill. t in 1991 and 34 million t in 1999 (cf. Tab. 2.6).

Table 2.6: Development of Foodstuffs and Industrial Production

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Foodstuffs (Mill. t)	22.0	24.2	25.5	26.2	27.6	29.2	30.6	31.8	34.3
(% p.a.)	.	10.0	5.4	2.7	5.3	5.7	4.8	3.9	7.9
Industrial production (Bill.VND)	15,471	18,117	20,412	23,214	26,584	118,097	134,419	151,223	166,965
(% p.a.)	.	17.1	12.7	13.7	14.5	14.2	13.8	12.5	10.4

Sources: Nien giam thong ke [Statistical Yearbook] 1999
 (1991-1994: at constant 1989 prices;
 1995-1999: at constant 1994 prices)

The most important changes in agriculture occurred in 1988. Since then farmers have been permitted to lease land for a period of 15 years. In 1993 the maximum lease period was extended to 50 years. As part of the price reform, the system of prescribed fixed prices in agriculture was completely eliminated in 1989. As a result of these changes the farmers' production capacity has been liberated. Collectives now play only a minor role in the agricultural sector, limited for the most part to the supply of technical resources and as administrative bodies. Evidence of the success of reforms cannot only be seen in the fact that Vietnam is now able to cover its own basic needs, which was still not the case in 1986, but also in the fact that in 1994 Vietnam was the third largest rice exporter in the world, with 2.0 mill. tonnes, following Thailand (5.0 mill. t) and USA (2.7 mill. t). Vietnam advanced to being the second largest rice exporter following Thailand in 1997 (3.5 mill. t)/1998 (3.8 mill. t).

State-owned and private enterprises

In 1989 the SOE were made largely autonomous. Fixed prices and subsidies were abolished. Since then the SOE have been forced to operate with their own funds and their own revenue, with no compensation for losses, as had been usual in the past. Private enterprises were permitted alongside the SOE, with various legal forms. As a consequence, of the ca. 12,000 SOE in existence in 1990, only ca. 6,500 remained in 1992 (cf. Tab. 2.7); The objective was to further reduce this number to around 3,000 by the year 2000. The number of industrial SOE dropped from 1,958 in 1995 to 1,821 in 1998. Of these, 575 were central and 1,246 were local SOE (Statistical Yearbook 1999: 156-160). A special part of the enterprise reform programme involves privatisation through the sale of shares by the government. This began in June 1992. Seven SOE were to be converted into joint-stock companies. So far this 'experiment' has only even been

begun in three of these enterprises. 'Legmex', a textile and shoe manufacturer, is the only one to have been fully transformed into a joint-stock company so far. It has capital of 13.1 million USD. The company floated 100,000 shares; any individual shareholder was permitted to purchase up to 10,000. By July 1993 all shares had been sold. Following this first attempt, between 1992 and 1997 only 18 SOE were privatised, but then by the end of 1998 a total of 120 had been privatised. It was decided to privatise a further 450 SOE in the course of 1999.

Table 2.7: State-Owned Enterprises in Industry and Agriculture (1992)

Industrial Branch	Number of SOE	Capital (billion VND)	Turnover (billion VND)	Employees (1,000 persons)	Average Wage (1,000 VND/mo.)
Total	6,544	44,964	108,372	1,822	243
Industry in total	2,271	21,818	28,952	743	267
Mechanical engineering	282	965	1,188	71	202
Electrical/electronics industry	104	426	1,020	20	282
Chemistry incl. fertiliser and rubber	183	1,048	3,193	54	315
Agriculture	661	3,763	2,162	273	144

Source: Nien giam thong ke [Statistical Yearbook] 1993

In some cases the hesitation in privatising the enterprises was largely due to management and employees. They were unconvinced of the future prospects of potential companies since, for example, the staff were supposed be potential buyers. In other cases it was not possible to calculate the real value of the business capital.

From the mid 1990s onwards, SOE working in a similar technological field were grouped together to so-called corporations. To ensure that they could develop independently and effectively compete in the free market, they were no longer directly subordinated to a particular ministry. Instead, a supervisory board was appointed in each, with its members selected by the government. The ministries were no longer permitted to directly intervene in the enterprises' day-to-day affairs. Their role was now rather to establish the basic conditions for enterprise activities by drawing up legislative and other regulations. Parallel to the economic changes, some of the relatively numerous branch ministries were merged and thus the state administration and its apparatus downsized.

Adjustments were also made in the way in which business was conducted. Until 1989 the state provided the economic units with capital - in the form of contributions, not as a loan. For their part, these economic units passed all income on to the state. In 1990 subsidies for the SOE were removed in all economic sectors and instead of passing all income on, the enterprises' profits and turnover were taxed. One consequence of this was the reduction in the number of personnel in the state enterprise sector, primarily to curb costs. At the same time, in 1992 in the interests of consolidating the budget, the State Bank ceased its inflationary practise of printing money to balance the budget. The state deficit can now only be covered through the sale of government promissory notes or treasury bonds.

Foreign trade

Foreign trade was formerly a state monopoly. Export and import prices were laid down by the state and the export price thereby subsidised in order to be internationally competitive. As early as 1986 reform of this area began and by 1990 export quotas were only fixed for 12 products, export subsidies had been eliminated and export licences had been awarded to many firms. All enterprises have been permitted to directly negotiate with foreign partners since 1991.

Following the collapse of the Soviet Union and the changes occurring in Eastern Europe, in 1991 foreign trade with the former CMEA countries was largely interrupted. Vietnam, however, quickly reoriented its trade and found new partners. With the introduction of a targeted exchange rate mechanism for the Vietnamese Dong (VND), the magnitude and competitiveness of Vietnamese exports has continually risen. The foreign trade structure has changed substantially. Until 1988 there was effectively no mineral oil production and no rice export; today mineral oil and rice comprise half of the total export volume. Next largest share in exports are seafood and light manufacturing products. At the same time, trade volume with the ASEAN nations has risen from 60 to 70% and with the EU from 15% to 20% of total foreign trade. Apart from oil, most exports go to Singapore, followed by Hong Kong and then France. Export to Europe only represents about 10% of total export volume. Approximately 50% of exports go to industrialised countries.

In 1994 the export volume was already three times higher than it had been in 1989 and in the following years it reached growth rates of over 30% (cf. Tab. 2.2). The sharp rise in imports until 1997 was largely a consequence of the high levels of foreign investments and the fact that the

government invested large sums in upgrading public infrastructure (transport, education and health care), loosened import quotas and lowered import restrictions. Due to the financial crisis, export to the ASEAN countries fell by 26% in 1998 in comparison with 1997. That year price reductions led to an export loss of ca. 1 billion USD (the oil sector alone lost 460 mill. USD) and total export growth amounted to only 1.9%. Ready-made clothing was the main export commodity, followed by rice and oil. Imports even declined by approximately 1%. Imports are still regulated by law. According to the import duty law of 1992, imported goods, in particular those that could be produced domestically or that are deemed luxury goods, are heavily taxed. For certain products (cigarettes, alcohol, cars) the duty can be as high as 200%; for raw materials and machines on the other hand it can be as low as zero or one percent.

To encourage foreign investments in Vietnam, a total of 1,193 licences for direct investments had been issued by the end of 1994, with a value of 11,693 million USD. The manufacturing industry, hotels and tourism as well as the exploitation of mineral resources are the three preferred areas of investment for foreigners. Due to the low labour costs, investments in the manufacturing are generally concentrated in the export-oriented branches (foodstuffs, clothing and textiles). In the period from 1988 to the end of 1994 most investors were from countries in the Asian-Pacific region. Leading positions were held by Hong Kong (217 approved projects with a total of 1.65 billion USD), Taiwan (182 projects, 1.931 billion USD) and Singapore (80 projects, 1.084 billion USD). As a consequence of the financial crisis in Asia, FDI has declined substantially (cf. Tab. 2.8).

Table 2.8: Foreign Investment

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Number of Projects	151	197	269	343	370	325	345	275	312
Financial Resources (Mill. USD approved*)	1,322.2	2,165	2,900	3,765.6	6,530.8	8,497.3	4,649.1	3,897	1,568.3

* Realisation considerably lower

Source: Nien giam thong ke [Statistical Yearbook] 1999

The funds actually realised by FDI amounted to 2.3 billion USD in 1996, 2.84 billion in 1997 and 1.7 billion in 1998. The approved FDI funds amounted to 3.9 billion USD in 1998, representing a drop of ca. 16% in comparison with 1997. According to calculations made by the Ministry of Planning and Investment (MPI), between January 1st 1988 and December 31st 1998 (11 years) a total of 34 billion USD were approved for 2,069 FDI projects in Vietnam. Singapore was the top

foreign investor (6.5 billion USD), followed by Taiwan (4.5 billion USD), Japan (3.2 billion USD) and South Korea (2.75 billion USD) (cf. Ch. 3).

Inflation/finance system

Until 1988 the Vietnamese State Bank functioned as both bank of issue and a commercial bank. In 1990 two laws were passed, one regarding the State Bank (bank of issue) and another regarding transaction banks, cooperative banks and financing companies. This transformed the banking system into a market-oriented dual system. In the meantime further changes have been made both to the legislative regulations and the training of qualified personnel. In 1995 a first, relatively primitive share market was opened, in July 2000 the international stock exchange.

Inflation was and continues to be a significant problem. The prices on the free market used to be far higher than the official fixed prices. Since 1986 the official prices were therefore slowly raised and in 1989 had been brought to the level of the black market prices. This occurred simultaneously with the dismantling of the subsidy scheme, which had been in place until this time in the form of food ration cards as well as coupons for other goods and had had two price systems (official and free market).

In association with this dual market and price system, until 1989 the exchange rate of the Vietnamese dong (VND) was strictly controlled by the state. The overvaluation of the local currency hindered Vietnam's international export competitiveness. To deal with this problem the state devalued the dong. Thus, the exchange rate fell from 4,300 VND to a USD in 1989 to 10,800 VND/USD in September 1991. Until 1995 the rate remained virtually constant at 11,050 dong per dollar. It dropped to ca. 14,000 VND per USD in 1998 as an effect of the financial crisis. To stabilise the exchange rate the State Bank intervenes by buying and selling both currencies. In an attempt to curb inflation, interest rates for bank deposits in VND have been raised since 1992 and the uncontrolled printing of bank notes for the benefit of the state budget halted. The inflation rate was thus decreased from 67.5% in 1991 to 5.2% in 1993 (cf. Tab. 2.9).

Table 2.9: Gross Domestic Product (GDP) and Inflation

Year	1991	1992	1993	1994	1995	1996	1997	1998
GDP Growth in %	6.0	8.6	8.1	8.8	9.5	9.6	9.8	6.2
Inflation in %	67.5	17.25	5.2	14.4	12.7	4.5	3.6	9.2

Sources: Diem tin kinh te [Economic Overview] No. 193, 24.1.1998
 Bao Nhan dan [The People's Paper], Hanoi, 19.12.1998, p.2

In 1994 inflation had risen to 14.4% again in the aftermath of the heavy losses suffered in the rice crop due to flooding in several provinces in South Vietnam's Mekong Delta (foodstuffs make up about 50% in the price index). After decreasing to 3.6% in 1997, the financial crisis led to a renewed rise in inflation with 9.2% in 1998. These fluctuations reveal the extreme vulnerability of Vietnam's economic development, not least due to the continuing dependence on agriculture and natural phenomena.

Agriculture continues to play a crucial role in Vietnam's future development. Production should above all be strengthened by extending the amount of cultivable land and increasing yields. Yield in turn depends on scientific-technical advances, i.e. on the introduction of new breeds and varieties with higher productivity, on the realisation of several crops per year and on new cultivation methods. The state supports agriculture by ensuring reasonable prices for fertiliser and pesticides. Lending policy and infrastructure should also be improved in the interests of agricultural production. An effective irrigation and drainage system is lacking in Vietnam, as are storage and processing capacities for agricultural output. This leads to post-harvest losses being very high, in the case of rice, for example, they amount to between 15 and 20% of the crop. In the long term the still dominant orientation towards rice needs to be supplemented and overcome by crop diversification, in particular with coffee, rubber, cashew nuts, cane sugar and other plants, which should replace some rice crops.

Industry is still only weakly developed. This sector's share in GDP amounts now to ca. 35% (including mineral oil and energy production). The introduction of reforms in industry turned out to be considerably more difficult than was the case in agriculture. The centrally planned heavy industry had virtually no funds for acquiring new technologies and materials. In contrast light industry had fewer difficulties, in particular the textile industry and the processing of agricultural output developed well during the reforms. The development in Vietnam was advantageous for the advancement of mineral oil production, which began in 1992. So far, however, all oil must be exported since the country has no refinery of its own. The export of crude oil did enable investments to be made in heavy industry though, so that good rates of growth were achieved, resulting in the dynamic development of this sector alongside light industry.

Apart from extending capacity and boosting production, making the enterprises more economical also plays an increasing role as a reform goal and basic prerequisite for sustainable economic development. This has, however, continued to be a serious problem. As of yet no suitable forms

for privatisation have been found. Without a developed share market, privatisation via the sale of interim certificates is hardly possible. A further problem lies in the fact that neither business economics nor even accounting systems have yet been standardised in line with international guidelines. The Value Added Tax (VAT) Law was only introduced uniformly throughout the entire country in 1998. Therein lies an important prerequisite for controlling the efficiency and improving the administration and financial control of the SOE. There is also resistance on the part of employees in the SOE and on the local level of the Party and administration; 30% of these enterprises are currently producing with virtually no profit, so that a complete switch to cost-effectiveness brings with it the threat of layoffs and wage reductions or even bankruptcy. This must be considered in the light of the fact that unemployment has become an immense problem in Vietnam since 1995. Even then 2 million of the total 34 million strong workforce had no job and at least a further 5 million had only part-time employment. About 1.2 million young people join the labour market each year, of whom at best 50% can be integrated into the paid workforce. Unemployment has also increased as a result of so many SOE being closed down, merged or privatised, the army being downsized and the agricultural cooperatives in North Vietnam being restructured and in some cases dismantled.

The uniform enforcement of laws also poses a significant problem. There is still no uniform enforcement agency. This results in the same laws sometimes being applied differently in the various provinces³, in no small part also due to the lack of adequately trained and qualified personnel. The situation is similar with regard to the issuing of import licences. Although import quotas have not existed for several years now, the procedure to acquire an import licence or permit is still very protracted, unclear and unpredictable. Further problems lie in the non-uniform tax rates in the various provinces, which has contributed to the reestablishment of a black market, smuggling and also corruption within the administration. This is simultaneously part of the infrastructure problems that block economic development, at least in some provinces. It must also be considered here that the real influx of investment funds from abroad has remained small. Thus, while import licences had been issued for a total value of 10 billion USD by the start of 1995, only about 1.5 rather than the envisaged 3.5 billion USD were actually invested. The influx of

³ Provinces are administrative regions in Vietnam.

foreign capital is also hindered by the outlined problems with legislation, its enforcement and the complicated administrative procedures.

3. Science and Technology in Vietnam

Although education and culture play a key role in Vietnam's long historic traditions, the country's science potential has most significantly been influenced by the long periods of war during and after the Second World War.

Following French colonial rule (1858-1954) the research system in Vietnam consisted of several Pasteur Institutes, the Institute for Orient Research, the Institute for Marine Research and a few tertiary institutions (for medicine, agriculture, education and art, natural sciences and technology). These facilities were, however, not designed to serve Vietnam alone, but were rather conceived as being for Indochina as a whole. In terms of research, the main focus was on basic research.

During the war of liberation from France (1945-1954) the first academic cadre was trained abroad (1950 in China and the Soviet Union) as well as within Vietnam. There were three universities in the country (for medicine, the natural sciences and education); two research institutes were established (for social sciences and weapons technology). The years between 1954, when peace had been re-established in North Vietnam, and 1965 were a tremendous period of development for research facilities in the country. On a political level it had been assumed that with the help of S&T output, hunger and poverty would be eliminated within a short period of time and the economy could be rebuilt quickly. The Vietnamese government passed various resolutions and directives with the objective of initiating a science revolution in the country.

But in particular during the war from 1965 to 1975, almost all R&D facilities were destroyed and a large proportion of the cadre of highly trained scientists were killed. The resulting disproportions were not smoothed out in the following years; in part they were actually further intensified due to the unbalanced processes. Thus the S&T potential was relatively quickly extended in comparison with the economic basis: Between 1975 and 1982, for example, the produced annual national income grew by 4.6%, while the number of R&D employees jumped by 14% and the cadre of university graduates rose by as much as 17%.

In 1975 there were approximately 12,000 scientists and other R&D employees, including ca. 5,000 graduates and 500 PhDs; in 1985 Vietnam already had a potential of 37.5 thousand

scientists (university or polytechnic graduates) for R&D. With 625 scientists per million inhabitants, this represents about four times the average for all developing countries at this time. Eighteen thousand scientists were employed in tertiary institutions, fifteen thousand in branch R&D facilities, 2.8 thousand in national research centres and 1.7 thousand in Committee for Social Sciences institutes.

In 1987 there were 234 S&T facilities outside tertiary institutions, including 165 (or 71%) R&D facilities. They were generally subordinate to specific ministries and were highly fragmented. Only 23 facilities were linked to light industry or food processing enterprises. There were 142 tertiary institutions covering all subject areas: six universities, 24 technical universities, 18 Schools of Fine Arts, 30 universities for medicine and pharmacy, sport and gymnastics, seven universities for economics, eight teacher's institutes and 40 teacher's colleges. The remaining universities and polytechnics fell under the responsibility of the Ministry of Internal Affairs and Defence. Within the higher education sector there were 19 special R&D facilities in 1985 and ca. 40 in 1989. The 18,614 professors and lecturers (including 1,780 PhDs) spent (nominally) approximately one third of their time on R&D activities.

The system of scientific documentation and information also developed very rapidly. In 1986 it encompassed a total of 244 facilities with 2,000 employees, including 1,500 graduates. Up to 1.9% of all S&T expenditure was employed here. Approximately 300 different scientific periodicals as well as internal S&T papers were published.

Most S&T facilities were located in the capital city Hanoi (181 or 77%) and in Ho Chi Minh City (27 or 11.5%). The remaining 26 (11%) were located in various regions, whereby the highlands of Tay Nguyen in Central Vietnam formed a third central area.

Dominant in terms of Vietnam's S&T potential was the workforce. The basis for this was the rapidly growing number of highly trained university and polytechnic graduates in the country: In 1975 there were 461,800, in 1980 774,400 and in 1982 911,300. Their structure according to their fields of training and employment is presented in Table 2.10.

Table 2.10: Structure/Distribution of the S&T Cadre (University and Polytechnic Graduates) according to Fields of Training and Employment (1982)

	Proportion of the Cadre according to Field of Training (%)	Proportion of the Cadre according to Field of Employment (%)

<u>Total:</u>	<u>100</u>	<u>100</u>
of which		
- Natural Sciences	39	10
- Industry, Transport, Construction, Postal Services and Telecommunications	25	40
- Health care	6	12
- Agriculture, Forestry and Fisheries	11	25
- Social Sciences	16	11
- Other Branches	3	2

Source: Pham/Dang 1990. p.237

Of this total potential of highly qualified graduates, 33.5 thousand were employed in the 234 S&T facilities in 1987. They had the following qualification structure:

	Persons	%
Dr. sc. (Postdoctoral Qual.)	107	0.3
Dr. (PhD)	1,485	4.5
University Graduates	14,850	44.5
Polytechnic Graduates	17,058	50.9

If one then adds to the first three groups (those with at least a university degree) the R&D time allocation of the 18.6 thousand professors and lecturers (ca. 1/3), then one comes up with the R&D employment of a cadre of ca. 22,600 highly trained scientists (in full time equivalents – FTE).

In 1985 there were over 4,900 PhDs in Vietnam, on 31/12/1988 there were already 6,417 (cf. Tab. 2.11).

Table 2.11: Number of Doctorates (PhD by Disciplines)

Scientific Field	1985 %	1988	
		%	Persons
Natural Sciences	35.3	34.9	2,235
Technical Sciences	33.6	31.9	2,048
Medical Sciences	5.8	6.1	392
Agricultural Sciences	6.6	6.5	419
Social Sciences	18.7	20.6	1,323
% Total (Pers.)	100 (4,900)	100	6,417

Source: Ủy ban Khoa học và Kỹ thuật Nhà nước [State Committee for Science and Technology], Hanoi, 1989

International cooperation played a significant role in the development of S&T potential, in particular regarding the qualification of a cadre of highly trained scientists and literature and equipment orders. Alone in the period between 1981 and 1985 5,000 Vietnamese specialists from

51 ministries and provinces were sent abroad for research, internships or the exchange of experiences (sojourns averaging 5.5 months per person). The specialists were in 18 countries; approximately 4,500 in socialist and 500 in capitalist countries. Given the conditions in the country, many scientists could not be employed in accordance with their training, and they had no possibility to further their qualification - their knowledge is therefore often no longer adequate for today's demands. The situation was further aggravated and productivity diminished by the inadequate financial and material-technical resources available to this cadre of scientists.

Expenditure on S&T increased during the 1970s and 1980s both in absolute terms and in relation to the national income (cf. Tab. 2.12).

Table 2.12: Expenditure on S&T

Year	Million VND	In Relation to National Income (%)
1965	23 ^x	0.5
1970	32 ^x	0.7
1975	69	0.5
1980	114	0.4
1981	215	0.4
1982	488	0.4
1983	582	0.5
1984	850	0.5
1985	1,150	0.7
1986	800	0.5
1987	2,400	0.7

^x Figures only for North Vietnam

Source: Pham/Dang 1990, p. 228 and Ta, 5/1998 (NISTPASS, Research-Project)

The majority of expenditure on S&T, namely 85%, came from the state budget in 1982. Other sources were profits from enterprises and R&D facilities, loans, economic contracts with foreign firms and aid from international organisations. During the period from 1986 to 1990 it was intended that the state budget cover only 70% of S&T expenditure and the remaining 30% come from other sources - however the share provided by the state budget remained around 80%.

In relation to the above-mentioned dynamics of R&D employment, the available financial resources were simply too meagre. R&D investments in particular only covered 50 to 60% of requirements and amounted to a mere 0.5-0.7% of total investment in the economy. Almost all research equipment was and is imported. Approximately 1% of the annual total import currency sum is used to supply scientists with research equipment and materials, whereby 3/4 was funded through foreign aid. Despite this the level of equipment was and is inadequate. In addition, most

equipment in stock is incomplete and 95% is outdated. Even the modern research equipment that was brought in from socialist and capitalist countries as well as with the assistance of the UN development programme (UNDP) could not be fully utilised: Apart from other reasons, such as lack of electricity or poor water supply, there was a lack of much material well as replacement parts. The support provided free of charge by capitalist countries and by international organisations in the context of S&T cooperation amounted to ca. 10 million USD between 1981 and 1985 (France alone provided 5 million USD). Of this sum, about 890,000 USD was used for the import of equipment and materials. Vietnam also received a relatively large amount (ca. 80 million USD) from UN programmes between 1982 and 1986, including 70 million USD just for 30 R&D facilities.

Aside from research equipment, the provision of other prerequisites for S&T development, e.g. seeds and plants for breeding as well as literature, also play a significant role in Vietnam's S&T potential.

Before 1985 management of the Vietnamese economy and S&T was typically characterised by centralisation of command. All R&D institutes were operated along the lines of the model that prevailed in the former Soviet Union. They were owned and funded by the state, organised and managed as departmental organisations, and specialised according to research fields and industrial branches. Research was very neglected in the higher education sector. S&T activities were planned by a centralised, bureaucratic and subsidiary mechanism using the well-known model of planning in a "two-down and one-up" process between ministries and R&D institutes (corresponding to the economic planning process adhered to in Vietnam at that time). The ministries also allocated the funds for each project, appropriated the results and decided on their application in production units and fields. The strategies for S&T activities in Vietnam were not clear. They were dominated by large-scale S&T profiles and lacked clearly set priorities.

The state budget covered the complete costs of all R&D activities in the country, even industrial R&D. The total budget for S&T activities was very limited and it relied mostly on foreign sources which were included in the state budget. The Ministry of Finance (MOF), in consultation with the Ministry of Science, Technology and Environment (MOSTE), determined the allocation of resources for each ministry, which then made further allocations in the form of institutional funding. The R&D institutes could not earn money from other sources. As a consequence their behaviour was guided by the desire to create good relationships with higher-level management bodies; they

complied with their orders in the hope of gaining all-round assistance from them. The R&D institutes' activities included neither marketing nor technological innovation and transfer.

Personnel in R&D institutes had permanent contracts, resulting in an almost complete lack of fluctuation. The salaries, bonuses and hazardous substances allowances provided for S&T workers were the same as for other administrative agencies. This system of employment encouraged S&T employees to live "mandarin" style. It had no economic levers or incentive systems to encourage personnel to engage in practically oriented S&T activities. On the other hand, industrial enterprises received no incentives or pressure to engage in innovation and R&D.

S&T Policy and R&D Organisation

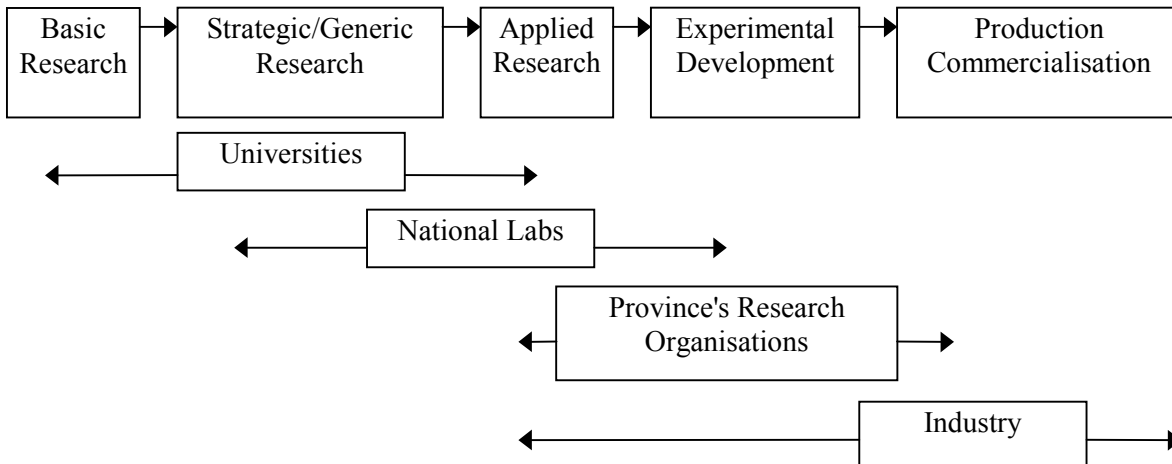
Since the early 1980s, S&T policy has gradually been moving away from a centrally planned system, with changes taking place mostly through the reform of the structure and functions of R&D institutes, but also in planning, financing and employment schemes.

The change in behaviour regarding R&D activities began in effect in 1981: R&D institutes were then allowed to establish horizontal relations with enterprises and other R&D institutes in the form of business contracts and were permitted to earn a small amount of money as profit for their activities. R&D contracts are, however, based on the assumption, that the assigned tasks are actually accomplished and end up with applicable results. This policy was supposed to make the R&D institutes more flexible and involve them directly in production activity. Additionally, in 1983 it became possible to extend the functions of R&D institutes to test production, manufacture of individual products, small series production and S&T services applying the R&D outputs that had not been previously applied by any production unit. In this case, they could sell products and services and make money for themselves. Besides permitting these R&D contracts, the government attempted to transform some R&D institutes that were very closely linked to production and subordinated to branch ministries into state enterprises in order to strengthen those R&D activities that served the needs of enterprises. Since 1987 the government has increasingly liberalised R&D activities: R&D institutes are now also allowed to enter relationships in the form of joint ventures with foreign institutions and some research institutes have already done so; individual scientists can now sign R&D contracts with enterprises and others.

Reforms in the field of S&T organisation began with the development and implementation of a new model for the organisation of R&D activities based on the experiences of developed countries with

the "linear model of innovation". The Vietnamese basic model included a new system of combining S&T activities and organisations (cf. Fig. 2.2).

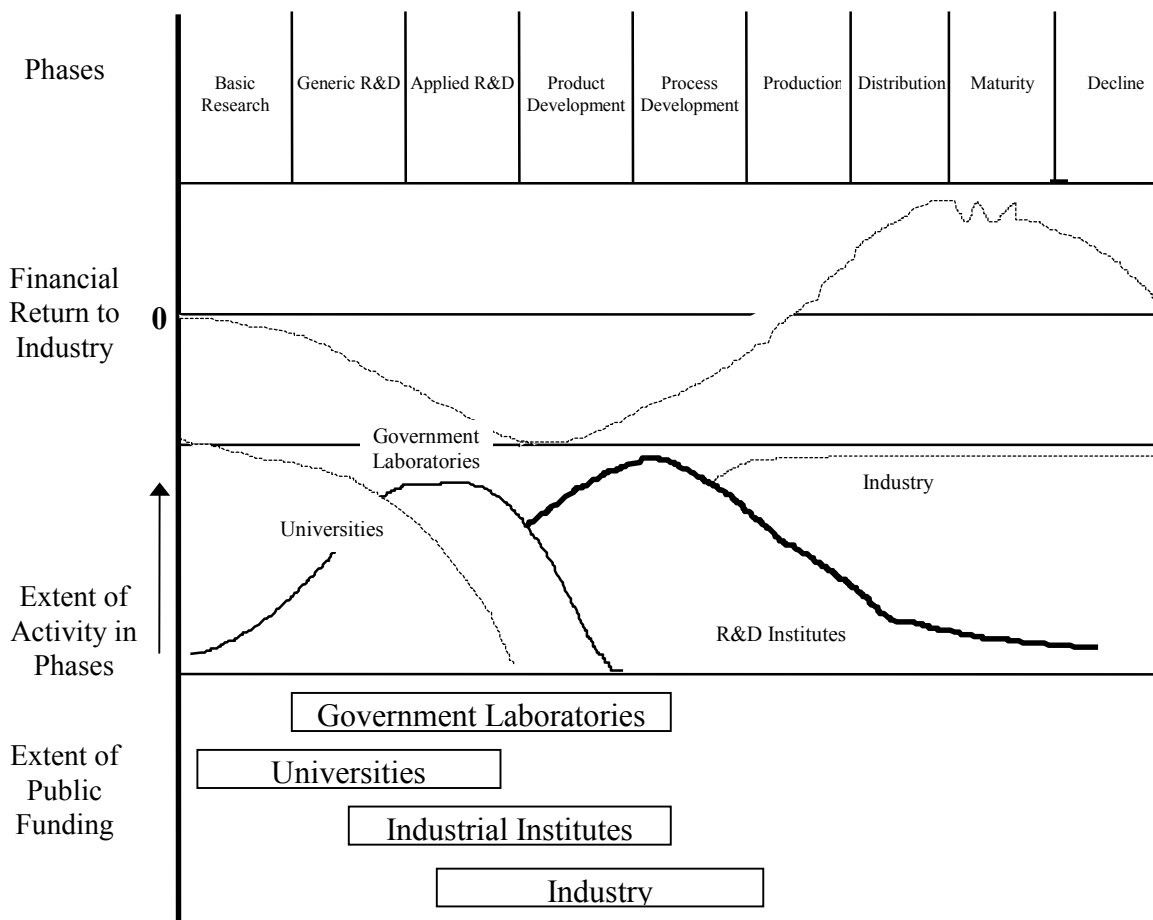
Figure 2.2: Range of S&T Activities by Sectors



Understanding the innovation chain with its R&D activities and organisations of different characteristic types was a very important prerequisite for the restructuring of the R&D system, which involved allocating special R&D activities to (suitable) organisations with appropriate funding. The roles of government, the public, the market and industry had to be precisely identified and accepted by all actors in society. The next important task was that of reorganising the S&T system (STS) by rearranging the structure and function of organisations involved in R&D along with matters of financial resources, their sources and allocation.

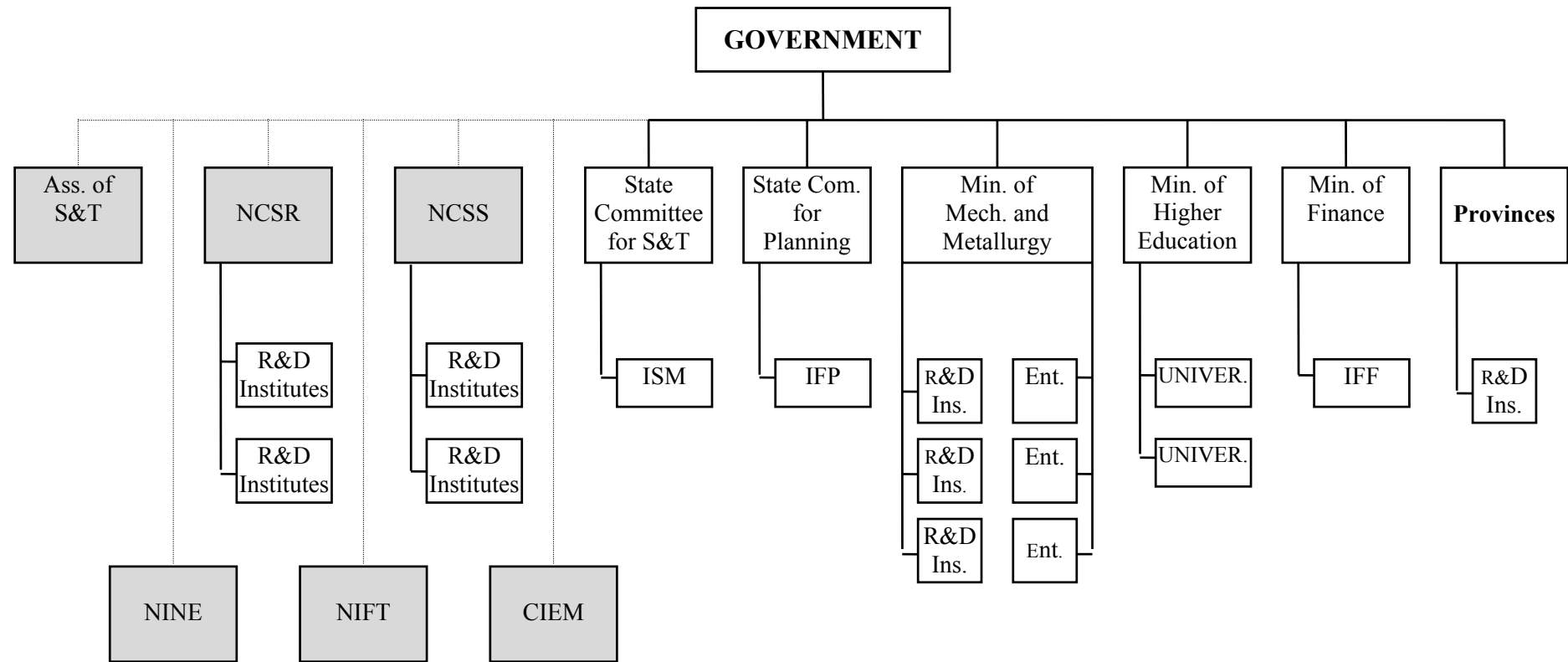
The extent of public funding, the participants in the various R&D phases, the financial return to industry and the innovation chain can be described as follows (Fig. 2.3).

Figure 2.3: The Innovation Chain: Participants and Public Funding



The real restructuring of the R&D system followed these principles: More proximity to production and commercialisation; more interaction between R&D, education and production; more concentration of the activities of R&D institutes on applied R&D. The organisation of the R&D system was reformed according to these principles. After the first phase of restructuring, in 1986 the landscape of the R&D system was as follows: The five big national research centres or institutes (for natural sciences: NCSR; social sciences: NCSS; technology: NIFT; nuclear energy: NINE; economic management: CIEM) were subordinated to government; a lot of key R&D institutes still belonged to branch ministries; special branch R&D institutes were transferred to enterprises; new R&D institutes were created in the provinces or within universities (see Fig. 2.4). There were also changes in funding. Institutional funding was partly replaced by the principle of self-financing facilities. Neither the personnel levels nor the salary levels remained as fixed quantities. In 1989 the principle of contract research was also permitted for ministries. They could sign contracts with R&D institutes in order to fulfil state research programmes/projects and the price could be also negotiated.

Figure 2.4: Vietnam's R&D System in 1986



The number of research facilities then grew - from 170 in 1985, to 264 in 1990 and 334 in 1995. In 1990 there were only 58 research facilities in tertiary institutions, by 1995 this number had increased to 82. However, 80% of R&D facilities were concentrated in Hanoi, which is economically unpropitious. On the path to democratisation and privatisation, 50 R&D facilities were already privately owned by the end of 1993 and 30 were located within the industrial sector. The number of these facilities has increased further in the meanwhile. In 1995 there were 102 *tertiary institutions* with various subject areas in Vietnam (cf. Tab. 2.13) and with approximately 20,000 professors and lecturers. They taught 273 subject areas and 2,024 subjects and were directly involved in R&D in 82 university R&D facilities. There are 10,000 graduates each year and 26 students per 10,000 residents. In 1994 two national universities were established from several smaller polytechnics in Hanoi and Ho Chi Minh City. Provincial universities were also established in a similar manner in Hue, Da Nang and Thai Nguyen.

Table 2.13: Number of Tertiary Institutions by Subject Areas (1995)

Tertiary Institutions in the Field	Number	Percent
Natural Sciences and Engineering	11	10.7
Industry	13	12.7
Agriculture	8	7.9
Economics and Finances	8	7.9
Education	44	43.1
Health and Sport	10	9.8
Culture and Art	8	7.9
Total	102	100.0

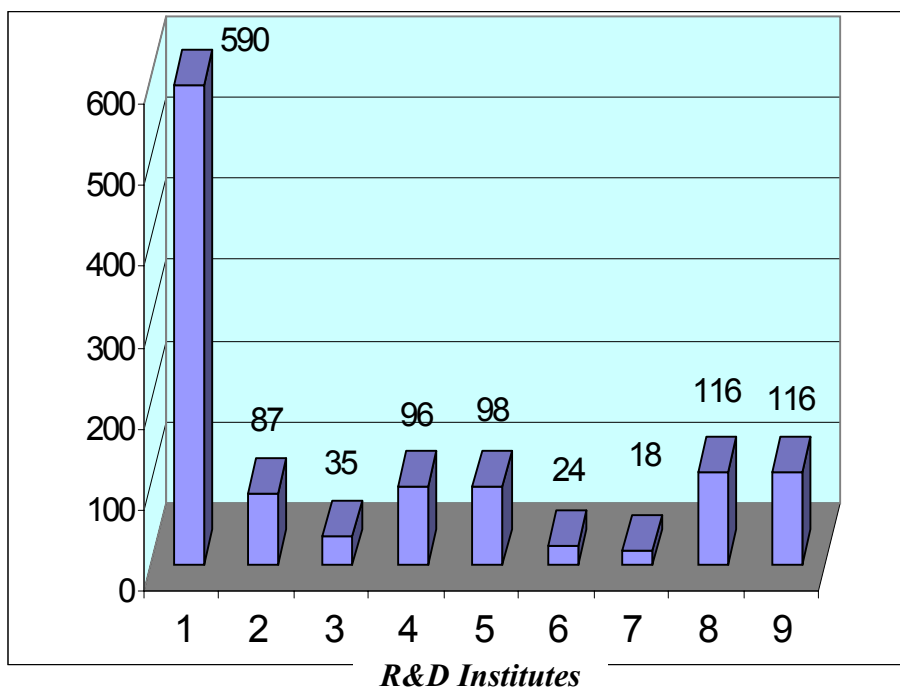
Source: MOSTE: 50 nam hoat dong Khoa hoc va Cong nghe Vietnam [50 Years of Science and Technology in Vietnam (1945-1995)], Hanoi, 1995

To continue the restructuring of the R&D system, in 1992 the government allowed economic units under all forms of ownership to set up R&D institutes. Basic research was to be transferred to the universities, which had previously done only teaching. The new R&D institutes in the universities were to cover basic research and were also able to carry out applied R&D. Generally, their R&D was to be more closely linked to production as well as to education. The two national centres for natural and for social sciences were to be restructured, the number of their R&D institutes radically reduced and concentrated mainly on applied research, which had been deemed a priority. R&D institutes subordinated to ministries were to be reduced to a number of key R&D institutes and the others transferred to enterprises. The existing universities or R&D institutes in rural areas could take

over the role of provincial R&D institutes. Enterprises took on R&D institutes or could set up new ones for their purposes.

In 1993 these measures reduced the number of R&D institutes in each of the two national centres (for natural sciences and technology: NCNST with 17 research institutes and for social sciences: NCSSH with 16 institutes). In 1996 the government decided to retain 41 branch R&D institutes subordinated to the branch ministries, while six were transferred to enterprises (or conglomerates) and the others were set to be transferred to self-reliant R&D institutes or to enterprises. So the R&D institutes have new affiliations (Fig. 2.5), the R&D system in Vietnam has a new landscape (Fig. 2.6), and NCNST has a new structure with 17 research institutes encompassing 16 self-reliant units, 9 laboratories and 15 enterprises (Fig. 2.7).

Figure 2.5: Affiliation of R&D Institutes in 1996



1. Total (number of inst.)

2. University

3. Enterprise

4. Association*

5. Ministry

6. NCSSH

7. NCNST

8. Large R&D Institutes

9. Provinces**

* An association of R&D institutions working in the same general research area and financed via contracts/projects.

** These institutes are subordinated to provincial authorities.

Source: Van phong Dang ky hoat dong Khoa hoc Cong nghe [Office for the Registration of S&T Activities], MOSTE, Hanoi 1996

Figure 2.6: Vietnam's R&D System in 1996

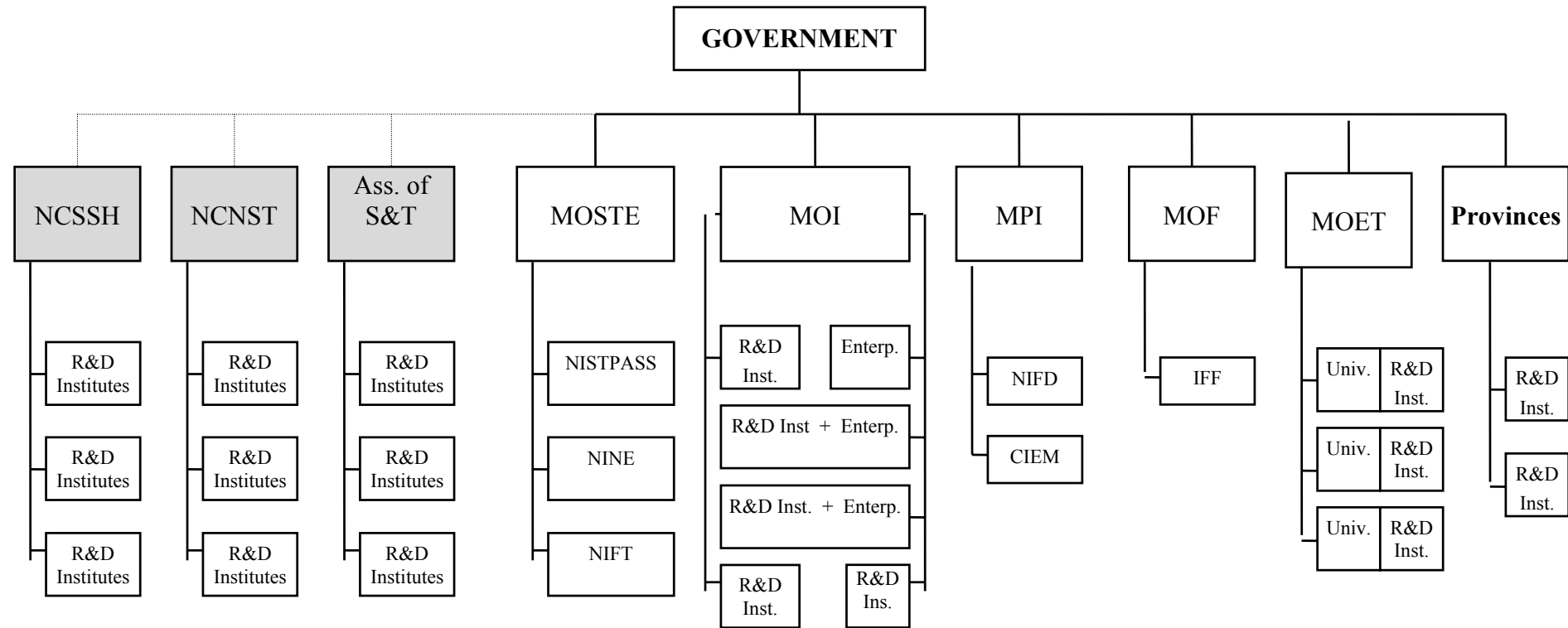
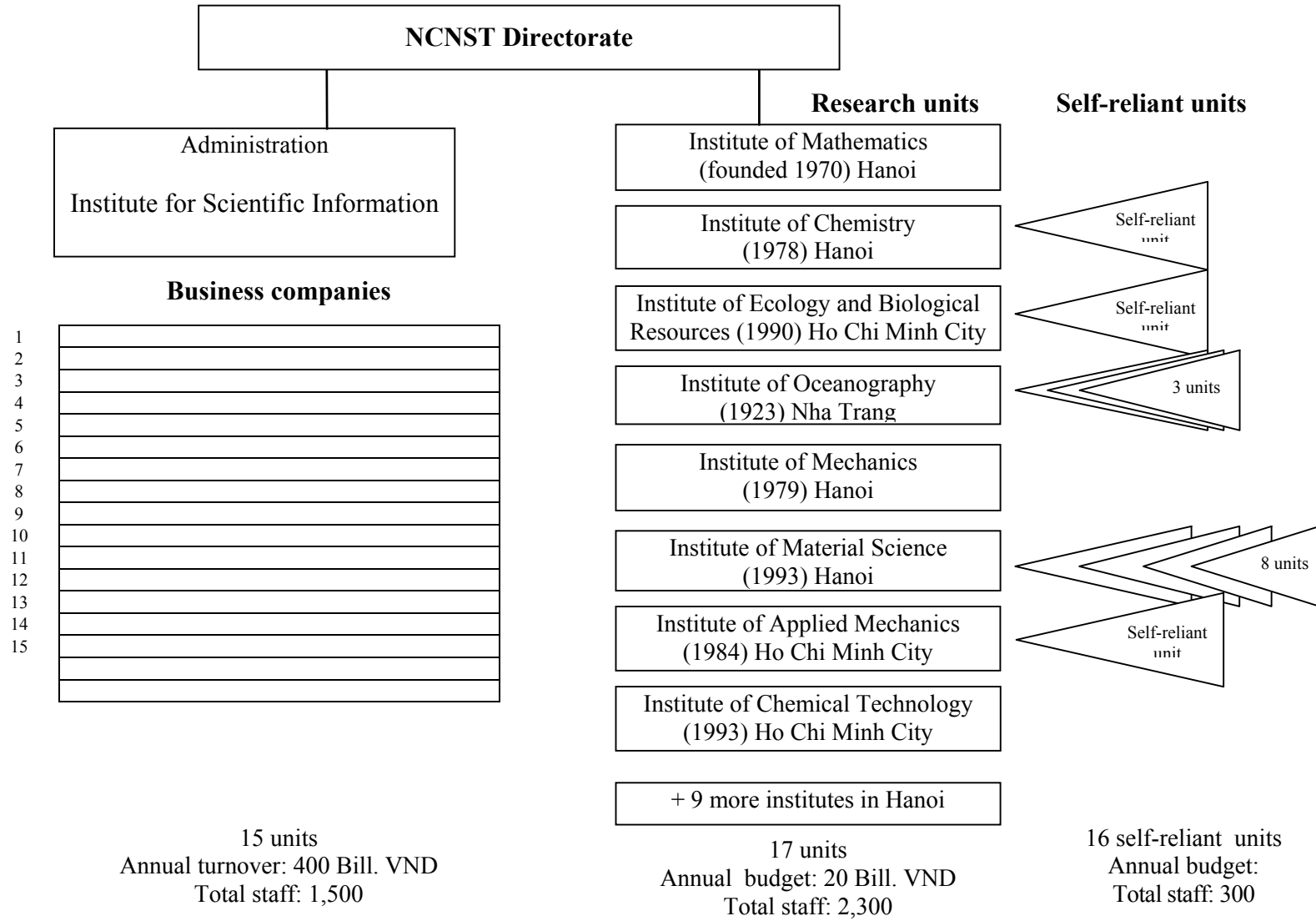


Figure 2.7: Vietnam's National Centre for Natural Sciences and Technology (NCNST) (1997)



In implementing this policy, the government was faced with the following problems: The R&D institutes' horizontal relations had been poorly developed. Orders by R&D institutes for services provided by other R&D institutes were negligible, apart from orders for products. Enterprises tried to import necessary technologies, whose development would previously have been assigned to R&D institutes by ministries. Moreover, the enterprises lacked sufficient funds to carry out long-term technological innovation plans and required nothing that needed to be ordered from R&D institutes, i.e. within the enterprises the new conditions were not yet in place that determine the need for R&D results, so that even the opening of new opportunities for direct relations between them did not promote innovation.

On the other hand, this caused great difficulties for the institutes in connection with the reduction of state funding for R&D. It led to a shift in activities from R&D to more production and services and sometimes to changes in the profile of an R&D institute with it becoming a self-reliant technical service organisation or something similar.

The transfer of branch R&D institutes into enterprises ran into difficulties as well. There was no significant demand for R&D activities and insufficient funds for investment in infrastructure, expensive equipment, etc. The institutes occupied a lower rank in the organisational hierarchy and lost their freedom, which often lead to the dissolution of long-standing teams of scientists.

The transfer of basic research institutes from the two national centres to universities has not in fact taken place - because no R&D institutes wanted to move there. They felt they would lose their autonomy. The solution to this problem appears to lie in the new budget allocation requiring basic research activities to shift more and more to the universities.

As industry was less developed and the encouragement of R&D activities lacking, industry could not develop a strategy on technology. The consequence is that the R&D institutes cannot find a market in Vietnamese industry. The technologies generated domestically encounter difficulties in being incorporated into production. With their R&D results intended for production, they try to produce by and for themselves. This lead to demands being made that institutes be able to establish (state) enterprises to go into production with their R&D results and perform technical services. Linked to this demand is the endeavour to employ institute personnel for whom there is neither sufficient R&D work (i.e. contracts) nor enough money coming from the government and enterprises.

Table 2.14: R&D Organisations of Central Institutions (1998)

No.	R&D Organisations (Affiliation)	Total No. of Organisations	No. of Organisations Conducting				Personnel		
			Basic Research	Applied Research	Experimental Development	Services	Total	Scientists & Engineers	Remaining
1	Total	606	26	580	312	534	26,806	19,157	7,649
2	Universities	115	1	115	64	99	2,666	2,379	287
3	Enterprises	58	1	55	43	55	4,282	2,678	1,604
4	Associations	154	1	148	55	143	2,188	1,953	235
5	Branch ministries	121	5	116	66	106	10,911	7,384	3,527
6	NCSSH	17	9	9	0	10	678	624	54
7	NCNST	20	6	19	11	16	1,917	1,528	389
8	Large Research Institutes	121	3	118	73	105	4,164	2,611	1,553

Source: Van phong Dang ky hoat dong Khoa hoc Cong nghe [Office for the Registration of S&T Activities], MOSTE, Hanoi, 1999

Table 2.15: Distribution of R&D Organisations and Personnel According to Ownership (1998)

	Total	Ownership			
		State	Enterprises	Cooperatives	Private
R&D Organisations	785	472	29	259	25
Personnel	29,285	23,414	2,165	3,430	276
Of whom: - Full-time	25,338	21,193	2,055	1,950	140
- Part-time	3,947	2,221	110	1,480	136

Source: Van phong Dang ky hoat dong Khoa hoc Cong nghe [Office for the Registration of S&T Activities], MOSTE, Hanoi, 1999

Table 2.16: Distribution of R&D Organisations and Personnel According to S&T Fields (1998)

	Total	S&T Field				
		Natural Sciences	Engineering Sciences	Agricultural Sciences	Medical Sciences	Social Sciences
R&D Organisations	785	93	354	146	31	161
Personnel	29,285	3,822	13,821	6,964	817	3,861

Source: Van phong Dang ky hoat dong Khoa hoc Cong nghe [Office for the Registration of S&T Activities], MOSTE, Hanoi, 1999

The newly adopted R&D system is more liberal and decentralised. There were a total of 785 R&D organisations in the country in 1998, but 606 were central and 179 provincial level. The 606 central R&D institutes consist of 121 from ministries, 20 from the NCNST, 17 from the NCSSH, 154 from S&T associations, 115 from universities, 121 self-reliant units of large research institutes, 58 from enterprises. These 606 R&D institutes could be classified by R&D phases: 26 participate in basic research, 580 in applied research, 312 in development and 534 in technical services. Although the R&D system landscape has changed in terms of ownership and affiliation, the problem is that the institutes could not play an effective role in innovation. Unusual is the fact that the number of R&D institutes participating in development is small (312 of 606 or 51%) but the number in applied research very high (580 of 606 or 96%). The number of R&D institutes is growing very rapidly from year to year, but jobs are limited (see Tab. 2.14). The latest structure of R&D and personnel according to ownership and in different S&T fields can be seen in Tables 2.15 and 2.16.

The Information Technology Sector

In 1993 the Vietnamese government issued a resolution on information technology (IT) in which it prioritised the development of the software industry. It emphasised the necessity for specific policies and measures in order to achieve the declared aim of producing valuable IT products and services. Potential measures were seen to be, for example, the establishment of software development centres and enterprises manufacturing IT equipment as well as strengthening the informatics servicing network (NQ 18-CP, 4/8/1993). A national IT programme was quickly developed and implemented since 1995, but in the 1996-1998 period, the software industry was still in its infancy.

In recent years Vietnam has succeeded in building up a strong human resource potential for IT, thus creating an important foundation for the development of the software industry. A large number of managers, staff and specialists have already been trained.

The government invested in building IT departments in six universities. These universities have set the target of training 2,000 computer science graduates every year. Over the last 4 years, a total of 7,000 students completed their studies. A computer science department has been set up in each of the other universities and colleges and all students have access to training in basic computer science skills. If teaching in other educational institutions, self-taught skills and re-training (for economists and engineers) is taken into account, it can be estimated that every year

another 3,500 people in Vietnam are trained in basic computer science. The target of training 20,000 IT graduates in the year 2000 appeared feasible. Thus, by the year 2005, if no other special measures are undertaken, Vietnam will have about 38,000 people who master at least basic IT knowledge and skills. Experience from countries with a strong software industry indicates that it is optimal to have 25% IT university graduates and 75% programmers. By these criteria, Vietnam now lacks sufficient programmers while the IT university graduates are not capable enough to guide those programmers who are there. The current training structure has led to a shortfall in project leaders, managers and analysers, and especially professional programmers. Training quality is poor as teaching staff are not able to update information and improve their knowledge, they lack research and teaching facilities and theory is not linked to production requirements. Currently, Internet access remains a luxury for both trainers and trainees.

Vietnam can build up the required number of programmers by teaching computer science at vocational training schools. In addition, IT companies and colleges will also provide a large number of programmers for the future software industry. Currently Vietnam has about 25 companies specialising in software development and 30 others involved in software development in addition to their other activities. Software industrial parks (IP) have been established, including the Hoa Lac High-Tech IP; the Ho Chi Minh City Software Park; the Tan Thuan Software Park; and the Hanoi Software Center.

At present, the government allows Vietnamese organisations and individuals to enter into joint ventures in IT research and training with foreign partners. This appears to be a favourable opportunity for the training and development of the human resources required for Vietnamese IT to meet international standards. Ho Chi Minh City has implemented five programmes of action and is investing ten million USD in the software industry over the 2000-2005 period, including a large-scale programme aimed at developing the software industry training system. The government is also developing a national programme on software industry development. Construction has begun on a high-tech zone in Hanoi.

In the coming period, Vietnam's policies will focus on the training of IT teachers and improving training materials, including subjects relating to IT, and on promoting Internet use. Governmental assistance will be provided to enterprises to train programmers to meet state criteria, to send their staff to training courses both within Vietnam and abroad, and to export software labour.

Assistance will also be given to vocational training centres providing IT training for university graduates or secondary school leavers enabling them to become programmers.

The Biotechnology Sector

In 1994 the government issued a resolution on biotechnology outlining policy up to the year 2010. It stated that by 1994 Vietnam had trained a pool of biotechnologists with various specialisations and working at different technological degree (education). However, they were not coordinated and there was a shortage of leading experts. They could not work efficiently as their working conditions were substandard and they lacked access to the latest information to keep themselves up-to-date with international developments. Several facilities were working with biotechnology but were scattered, and had poor infrastructure. As a consequence, the operation of these facilities was also inadequate.

The government announced various measures to combat these weaknesses, including the establishment of a Biotechnology Institute within the National Centre for Sciences and Technology; gradually upgrading the laboratories of other research institutions so that they will be able to receive and improve foreign technologies; transferring some laboratories specialising in specific and mid-level technologies (degree: low, mid, high-tech) to enterprises and creating favourable conditions for the enterprises to invest in their own S&T facilities.

The government maintains that it is necessary to rapidly develop a contingent of scientists specialised in biotechnology, who should be coordinated with regard to their respective expertise/education-degree. Training facilities and programmes at universities should be developed and refurbished quickly to provide regular training as well as retraining for biotechnologists.

The government has entrusted the Ministry of Science, Technology and Environment (MOSTE), among others, with the task of developing a plan on the reorganisation of S&T facilities specialising in biotechnology. It also gives the Ministry of Education and Training (MOET) and MOSTE the task of developing a plan on training biotechnologists for different fields and education-degree at domestic and overseas universities. The state encourages contacts between Vietnamese and foreign biotechnologists in seminars and workshops both within Vietnam and abroad. The state has also increased investment in research activities within the framework of a

national biotechnology research programme, and encourages young scientists to carry out research activities in this field.

In order to improve biotechnology skills, the government deems it necessary to develop pilot enterprises to design and manufacture biotechnological equipment. The state encourages the employment of foreign or expatriate Vietnamese experts. These experts may either work as advisors or directly participate in the planning process of development programmes, personnel training and technological research.

Vietnam began to train biotechnologists in universities as early as in 1955. Since 1985, the state has invested in a major programme on biotechnology research. There are now about 200 biotechnology specialists in the country. The Biotechnology Institute under the NCST has been substantially consolidated and strengthened. This has encouraged many expatriate biotechnologists to return to Vietnam to work there. This sector has contributed greatly to creating new strains and breeds of agricultural products, particularly high-yield hybrid rice, which has helped increase rice output.

However, many weaknesses remain, including a shortage of geneticists and specialised biotechnologists. This lies in the fact that training has been focused on biology but not technology, resulting in great constraint in applying biological findings to technological work. Vietnamese experts have been highly appreciated abroad but within the country they still cannot bring make optimal use of their potential. The major reasons behind this include poor working conditions, less access to the latest information, theory not being combined with production, low salaries. In particular, there is a shortage of semi-industrial and pilot equipment. This prevents the application of laboratory findings to industrial production. In the light of such a situation, manufacturers often seek foreign rather than domestic technologies. Thus, in addition to providing technological training for university students within Vietnam or sending them for training abroad, the government is allowing foreigners to enter into joint ventures with Vietnamese partners in biotechnology education and research. It should help overcome the existing weaknesses.

Vietnam now has about forty laboratories carrying out biotechnology research at different levels (eight under the MOET; six under the Ministry of Agriculture and Rural Development; four under the Ministry of Health; twenty under the Hanoi Biotechnology Institute; and two under the Ho

Chi Minh City Tropical Biology Institute). In the near future the government plans to build laboratories for molecular biology, microbiology technology, animal embryo and cells technology, enzyme technology, vaccine and immunology technology and environmental biology technology.

The S&T Planning System

S&T planning in Vietnam has been carried out at three levels: central (ministerial), provincial and the micro level. The planning process did not change much during the 1990s and is essentially still a two-down and one-up process, which was very common in the old socialist system (projects were decided on from above and assigned to the institutes). On the basis of this planning principle, the state S&T plan is formulated by the MOSTE and approved by the Prime Minister in the form of state R&D programmes and projects for every five-year period. The plan encompasses the so-called priority areas of the country's S&T. In the preparation phase, ad hoc groups of renown scientists were established to advise in the formulation of the state R&D programmes by MOSTE. These ad hoc groups recommended not only the subjects and titles of programmes, but also the individual projects carried out within the programmes. After approval of the programmes and the nomination of their steering committee directors by the Prime Minister, MOSTE assigned the projects associated with the programmes to the various R&D institutes that conduct such activities. After 1989, state R&D programme projects and individual state R&D projects were no longer instituted by assignment, but by selecting scientist groups using the so-called 'bidding method'. Some state R&D programmes were transferred to the branch ministries for management. The expense or price of projects could be negotiated and services could be purchased in the form of a contract between the MOSTE, the concerned branch ministries and the R&D institutes. Since 1995 the process and procedure of R&D planning has once more changed somewhat. The Prime Minister decides the main research field, which MOSTE can then concretise into specific state R&D programmes. The branch ministries, the provinces, the two national research centres and the national universities have determined their own R&D tasks beside state R&D programmes in consultation with the MOSTE and also assigned them to the subordinate R&D institutes in the form of project-funding, signing contracts with them.

In 1999 R&D planning still involves central planning and bureaucracy, it is run by command from the higher to the lower level. Formally, there is a clear division between research fields (e.g. the

Ministry of Agriculture is assigned agricultural science and the Ministry of Health medical science), between MOSTE, different ministries, universities and industry. However, in reality, until now, no clear division of responsibility exists regarding different tasks. For example, MOSTE did a lot of research work that was assigned to the Ministry of Agriculture. The government seems to deal with the research area that should be dealt with by industry, and the principle of subsidiarity does not work. Because they are run bureaucratically, state R&D programmes and projects provide research results that satisfy only a small part of the need for technological innovation in production (about 2-4% of project results in the form of technology were applied in the production registered officially by the Ministry of Planning and Investment, or 15% according to experts' estimates). The government made a great effort to transfer more and more branch R&D tasks to the branch ministries, to concentrate on technological development and to avoid duplication and dispersion. Thus, the number of state R&D programmes and projects were reduced in every five-year plan, but it could not solve the problem of making R&D output from state programmes more suitable for technological innovation (see Tab. 2.17).

Table 2.17: Number of State R&D Programmes and Projects

	Numbers of Programmes	Numbers of Projects
1981-1985	75	1,500
1986-1990	55	1,000
1991-1995	32	700
1996-2000	18	200

Source: Own calculations

The fundamental problem here is the lack of participation on the part of industry and production in the planning process (for example, the absence of industry representatives in shaping the state R&D programmes). They should determine the items of R&D, utilise the results and be involved in R&D. In other words, R&D should be carried out more from the bottom-up, with more responsibility in the hands of industry and production. Besides supporting industry and production, the state should concentrate on R&D activities in fields of public interest.

The roles of MOSTE, of the two national research centres and of the branch ministries must be clearly delineated to avoid duplication or overlap in R&D. Based on the different characteristics of R&D, the most suitable mechanisms for planning processes should be found, so that the best R&D projects may be identified. Here more must be learnt from the experiences of developed countries.

The problem of funding trial (pilot) production runs remains unresolved. Due to the existence of many uncompleted R&D projects in the pilot phase of production, in 1990 MOSTE introduced so-called trial (pilot) production projects, which research institutes could carry out mostly as state projects (80-90%) i.e. with substantial state funding. They were an option designed to be used if results require only a small amount of work to be invested to achieve complementarity of technological processes, small-scale production, and/or better marketability of a product that is well-suited to societal demands. This essentially functions as a loan, with the project's leader having to return 80-100% of the funds provided to the state. Insofar as it is still research, no return can be expected. In other cases, however, R&D work that has already been completed is funded a second time - as "trial production"; in other words, double funding occurs. Returning the money always posed a problem. Much work is required to attract funding from enterprises rather than the government or to raise the venture capital required for these trial (pilot) productions.

R&D Financing

Before the 1980s, the national budget was the only source of funds for S&T activities in Vietnam. Since 1981 it has been resolved time and again that Vietnam should devote about 2% of its GDP to S&T activities. In order to obtain money from other sources, R&D institutes have been able to sign contracts since 1981 and since 1984 have been allowed to set up three internal funds (for awards, welfare and S&T promotion). Some R&D institutes did not establish these funds because they have no external income. Since 1988, the income of S&T workers at R&D institutes was no longer limited and could exceed the standard salary rate. At the same time, R&D institutes were no longer funded from the state budget according to their staffing levels, but according to the volume of R&D tasks they were assigned by the plan. Nowadays they are legally entitled to use seven different financial sources for their S&T activities (state budget, institute's own capital, bank loans, etc.).

To make R&D institutes more flexible, since 1983 they have been permitted to borrow money from banks to finance their S&T work. Since 1995, scientists, enterprises and R&D institutes have been able to borrow at the lowest loan rate to finance the application of S&T results.

As from 1987 R&D institutes have been allowed to sign S&T contracts at a negotiated price. In order to promote the application of new technology, enterprises were freed from paying tax for the first two years after beginning steady production with the new technology. Five percent of the profits earned in the first two years could be transferred to the authors and 10-15% to the R&D

organisations that made the new technology operational in the enterprises. In 1989, the form of contracts and negotiations was also applied in the relationship between ministries and those R&D institutes in which state R&D projects were conducted. And in 1992 it was confirmed that R&D activities, including pilot production, were no longer required to pay any tax, other than a turnover tax for technical services. For a long time there was no system of incentives in place to attract funding from other sources with which to promote R&D activities and technological innovation. To boost the amount of finance, in 1986 the branch ministries were allowed to set up funds for S&T activities alongside those provided by the state budget. The beneficiaries of this fund were enterprises and R&D institutes subordinated to the ministries. Furthermore, in 1992 the provinces were also permitted to set up funds for S&T activities aiming to solve S&T problems in their area. The beneficiaries were the enterprises under their authority.

But in reality, so far the government has only been able to provide about 0.2-0.3% of GDP for S&T funding annually (under 1% of the state budget). This amounted to 55 million USD in 1996. As from 1997, state budget appropriations for salaries or operating expenses of numerous R&D institutes were to be cut - on the one hand as a means of binding R&D institutes to enterprises and making others self-reliant or turning them into new enterprises, and, on the other hand, in order to transfer responsibility for funding from the state to the enterprises. But this had still not happened by 1999 and the government has begun to seek other ways to solve this issue.

All of these recently effected changes in financing are designed to promote S&T activities that are more suited to a market economy. But some problems have yet to be faced. A major contradiction lies in the fact that the state allows R&D institutes to be increasingly financially independent and funded less by government, thus becoming more self-reliant and accountable, but they cannot obtain contracts for R&D work or technical services from enterprises because the latter do not exhibit a need for this R&D work. In order to solve the problem of inadequate finances, the R&D institutes try to do anything that will earn money and are moving away from R&D. In some cases, if they invented a new technology which was commissioned and funded by the government, they tried to keep it and reap the benefits themselves, and also failed to transfer such new technology, which was a result of public research, to others. In the past, twelve R&D institutes subordinate to the former Ministry of Mechanics and Metallurgy tried to become entirely economically self-reliant in their activities and did not receive any funds from the state, but two years later they had still not overcome the problem of financial shortfall. Until now, the problem of what financial principle

could be applied for organising the R&D institutes in Vietnam has not been solved, nor has the question of whether they will become profit, non-profit or semi-profit organisations.

The financial incentive system is very weak. The bank loan scheme did not induce R&D institutes, enterprises and entrepreneurs to borrow money for S&T activities. The effect of tax reduction and profit sharing in the development of new applied technology is very limited. There was no venture capital and no medium-term or long-term bank loans for technological innovation. In many ministries and provinces S&T funds were established but they were very limited. Money made available from funds, in which both enterprises or R&D institutes had a share, was very meagre, because these organisations were financially weak. The total S&T budget, from state sources and others, was about 0.4% of GDP - very low in comparison with developed countries, which tend to allocate between 2 and 3% of GDP to S&T activities. State budgetary appropriations for S&T activities constituted only 0.2-0.3% of GDP. That means that the state share of the budget was reduced from 100% to 60% and the share from production and foreign sources had increased from a tiny amount to about 40%. Nevertheless, the proportions between state and industry sources was 80:20, instead of 20:80 or 30:70, as in other countries. The expenditure in the last decade can be seen in Table 2.18.

Table 2.18: R&D Expenditure

Year	Total R&D Expenditure		R&D Expenditure as a Percentage of	
	(Mill. VND)	(Mill. USD)	Total National Expenditure	GDP
1990	86,400	14.49	1.10	0.21
1991	107,000	14.07	0.88	0.14
1992	203,000	18.27	0.89	0.18
1993	349,000	33.08	1.00	0.25
1994	497,000	45.56	1.02	0.28
1995	605,000	55.00	0.94	0.26
1996	630,000	57.30	0.90	0.23
1997	710,000	64.54	0.90	0.23
1998	794,000	72.18	1.00	0.22

Source: Vu Ke hoach, Bo Khoa hoc Cong nghe va Moi truong [Department of Planning], MOSTE, Hanoi, 1999

The share of salary and operating expenses of R&D institutes (provided as basic institutional funding) is still high (about 35% of an institute's total budget); the share of state S&T programmes and projects (projects funding) is about 35%; the share of S&T activities for ministries and provinces is about 30%. The money paid for salaries and operating expenses is badly managed, in part because no R&D results are demanded from these organisations in return, and it is only used to

maintain the S&T staff. In future, this model should be done away with. The mode of allocation should be changed so that the portion determined for institutional funding is reduced and the portion intended for state S&T programmes and projects should be increased. Moreover, it is necessary that more money be transferred to the branch ministries and provinces for S&T activities, so that they can create S&T programmes or projects that tie in directly with the practical problems in their areas or provinces. This would be a tool to decentralise S&T activities and at the same time to force actors to take more responsibility for making their S&T activities more effective.

Employment in S&T

The most significant change in S&T employment policy was the elimination of lifelong employment and its replacement with employment through limited contracts. The S&T workers were permitted to earn money on another basis than that of the fixed salary rate, and their income was also no longer limited. The low salary combined with the low work load assigned by R&D institutes had resulted in many S&T workers receiving a salary from the state although they did other work than the R&D tasks the state commissioned, and even worked outside of R&D. Many S&T workers have left the R&D institutes for joint venture enterprises or other foreign-owned offices in order to earn more money.

Professional work in S&T in Vietnam is no longer as attractive as it had been. The R&D institutes lack junior staff members. Younger people now tend to study more economic subjects. This led to the problem that a generation of technical personnel will be missing in future. This problem applies not only to S&T institutions, but to the economy and society as a whole.

While the number of employees in the science sector fell from 52.2 thousand in 1990 to 48.1 thousand in 1993, the number of scientists and engineers has remained virtually constant since 1990 with ca. 23,000 persons in the research facilities. In addition, approximately 7,000 persons (FTE) are still engaged in research in the higher education sector. There was a total of ca. 544 thousand graduates in Vietnam in 1994. The distribution according to scientific field is illustrated in Table 2.19.

There were 8,000 PhDs in 1995, 397 professors and 1,057 lecturers.

Table 2.19: Graduates in Different Scientific Fields (1994)

Scientific Field	Graduates
Natural Sciences	124,405
Engineering	95,591
Medicine	37,141
Agricultural Science	32,015
Social Sciences	249,596
Other	5,231

Source: Bao Nhan Dan [The People's Paper], 2.1. 1995

Equipment in research facilities

The entire available surface area per R&D employee amounts to less than 10 m². Almost all research equipment is imported. The level of equipment is usually inadequate. In addition, most equipment in stock is incomplete and 95% is obsolete. The precision and reliability is therefore very limited. In many cases the equipment in R&D facilities is more outdated and less modern than that used in industry. It is often only able to be utilised to a limited extent (only a few hours per day). The support provided free of charge by capitalist countries and by international organisations is very significant for Vietnam, not only with regard to the qualification of personnel, but also for the supply of equipment and material for R&D.

4. Conclusions

The Vietnamese state is developing a socio-economic strategy up to the year 2010 which identifies that S&T in the service of socio-economic development is a very important strategy. The Law on Science and Technology approved by the Vietnamese National Assembly in June 2000 asserts that national priority be given to S&T development. S&T play a key role in national development and as a foundation and motivation for national industrialisation and modernisation.

As a result S&T policy in Vietnam will be increasingly oriented to free market mechanisms. R&D functions will be rationally distributed in higher education, government and industry. Basic research will mostly be conducted within the higher education sector; the two national centres will be required to concentrate on applied R&D; many R&D institutes will be transferred from the control of ministries to enterprises; enterprises will be able to set up R&D units. Other types and forms of ownership of R&D organisations will be promoted: S&T parks are being set up in Hanoi and Ho Chi Minh City to strengthen high-tech for economic development. Vietnamese S&T must participate far more in the process of industrialisation.

S&T planning should be more decentralised in future. The mechanism will change to directive planning, enabling influence from the bottom up to be strengthened. The state will concentrate on public research, while industry should conduct its own research. The state will support this by creating an incentive system, promoting an environment that encourages the enterprises to carry out more industrial research and technological innovation, and invest more capital in them.

In the year 2000 the state budget for S&T is expected to be 2% of total state expenditure. Industry and the privately owned sector must be mobilised to finance R&D activities. The ratio between the state on the one hand, and industry and other actors on the other should be 50:50. New principles and an incentive system for mobilising money for R&D and innovation by venture capital and tax reduction (regulated in the laws on VAT, enterprise income tax, foreign investment and domestic investment) should be widely applied in order to encourage the enterprises to do more R&D and innovation work. State budget allocations should be further reformed with an orientation toward decentralisation. Foreign funding for S&T in Vietnam could be established in the near future.

A problem to solve in the future is the lack of a younger generation in R&D institutes and universities, and the small number of engineers in production.

The Law on Science and Technology also stipulates that the state invests in key projects and speeds up international cooperation on high-tech development; build some high-tech zones to improve technological capacity and develop high-tech industries; S&T institutions and enterprises that apply up-to-date technologies and manufacture high-tech products will benefit from tax incentives. The Law also states that the state should allocate an annual budget for human resources in S&T both within and outside the country (this applies not only to training talented newcomers but also to retraining qualified personnel and skilled technicians). Organisations and individuals are encouraged to participate in S&T (re)training and to apply for or grant scholarships to Vietnamese citizens to be trained inside the country or abroad.

Vietnam has been building a network of more than thirty national key laboratories to meet S&T targets, including the above-mentioned laboratories specialising in IT and biotechnology. These laboratories will not only provide a working space for local scientists but also attract many expatriate Vietnamese to return. The government has also prepared an S&T personnel training programme to ensure a highly qualified workforce will meet the needs defined as national priorities. Under this programme, young scientists will be sent abroad for training to fill in the

gap (in the past most Vietnamese scientists were trained in the former Soviet Union and Eastern European countries). In the year 2000 the Vietnamese government decided to invest more than 7 million USD in training and re-training scientists in order to achieve a balance in the number of university and mid-level vocational school graduates, between economists and technologists and between managers and technological experts. In March 2000 the government issued a resolution allowing foreigners to enter into joint ventures with Vietnamese partners (including wholly foreign invested enterprises) to invest in training, research and healthcare. A policy is being developed to attract expatriate Vietnamese scientists to return by creating conditions that will entice them to work in these fields.

With these policies and instruments Vietnam hopes to quickly develop its human resources in S&T, particularly in IT and biotechnology, to meet socio-economic development needs. These measures will contribute to changing Vietnam into a knowledge-based economy, in line with global developments.

The world is now entering the first decade of the 21st century. This is the century of a knowledge-based society. Bearing this tendency in mind and based on the theory of national innovation systems, Vietnam's S&T policy will further develop, based on the principle of combining the 'science push' model with the 'demand pull' model of technology and development, and by further decentralising R&D activities in conjunction with the acceleration of economic clusters.

References

- Bao Nhan Dan [The People's Paper], 02. 01. 1995: Chinh sach hop ly cho viec tang cuong tiem luc can bo KH-KT [Legal Measures in the Interests of Increasing the Capacity of the Scientific-Technical Cadre], Hanoi.
- Co so du lieu Luat cua Van phong quoc hoi Viet nam 2000 [National Assembly Data Bank of Vietnamese Law], Hanoi
- CPV (Communist Party of Vietnam), 1986: Political Report of the CPV Central Committee on the VI. Party Conference, Nhan Dan [The Nation], 12.1986.
- CPV (Communist Party of Vietnam), 1994: Dang Cong san Vietnam - Bao cao ve viec thuc hien Nghi quyet VII [Report on the Realisation of the VII. CPV Resolution], Hanoi.
- CPV (Communist Party of Vietnam), 1994a: Dang Cong san Vietnam - Nghi quyet ve Cong nghiep hoa hien dai hoa dat nuoc [Resolution on the Industrialisation and Modernisation of the Country] Hanoi.
- MOSTE (Ministry of Science, Technology and Environment), 1995: 50 nam hoat dong Khoa hoc va Cong nghe Vietnam [50 Years of Science and Technology in Vietnam (1945-1995)], Bo KHCN, MT [Science and Technology Publishers], Hanoi.
- MOSTE (Ministry of Science, Technology and Environment), April 1994: Bo KHCN,MT-Khoa hoc va Cong nghe trong su nghiep cong nghiep hoa hien dai hoa dat nuoc [Science and Technology in the Matter of Industrialising and Modernising the Country], Hanoi.
- Nien giam Thong ke [Statistical Yearbook of the SRV] 1984-1999, Nha Xuat ban Thong ke, Hanoi, 1986-2000.
- Phan Van Khai,1999: Bao Nhan dan [The People's Paper], Hanoi, 9. 1. 1999
- Pham Huyen and Dang Duy Thinh, 1990: Zum wissenschaftlich-technischen Potential der SRV, in: W. Meske (ed.) Wissenschaft der RGW-Lander, ITW der AdW der DDR, Studien und Forschungsberichte H.30, Berlin, pp. 222 - 238.
- Statistical Data on Vietnam's Socio-economic Development 1930-1984, Nha xuat ban Thong ke , 1985, Hanoi.
- Tap chi Nghien cuu Kinh te so,1999/2000: [Economic Studies] No. 249 2/1999 & 263 4/2000)
- Van phong Dang ky hoat dong Khoa hoc Cong nghe [Office for the Registration of S&T Activities], MOSTE, 1996, Hanoi.
- Vietnam Special Study, Deutsche Bank Research, October 1994, Hanoi.
- Vietnam - Overview and Outlook, Merrill Lynch, July 1994, Hanoi.
- Vu Cao Dam, 1986: Overview of Some Scientific and Technological Problems in the SRV, Hanoi, No. 4, p. 11–12.
- Vu Ke hoach, Bo Khoa hoc Cong nghe va Moi truong [Department of Planning], MOSTE, 1999, Hanoi.

Following periodicals were also analysed:

- a) Bao Hanoi moi [New Hanoi Newspaper]
- b) Diem tin Kinh te [Economic Overview], Ed.: General Director of Standardisation, Measurement and Quality, MOSTE, Nr. 1-88, Hanoi 1994-1996, Tong cuc TC-DL-CL, Bo KH, CN, MT
- c) Bao Thoi bao Kinh te Sai gon [Saigon Economy]
- d) Kinh te va Du bao [Journal of Economy]
- e) Ban tin Kinh te - Xa hoi [Forecasts Socio-Economic Journal]
- f) Tap chi Thong ke [Journal of Statistics, Hanoi]

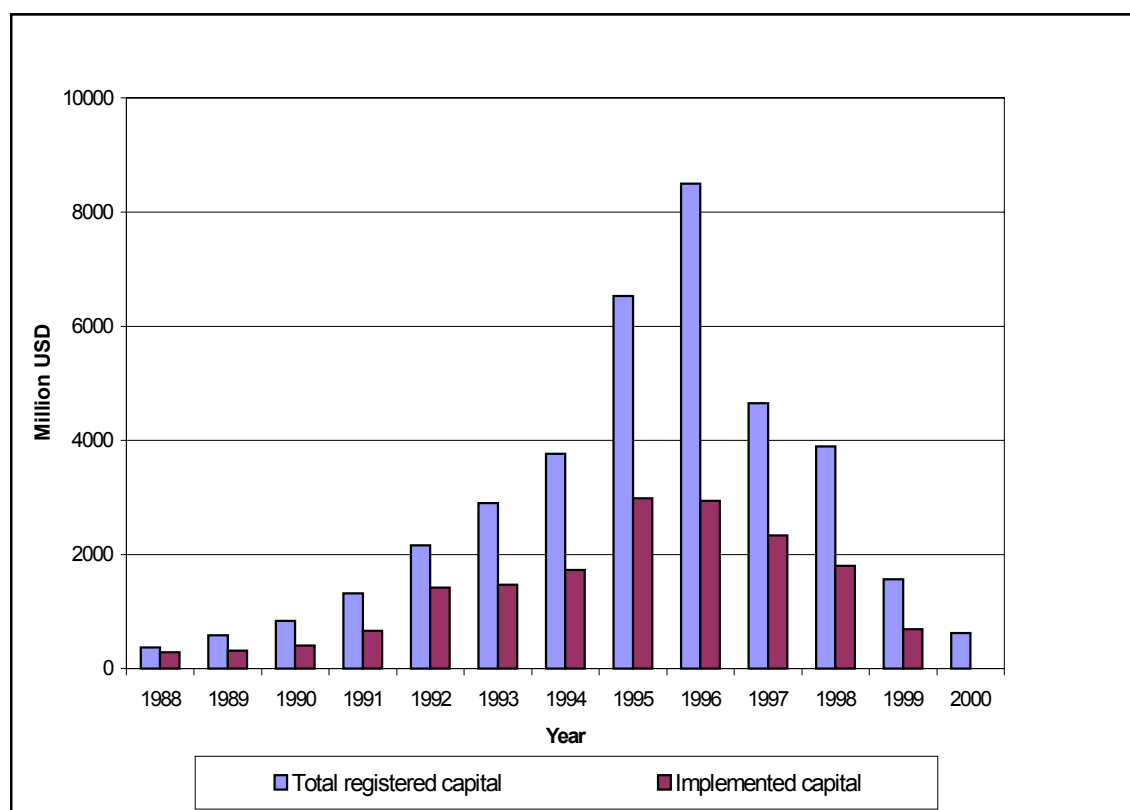
Chapter 3: Foreign Investment and Technology Transfer in Vietnam

Pham Huyen

1. Foreign Investment and Imported Technologies

According to official statistics, by early August 2000 more than 2,440 foreign investment projects had been licensed in Vietnam, with a total (registered) capital of 35.5 billion USD (cf. Fig. 3.1) (MPI 8/2000). So far, the sectors that have most attracted foreign interest are heavy industries (19%), construction (20%), light industry (11%), hotels and tourism (10%), post and transportation (7%), food industry (7%), oil and gas industries (6%), forestry and agriculture (5%). The lion's share of foreign investment (FI) has poured into Hanoi and Ho Chi Minh City. These two centres have attracted 75% of total FI value. Most projects have been concentrated in only six cities/provinces: Ho Chi Minh City (837 projects), the capital, Hanoi (348 projects), Dong Nai province (258 projects), Binh Duong province (303 projects), Hai Phong City (80 projects) and Baria-Vung Tau province (61 projects).

Figure 3.1: Foreign Investment in Vietnam (1988-2000)



Leading foreign investors in Vietnam are Singapore, with 6,806 million USD, Taiwan, with 4,820 million USD, Japan, with 3,903 million USD, and South Korea, with 3,740 million USD (cf. Tab. 3.1).

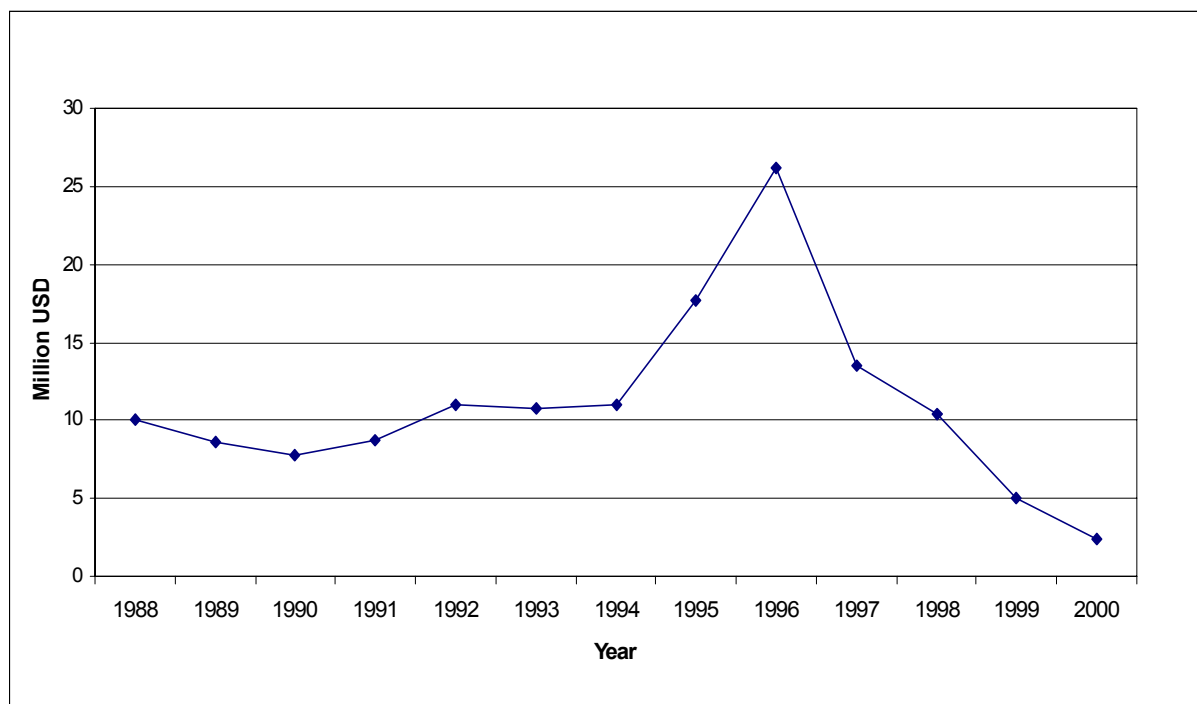
Table 3.1: Top Foreign Investors (2000)

Country	Registered Capital (Million USD)
1. Singapore	6,804
2. Taiwan	4,816
3. Hong Kong	2,658
4. Korea	3,470
5. Japan	3,902
6. British Virgin Islands	1,701
7. USA	1,089
8. Russia	1,559
9. Thailand	968
10. Malaysia	944
11. Australia	747
12. United Kingdom	649
13. Netherlands	588
14. Switzerland	522
15. Cayman Islands	468
16. Sweden	371
17. FRG	355
18. Bermuda	302
19. Philippines	261

Source: MPI 2000

About 15.9 billion USD, or nearly half of the total investment capital has been implemented. The total investment capital per project averaged almost 14.5 million USD. In 1995 and 1996 this amount increased. The average size of newly registered FDI projects dropped to 5.2 million USD per project in 1999. This represents a substantial decline when compared with the average size of newly registered FDI projects in 1996, 1997 and 1998 -18.4, 11.6 and 15.5 million USD respectively. This is an indication of foreign investors' growing concerns about the wisdom of investment in large projects in Vietnam and thus of changes in investment structure (cf. Fig. 3.2) (Vietnam's Economy 1999; Statistical Yearbook 1999).

The United Kingdom, Australia and the Netherlands have achieved a high ratio of implemented to registered capital. This is because their investment projects have mainly been in the field of oil exploration. Investors from Taiwan, South Korea, Singapore, Japan and Malaysia entered Vietnam later but the implementation of their projects has been faster than those from Europe.

Figure 3.2: Average Size of Registered FDI Projects

The foreign investment capital amounted to about 35% of Vietnam's total investment value and its production accounted for 6.3% (1995), 10.1% (1998) and then 10.3% (1999) of GDP. Joint ventures accounted for 100% of oil production. For steel this figure was 60%, for vehicles 63%, domestic electric articles 40%, food 18%, clothing 16% and chemical products 14%. The contribution made by the foreign investment sector's production to the governmental budget has been increasing: 195 million USD in 1995 to 317 million USD in 1998, when it made up 7% of the total governmental budget (this figure would be 20% if contributions from the oil and gas industries were included). Advanced technologies imported recently are primarily used in such areas as post and telecommunication, crude oil and gas exploration, electricity, electronics, cement, steel and vehicle production. In general, the level of technology in economic sectors with FDI is higher than in the other sectors. In those sectors without FDI, the level of technology is similar to that found in other Southeast Asian countries. Many products manufactured by enterprises with FI have achieved a high quality, met domestic demands and replaced imported goods. Some products have achieved significant quality standards, such as construction steel, fertiliser, stock feed and cars. The contribution made by these enterprises to total export turnover reached 800 million USD in 1996 and 2,450 million USD in 1999 (excluding oil exportation).

They made up 22.5% of total export value. In 1996 there were nearly 150,000 Vietnamese employees working in these enterprises, including 5,000 managers and 25,000 technicians (15% of the technicians are engineers and university graduates). 60% of workers have been trained. In 1999 there were 300,000 employees working in the economic sectors with FDI.

While some encouraging results have been achieved, much remains to be done to attract more FDI and improve its quality. The FDI flow began to decline in 1997 and the situation has been getting worse since a financial crisis broke out in the region (cf. Fig. 3.1 and 3.2). This is partly because the majority of FDI inflows (around 70%) originated from crisis-hit countries. In 1997, total new licensed foreign investment capital dropped by 49% compared with the year before, in 1998 it dropped by 16% and in 1999 it dropped by 60%. The structure and quality of FDI are also of concern to the government. Foreign investment has been directed to capital-intensive import substitution activities rather than to labour-intensive export production. It has also generally flowed into the same few cities and provinces due to the availability of infrastructure there. Until now FDI from ASEAN and Pacific countries has dominated, with a share of 67% of total FDI value. (The share of FDI from ASEAN alone was 23%.) The FDI from European countries increased from 23.2% in the 1991-1995 period to 25.8% in 1996-1999. Although the FDI inflows from the USA were not high (only 3.5%), the US investors' projects are quite promising - if the Vietnamese-American Trade Agreement is ratified.

Ninety-two percent of Vietnamese partners in joint ventures are state-owned enterprises (SOE). They account for 98% of total investment capital.

The number of *revoked investment licences* has been high recently. About 300 licences, with an investment value of 2.5 billion USD, have been revoked. The responsibility for this problem lies with both the Vietnamese involved and the foreign investors. Some investors did not fulfil their commitments; their calculations for projects were upset by changes in the market and prices both in Vietnam and in the rest of the world. Some foreign partners went bankrupt in other countries and were unable to continue their projects in Vietnam. The lack of project management know-how on the part of some Vietnamese staff has remained the biggest problem. Vietnamese managers do not have the necessary information to consider and control the legal entity status and financial capacity of foreign partners during project evaluation. Violations of laws by foreign partners have frequently not been dealt with.

The report by the Ministry of Science, Technology and the Environment (MOSTE 1995) on the *impact* of imported foreign technologies on the Vietnamese economy revealed that only 10% of machines and equipment were of a modern technological standard; 52% were considered to be outdated or completely obsolete (compared with those of the same category used in the rest of the world). The proportion of machinery and equipment of a modern technological standard is higher in joint ventures with foreign partners than it is in SOE and private, solely Vietnamese-owned businesses, but it is still only 44%. The rest only reach average technological standards. Of the 311 businesses surveyed on the effectiveness of technological renovation in recent years 76% report larger output, 93% better production capability, 90% increasing product quality and 90% improved economic effectiveness. The MOSTE report emphasised the role of these kinds of imported technologies for the establishment and development of SME and family-based economic sectors.

To create an environment that encourages foreign investment, the government has paid special attention to the adjustment of the Foreign Investment Law. The National Assembly adopted the latest amendments in May 2000. These provide more incentives in terms of foreign currency purchase, governmental guarantees for any foreign investment project, land-use-right mortgages, tax reductions, incentives for Vietnamese overseas investors, etc.

2. Foreign Investment and Domestic R&D

Vietnam's integration into regional and international economies is also progressing. At the sixth ASEAN summit, held in Hanoi in December 1998, Vietnam and its ASEAN partners reconfirmed their commitments to greater economic integration by accelerating the implementation of the Asian Free Trade Area (AFTA), the Asian Investment Area (AIA) and the liberalisation of trade and services, as well as the promotion of S&T, human resource development and environmental protection. A new tariff reduction scheme for AFTA was approved and published in 1998, demonstrating the government's resolve to further open its domestic market. This will obviously lead to very tough competition with foreign goods, even within the Vietnamese domestic market. According to the Director of the Central Institute for Economic Management in Hanoi the biggest challenge faced by Vietnam in its integration process will be the low competitiveness of Vietnamese enterprises (Le Dang Doanh 2000). Very few enterprises, even joint ventures, have R&D institutions. Neither the directors nor the management boards of most joint ventures are

interested in R&D. In interviews conducted by the author with nine Vietnamese directors of joint ventures in late 1998 and early 1999 (four in the industrial zone Bien hoa, Ho Chi Minh-City, two in Hanoi and three in Hai Phong), all stated that R&D is carried out in the foreign partner's country should it become necessary (Pham Huyen 1999).

This fact must be viewed in the light of the general role of R&D in Vietnam's enterprises. On one hand, R&D's contribution to competitiveness is not so obvious that the enterprises see themselves as compelled to have it. On the other hand, their investment capital is limited and the budget can only maintain daily production. Many executive directors are aware of the danger of stiff competition in the near future but few of them have any opportunities to strengthen their R&D capacity. In recent times a few - in the fields of telecommunications, oil and construction - have declared their interest in strengthening their R&D capacity by investing in and establishing R&D institutions. The majority, however, have not agreed to take over any of the R&D institutions that had been under the control of the various ministries. This has led to many ministries not being able to carry out the planned reorganisation of the R&D system. This has especially affected the Ministry of Health Care and the Ministry of Agriculture and Rural Development, both of which have to restructure many research institutes.

In order to formulate a master plan and conduct a feasibility study of the Hoa Lac high-tech zone in Hanoi, questionnaires were sent to about 7,500 enterprises in eleven countries (Japan, England, USA, Canada, France, Germany, South Korea, Hong Kong, Singapore, Thailand and Malaysia). Of the 1,600 replies (21% return rate), 209 expressed interest in foreign investment. Of these, 75 were interested in investing in Vietnam. Forty enterprises stated that they carry out R&D in collaboration with others, but none of them is interested in establishing an R&D institution for themselves. At the same time, 400 questionnaires were sent to enterprises within Vietnam. Of the 200 replies, 140 expressed interest in investing in the high-tech zone. Among them, 60 stated that they had definite plans to invest, 60 said that they "will perhaps invest"; 44% of the replies stated that they can establish R&D institutions. There were also answers from 17 research institutes in Vietnam. Two of them said they "wanted to move into the high-tech zone", six said they "may possibly move" and the rest expressed no interest whatsoever in moving (MOSTE/JICA 1997).

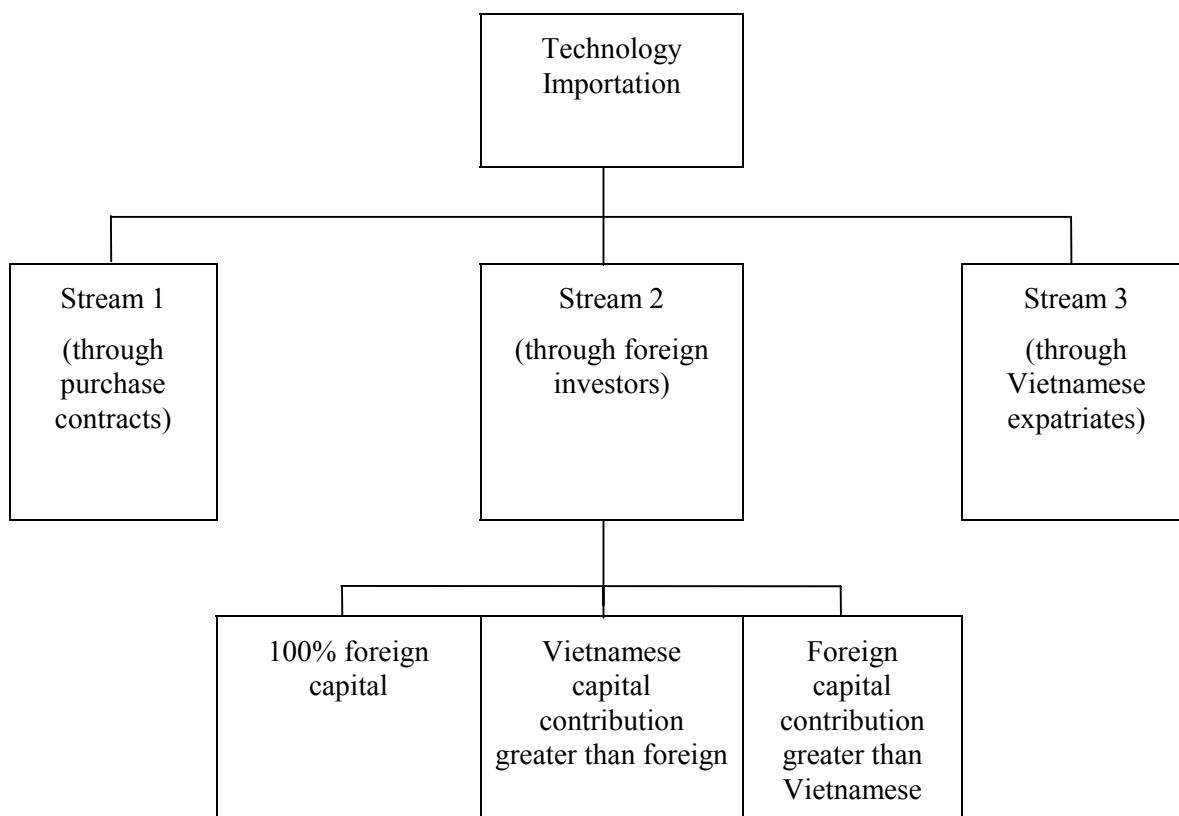
In general the foreign enterprises are primarily interested in manufacturing. R&D is only promoted if their production consistently requires it and it can be conducted by cooperating with

other institutions. It is highly unlikely that foreign investors will establish R&D institutions, especially for software development. Many Vietnamese enterprises realise the danger of lagging behind and are beginning to think about R&D, but they are limited by their meagre investment capital. The technology transfer between local enterprises was poor due to various impediments, such as the lack of state regulations and protection of copyright and intellectual property. However, since the Law of Science and Technology (May 2000) and subsequent relevant regulations were issued with some incentives (e.g. exemption from or reduction of tax) some enterprises have been considering promoting R&D activities.

3. Streams of Technology Importation

Technology transfer from foreign countries in Vietnam has been carried out through various flows (cf. Bui Tuong Anh, 1996). This is illustrated in Figure 3.3.

Figure 3.3: Streams of Technology Transfer



Stream 1: Technology transfer through purchase contracts

From 1954 (after the liberation of North Vietnam from French colonialism) to 1987 (before the collapse of the former USSR and Eastern European socialist countries) technology was mostly imported from socialist countries, India and some developed countries in the West. A serious mistake was made at that time in that technology transfer was limited to small components of machinery and equipment. This resulted in the complexity of technologies being underestimated and in organisational, software and other components of technology being neglected.

The doi moi policy emphasised the effectiveness of economic activities and made this the most important condition for technology import. Since its implementation, many more factors related to technology transfer have been realised and considered. The technology receiver in this case can buy, adopt and use as well as develop transferred technologies for their own interest without any dependence on the giver. But a technology transfer contract signed by the receiver has to be in line with the related governmental regulations (for example, limiting it to a specific sort and level of technology as well as limiting the forms it can take). The transfer process usually takes a long time and is very expensive. By transferring technology, the giver will not only benefit from the money paid by the receiver of this specific technology but also has the opportunity to explore the market potential of other technology they can offer. A major problem facing all receivers is how to get the right technology and to set an appropriate price.

Stream 2: Technology transfer through Vietnamese expatriates

Vietnam has a particularly high number of expatriates living in various countries. According to a recent report there are over 2.6 million Vietnamese living abroad and about 400,000 of them are scientists and technicians (Tran Trong Dang Dan 1998). Most of these people would prefer to come back to work in Vietnam if favourable conditions were available.

Neither the partner companies nor the giver's governments limit the technology transfer conducted through them. The receiver can thus obtain some technologies that could not be transferred in any other way. The transfer process is often shorter and its price lower thanks to the reduction of training costs and other expenses. Experience gained in the application of technology transfer in the field of electronics has been encouraging.

China has acquired much modern technology in recent years through some of its ca. 60 million expatriates. There is even a large central organisation for organising this. Vietnamese expatriates,

however, generally have little capital, while most enterprises in their home country are small or medium-sized, with limited financial capacity. It is therefore difficult to transfer technologies that require substantial investment capital.

Stream 3: Technology transfer by foreign investors

The technology transfer through foreign investors has been implemented in different ways, such as foreign direct investment (FDI), official development assistance (ODA), and grants from international organisations and programmes. About 70% of all foreign investment projects include activities related to technology transfer in the forms of training for technicians and workers, on-the-job consultancy, supply of materials, etc. Foreign companies, however, have usually incorporated these services and their expenses in the costs of construction, equipment and starting fees, instead of implementing technology transfer contracts.

According to a report by the Office for Technology Assessment (under the MOSTE) (Tran Phuong Hien 1997), only 80 technology transfer contracts (for about 2,000 projects) had been submitted to the Vietnamese government by the middle of 1997; 50 of them have been approved. The general features of 'Stream 3' can be formulated as follows: The foreign investor is also owner and user of the technology. The investor brings their technology into Vietnam in order to carry out their investment project and consequently the scale of investment depends more on investment conditions and the investment environment in Vietnam than on the capital capacity of Vietnamese enterprises. For Vietnam it is probably easier to improve conditions and create a more favourable environment than it is to find capital.

However, technology transfer is only one of many activities in an investment project and one of several measures to achieve the project's goals. In a developing country such as Vietnam, where the long-term development plan is still questionable, foreign investors attempt to get maximum profit in minimum time. It is therefore difficult to have modern technologies in an investment environment characterised by cheap labour and rich in natural resources. With more detailed consideration, three forms of technology transfer through foreign investment can be distinguished.

a) Technology transfer within projects with 100% foreign capital

This form of technology transfer can occur within large multinational corporations. The local workers are unable to understand the technology as a whole because they are involved in different stages in the working process. Moreover, foreign investors have tended to be very secretive about their technology. For example, the entire construction process of an assembly line for the production of a gourmet powder in Long Thanh (South Vietnam) was undertaken by Vietnamese workers, but the construction of a fermentation pot that has the biggest impact on powder quality, was done by Taiwanese workers. Similarly, Japanese employees were responsible for welding in the last stage of the production of electric motors in Bien Hoa industrial zone.

In general, this type of technology transfer makes an important contribution to increasing technological capacity in Vietnam but not the technological capacity of the Vietnamese. Some specialists stated that not only factories with 100% FI capital, but also joint ventures with capital contribution from the Vietnam side will collapse if foreign technicians withdraw (Pham Huyen 1999). Despite this problem, this form of investment has led some of the latest technology to be imported into Vietnam with other favourable effects: On the one hand, this technology creates good conditions for the rational use of labour and natural resources; on the other hand, the Vietnamese have opportunities to acquire a knowledge of "technological civilisation" (style of industrial work; treatment in production and business, etc.).

b) Technology transfer through projects with a major capital contribution by foreign investors.

Basically, the nature of this form of technology transfer is not very different from the first (within projects with 100% foreign capital), but there are some specific features to be considered. Despite the major capital contribution being made by the foreign partner, the law stipulates that in projects with a Vietnamese capital contribution of at least 20-30% of the total value, Vietnamese representatives must be members of the management board. Furthermore, according to the law governing FI in Vietnam, the Vietnamese partner in a joint venture has a right of veto over all important decisions. Therefore, some of the above-mentioned disadvantages for projects with 100% FI capital can probably be restricted. However, it also depends on the personalities of the Vietnamese representatives in joint ventures (how they strive to safeguard Vietnamese interests

and what qualifications they have in business and management) and on how Vietnamese law and state organisations can assist them.

In fact, many Vietnamese representatives in joint ventures have not been overly concerned about the common, national interest. It is not rare for them to sell out the common interest in seeking honour and privileges for themselves. Very few of them have been trained to manage businesses or technology transfer. The legislative and management systems in this area are still incomplete, enabling many foreigners to primarily use technology transfer to benefit from the joint ventures. Joint ventures make up 90% of foreign investment projects and in 90% of them the foreign side has made the largest capital contribution. The above-mentioned problems are therefore getting bigger and bigger (Tran Phuong Hien 1997).

- c) Technology transfer by joint ventures, with major capital contribution by Vietnamese partners

So far the number of such projects is not large, but they are becoming increasingly significant as FI increases. In principle, the Vietnamese partner (the receiver) has decisive rights in running the project. The receiver is allowed to use transferred technologies in their own interests, leading to an increase in their technology capacity. However, the lack of experience and management know-how, weakness in marketing, financial administration, personal management, etc., result in many important positions and decisions being held by foreigners. The foreign staff also control the technology transfer process. The Vietnamese partner usually fails to pay proper attention to detailed components as data processing, additional technologies. As a result, the technology system is not completed and it takes a long time for the technology to be put into operation.

4. Technology Transfer and Technology Assessment

General remarks on problems in technology transfer

Technology transfer from foreign countries to Vietnam has clearly speeded up the development of the country, but it has also brought many problems. Recently, not only public opinion but also politicians have strongly criticised the governmental agencies dealing with the management of technology transfer and have recommended measures to combat the negative impacts of technology transfer. There are many different reasons for this; the following are the most important:

- In many areas, the imported technologies do not satisfy the anticipated level. According to the National Agency of Standards, Measures and Quality (under the MOSTE) (MOSTE 1995), the majority of technologies are of average standard, outdated or completely obsolete. An investigation of 727 imported pieces of equipment and production assembly lines revealed that 70% were second-hand, some were manufactured as early as 1929. Most problems are in areas such as mining, food and stock-feed processing, the footwear industry and leather processing.
- Environmental protection is not safeguarded through technology importation. About 10% of foreign investment projects cause environmental damage. A report by the General Union of Labour showed that the concentration of toxic substances in the air around chemical and fertiliser joint ventures is eleven times higher than permitted and the soil contamination is 28 times higher.
- Inflated technology prices are very common. According to experts from the Ministry of Planning and Investment (MPI) and the Ministry of Trade, the price of imported technologies generally exceeds the average price in the world by 20%. These figures come from an inspection conducted by the Swiss company SGS in 14 factories with foreign investments. Some MOSTE experts stated that the inflated prices not only relate to equipment but also to training and daily allowances for foreign experts in Vietnam. Foreign partners often charge 30 to 40% more than would be normal. In some cases, the trainees did not gain sufficient knowledge and skills for them to carry out their work satisfactorily after completing the training course.
- In fact, the Vietnamese state organisations have not yet been able to control imported technologies. There is a lack of trained personnel capable of undertaking the state management of technology importation. Parallel to accelerating the qualification of managers, the government is putting a lot of effort into compiling and promulgating laws and regulations on the management of technology as well as into reorganising technology assessment activities.

Consideration and approval of investment projects

The authority to consider and approve investment projects is given pursuant to foreign investment project groups (cf. Amendment 2000; Resolution 2000).

The Prime Minister is responsible for *Group A projects*:

- Infrastructure construction of industrial zones and export processing zones, 'build-operate-transfer' (BOT), 'build-transfer-operate' (BTO) or 'build-transfer' (BT) projects.
- Projects with invested capital of forty million USD or more in the following fields: Electricity, mining, oil and gas, metallurgy, cement, chemicals, harbours, airports, cultural and tourist areas, and real estate business.
- Sea and air transport projects.
- Post and telecommunications projects.
- Cultural, press, publishing, radio and television broadcasting, training and education, scientific research and health care projects.
- Insurance, finance, auditing and inspection projects.
- Projects for the exploitation of rare and precious natural resources.
- National defence and security projects.
- Projects using five or more hectares of urban land or fifty or more hectares of land of other categories.

Group B projects are all projects that are not stipulated in group A. The MPI is permitted to decide on most of these projects, except those decided on by some important provincial People's Committees and the management boards of industrial zones. The main reason for getting governmental authority to licence investment projects is the number of projects in the region. Eight provinces and municipalities have or will have a large number of foreign investment projects, which have to meet the following conditions to be ratified:

- Accordance with the approved planning and socio-economic development plans.
- Investment value of at least ten million USD in Hanoi and Ho Chi Minh-City and at least five million USD in the other provinces.
- A quota of exported products in line with that periodically set by the MPI.
- Enterprises with foreign investment capital in which foreign partners are obliged to meet demands for foreign currency.
- Machinery and equipment comply with existing regulations. Exceptions can be made with the permission of a related authorised organisation.
- Compliance with environmental protection and labour safety regulations.

New regulations on technology transfer

In early 1987 the government began to pay attention to technology management and to issue related laws and regulations. Since then, technology transfer and technology assessment have

been stipulated by laws and by various government decrees and decisions. A short summary of new regulations governing technology transfer and assessment follows.

Subjects of technology transfer are industrial property; know-how; solutions to rationalisation of production, improvement and renovation of technology; service activities (consultancy, training, provision of information, technical services); machinery and equipment. Technologies that may not be transferred in Vietnam are those that may violate laws and regulations governing labour safety measures, sanitation, health, environmental protection and those that do not bring technical, socio-economic benefits or have a negative impact on the cultural and/or social security of Vietnam. Technology transfer must be conducted on the basis of a written contract. In the current regulations on technology transfer, it is stressed that the giver and the receiver of R&D results both agree to the right to apply for the protection of industrial property and payment of royalties to authors of the results. If there is no agreement between giver and receiver on this application right, the receiver has the right to apply for the protection of industrial property, payment of royalties to authors of the results and must pay royalties to the authors.

The calculation of *prices for technology transfer* is stipulated in detail in government documents. Any increase in the price of technology that is high-tech, or significant for the economic development of remote regions, or has a high export value will be considered by the MOSTE before being submitted to the Prime Minister for decision.

The ratification of contracts on technology transfer is stipulated as follows:

The MOSTE ratifies contracts on technology transfer if the transfer is within the scope of the law on foreign investment in Vietnam, the contracts include industrial property and the giver and/or receiver are using subsidies from the state.

The other ministries and provincial People's Committees ratify those contracts that do not belong to Group A. Fifteen days after ratification, these bodies must send copies of the contracts to the MOSTE for national registration.

Contracts that are not required to be ratified by MOSTE and where neither giver nor receiver are SOE must still be registered in MOSTE. Only contracts with a value of less than 50,000 USD do not need to be registered.

Technology assessment is one part of investment project assessment. For an imported technology the following aspects must be considered and evaluated:

Competitive products and their markets:

Market research and the choice of product and technology are of crucial significance for the development of an enterprise in general and of a technology choice in particular. A feasibility study for technology application must therefore involve forecasts of domestic and foreign market requirements. It needs to take into account products of the same kind available at present and in the future, the forecast of production capacity created by the technology, competition of product quality, and the form and price of products to be manufactured. Enterprises with FI capital that require imported materials, semi-products or equipment for their production, are required to export some of their products to achieve a currency balance unless their production can replace products stipulated in a list drawn up by government.

Technology level:

The expected technologies must correspond to those used throughout the world; at the very least their level must be higher than or equal to the existing technologies in Vietnam. When evaluating the level of a technology, its origin, period of manufacture and effectiveness must all be considered. The effectiveness of technology involves the following factors: efficiency, consumption of materials and fuel, level of automation, mechanisation, specialisation, work conditions, job creation, character of input materials, quality of products, environmental pollution, labour safety and fire prevention, effectiveness of investment capital and its recoupment duration.

Quality and functions of components of technology lines:

Components of technology lines must satisfy requirements for intended products and meet the demands of environmental protection and labour safety. The investor is liable for the quality of all technology. Equipment and machinery in the technology lines of investment projects in the following areas must be totally new: Ore selection, metallurgy, oil processing, production and distribution of electricity, cement, chemicals, fertiliser, pesticides, irrigation projects, waste treatment, health care, pharmaceutical products, food processing. In cases where the accuracy of

products is not specifically defined and neither the quality of products nor labour safety will be affected, the use of second-hand equipment is permitted so long as at least 80% of the quality control parameters laid down for new equipment are met. The special equipment must abide by particular regulations. Equipment evaluation is considers its origin, country of production, production year, features, character of input materials, quality, automation, mechanisation and operation condition. For second-hand equipment the following factors must also be taken into account: Who has used it, where, for how many hours and under which conditions, how many times it has been fundamentally repaired, which accessories it has and how it measured against set technical parameters when last controlled.

Raw materials and fuel used in production:

The use of local raw materials is encouraged. The main material source supply used in agricultural and forestry enterprises must be primarily from Vietnam. The use of environmentally friendly fuel is encouraged.

Labour and training:

In principle the workforce should be recruited within Vietnam, except for some special positions that must be filled by foreigners. All the workers in enterprises must be trained to meet the requirements of their positions. Working conditions must conform to labour regulations, the workers must be equipped with equipment and facilities that guarantee labour safety and hygiene and all enterprises must have fire and explosion prevention measures in place as well as first aid facilities.

Effectiveness:

Consideration of the effectiveness of technology must take into account its accordance with socio-economic development requirements and social and economic interests resulting from its application (e.g. new production capacity, job creation, new products, market expansion, increase of workers' input, contribution to the state budget and environmental protection). These factors are assessed with reference to the following indicators: net present value (NPV), internal return rate (IRR) and shorter time for capital amortisation.

Organisation of procedures:

The assessment of projects in Group A is coordinated by the MPI. It collects feedback from various related ministries, branches and provincial People' Committees and then submits an appraisal to the Prime Minister for the final decision. For projects in Group B, the MPI makes a decision after collecting assessments from various related organisations. In both cases the MOSTE is asked to assess the technology transfer contracts and environmental impact. These assessments must be sent to the MPI within 15 days; should this deadline not be met, approval is inferred. Within 40 days of receiving the investment application (for Group A), the MPI submits its assessment to the Prime Minister, and seven days after receipt of the Prime Minister's approval, the MPI issues the investment licence. In the case of Group B projects, the MPI makes its decision on the licence within 45 days of receipt of the application. All requests for amendments must be finalised by the relevant organisations within 20 days.

Provincial People's Committees issue investment licences within 30 days of receiving applications. Amendments must be finalised within 15 days. Departments of Sciences, Technology and Environment in the provinces are in charge of assessments of technology as well as technology transfer contracts. Should any issue arise that is related to the authority of ministries or branches, the People's Committee must consult with them.

Should problems arise during the assessment process, the MOSTE and Departments of Science, Technology and Environment have various options: Gathering specialist opinions, perhaps involving foreign experts; discussions with relevant organisations; use of foreign consultants.

5. Conclusions

Over recent years imported technologies have had a significant impact in various industries, for example increasing production capacity, labour productivity and product quality as well as settling employment problems for a considerable number of workers in Vietnam. Some branches have adopted advanced technologies. But in the majority of industries, the imported technologies have only reached an average or even outdated level when compared with global technological standards.

Technology transfer and assessment remain a substantial problem, which will not be easy to overcome in the next few years. To improve this situation, the state must, on the one hand, investigate and issue relevant regulations; on the other hand, it must quickly train managers in this field. The regulations issued must be amended or updated because some are not responding to the real situations, in some cases they are even formulated in a contradictory way.

Since 1986, under the *doi moi* policy, a considerable number of technologies have been imported. This has, however, not yet brought about a significant improvement of the general technological level of various industries (UNDP 1998). There are different causes for this delay and it is necessary to analyse this issue in more detail, especially concerning technology transfer within Vietnam. The creation of a supportive environment is essential to help individuals, communities and enterprises in both the state and non-state sectors to expand their import of technology and to broaden their participation in the development process.

References

- Amendment 2000: *Viec thuc hien va cac giai phap thu hut dau tu truc tiep nuoc ngoai* (Implementation of and solutions to FDI-attraction, MPI report on amendment to Law on Foreign Investment), 3/2000
- Amendment 2000a: *Bo sung luat dau tu nuoc ngoai* (Amendment to Law on Foreign Investment), 7/2000
- Bui Tuong Anh 1996: Study report on UNDP projects, Consulting Co. for Technology Transfer, Hanoi
- Central Institute for Economic Management, 2000: *Vietnam's Economy in 1999*, Statistical Publ., Hanoi
- Le Dang Doanh 2000: *Kinh te Viet nam sau 15 nam doi moi - Thach thuc va trien vong* (Vietnam's economy after 15 years of Doi Moi - Challenges and Prospects). 3/2000
- MPI 2000: *Bao cao 8 thang dau nam 2000 ve tinh hinh dau tu truc tiep cua nuoc ngoai o Viet nam- Bo KHDT* (Report on FI projects in the first 8 months of 2000 in Vietnam, MPI), Hanoi.
- MOSTE 1995: *Impacts of imported technologies on the Vietnamese economy*, Hanoi, October 1995
- MOSTE/JICA 1997: *Master Plan and Feasibility Study of High-Tech Zone Hoa Lac – Hanoi*, Ministry of Science, Technology and Environment (MOSTE) and Japanese Research Group JICA, Hanoi
- Pham Huyen 1999: *Ket qua phong van voi cac giam doc cac doanh nghiep hop tac dau tu* (Results of interviews with joint-venture directors), 3/1999
- Resolution 2000: *Nghi dinh cua Chinh phu quy dinh chi tiet thi hanh Luat dau tu nuoc ngoai tai Vietnam* (Vietnamese Govt. Resolution defining the handling of the law on foreign investment), 31/7/2000
- Statistical Yearbook 1999: *Nien giam thong ke 1999*, Hanoi 2000
- Tran Phuong Hien, 1997: *Quan ly Nha nuoc ve cong nghe trong giai doan kinh te thi truong* (State Technology Management in the Period of Market Economy, Office for Technology Assessment, MOSTE), Hanoi
- Tran Trong Dang Dan 1998, *Sach nghien cuu ve "Nguoi Viet Nam o nuoc ngoai"*, Nha Xuat ban Chinh tri quoc gia (Research Book on Vietnamese Overseas), Political Publishing House, Hanoi
- UNDP 1998: *UNDP Development co-operation report*, Hanoi, June 1989

Chapter 4: Dynamics of Vietnam's S&T Potential in Socio-Economic Context

Werner Meske

1. Science and Technology Indicators

Indicators have been developed to facilitate the description and evaluation of science and technology systems. They are being used by an increasing number of countries, in particular to provide basic information for politics, the economy and science itself. It is a matter of significant concern to better comprehend the relationships between scientific, technical, economic and societal development and to be able to understand S&T in terms of this comprehensive context (cf. OECD 1992). Research continues to this day, regularly bringing new insights as well as problems in the leading countries (cf. Porter/Stern 1999).

The most common international indicators used at this time were largely developed in the context of OECD work, constantly extended and refined. The best-known examples for the measurement of S&T activities are the "Proposed Standard Practice for Surveys of Research and Experimental Development – Frascati Manual" (OECD 1993) and the "Proposed Guidelines for Collecting and Interpreting Technological Innovation Data – Oslo Manual" (OECD 1997). The supplementing of R&D statistics with innovation indicators is closely linked to the further development of theoretical perspectives. The approach that has become generally accepted is one that has increasingly replaced the originally relatively isolated description of an R&D system with its incorporation into the analysis of extensive 'national systems of innovation' (Freeman 1987, Nelson 1993, Edquist 1997). The leading industrial nations originally collected R&D statistics only sporadically. In the meantime a highly developed system of regular data collation has been built up using a multitude of S&T indicators, including not only input but increasingly also output indicators. Internationally known are above all the biennial US reports issued by the National Science Board of the National Science Foundation (NSB 1999); they were developed from 'science indicators' into 'science and engineering indicators'. Similarly well known are the OECD series "Science, Technology and Industry Outlook" (2000) and the "European Report on S&T Indicators" (CEC 1997). In Germany the "Bundesbericht Forschung" ('Federal Research Report'), issued every four years by the Federal Ministry of Education and Research (BMBF), has become

established (BMBF 2000), supplemented by an annual report "on Germany's technological capacity" (Bericht 2000).

It is hardly surprising that Vietnam is battling with a multitude of difficulties as it attempts to develop and effectively implement the *doi moi* policies on the reorganisation of the S&T system. The objective of these strategies is, of course, to promote innovation, industrialisation and economic upturn. One of the reasons behind these problems is the lack of meaningful and longer term data series on important economic, technical and scientific resources and activities in the country. We thus consider the improvement of R&D statistics in line with the OECD Frascati Manual to be a vital task in this area; similarly, the collection and analysis of further crucial S&T and innovation data must have a high priority. A fundamental problem lies in the fact that to date no meaningful analysis has been made of either the R&D system or the innovation system in Vietnam. Especially in view of this shortcoming and the incomplete data basis, in the following the statistical and other data actually available (primarily collected by Vietnamese authors) will be drawn upon to gain a first overview of the magnitude and the fundamental structures and tendencies of S&T potential in the context of Vietnamese socio-economic development during the *doi moi* period. This is a prerequisite for sound conclusions about future possibilities for the development of S&T in Vietnam.

2. Economic Structure and Innovation

Any consideration of how to integrate R&D into the national innovation system and into industrial innovation processes, must take into account that Vietnam is still an agrarian and less-developed country with enterprises that are mostly small and usually not very technologically advanced.

The number of persons employed in agriculture (including forestry and fishing) has grown from 19 million in 1985 to 25.4 million in 1997. Their share within the total labour force was 76% in 1985 and had decreased to around 72% at the beginning of the 1990s. It was only in 1995 that it began its fall to 68%. In contrast, the number of industrial employees was relatively low and has remained so; 2.8 million in 1985 (with a share of 10.8%), and between 3.4 and 3.5 million during the 1990s. Their share within the total labour force actually dropped from 11.2% in 1990 to 9.5% in 1997! Even taken together with the remaining branches of material production (especially the construction industry), which had a share of approximately 2-3 million employees (ca. 7-8%), the proportion of industry (in the widest sense) has remained below 20% and even fallen slightly. Until 1995 that drop is attributable to

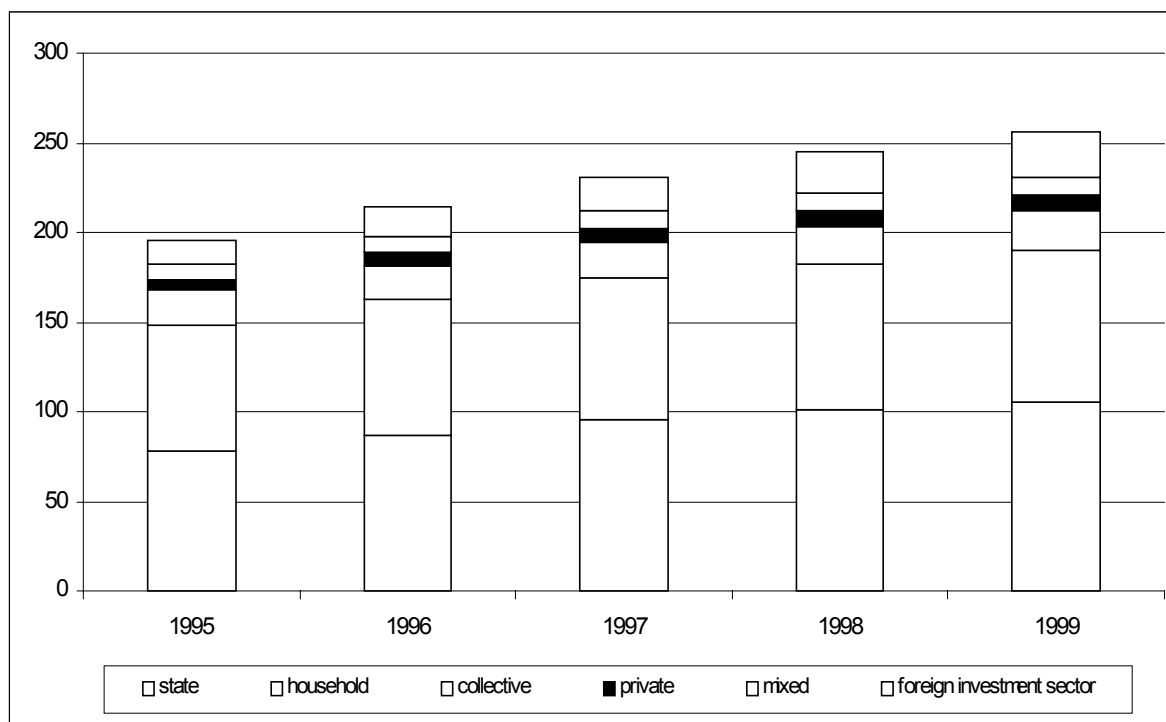
growth in agriculture, and after that to increased employment in the non-material sphere, i.e. in the services sector. This sector had a share of around 6% until 1995, and around 8% since then. Traditional areas of activity (education/training, health care, state administration) predominate within the sector, whereas 'modern' activities (the financial sector, knowledge-based services) are only weakly developed.

This data alone suffices to convincingly demonstrate that Vietnam has to this day remained an agrarian country in terms of social structure. Agriculture (together with fishing and forestry) employs more than two thirds of the workforce, as opposed to industry, which together with construction and other branches of material production employs less than 20%, while the services sector comprises less than 10%. The private sector (which the co-operatives now fall under due to their changed character) with its 91% share of the total labour force (1997) has at the same time remained predominant. Employment in the state sector, on the other hand, fell from four million (1986) to below three million in the 1992-1994 period, and has since then risen slightly, to approximately 3.4 million (1999). This was especially a result of increases in the 'education and training', manufacturing and construction sectors. Nevertheless, the state sector's share of the total labour force has dropped from 15% in 1985 to below 9% since 1993.

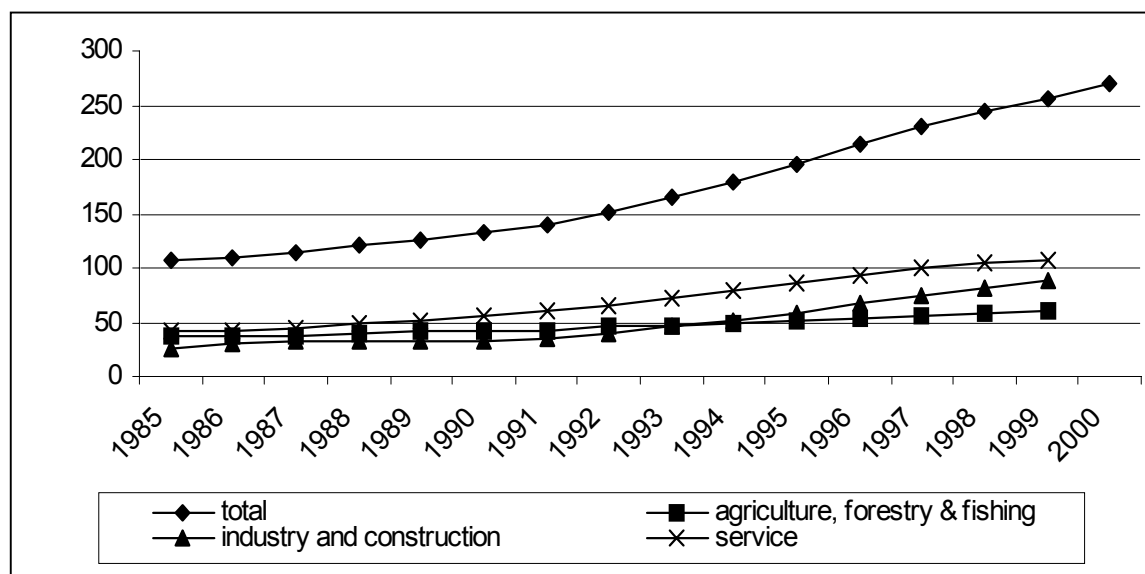
In the case of GDP structure according to ownership, a relatively high – with respect to the structure of the total labour force – but also fairly constant state-sector share of around 40% is discernible. That also means that the private sector in its various forms¹ continues to produce around 60% of GDP. Although the foreign investment sector's share rapidly increased in the 1990s, it still plays no more than a minor role, having a share of just 6.7% in 1995 and 10% in 1999 (cf. Statistical Yearbook 1999: 25) (cf. Fig. 4.1).

Within the structure of the GDP, the three sectors of agriculture (including forestry and fishing), industry (including construction) and services have proportions of 25-40% each, a marked deviation from the structure of the labour force. Agriculture with its comparatively high share of the labour force (which has fallen from over 70% to around 68% in 1997), has a notably lower share of the GDP, and one has fallen much more than its proportion of the labour force – from 35% in 1985 to 23.7% in 1999. By way of contrast, industry, despite its relatively low and even falling share of the labour force, has been able to increase its share of GDP from 25% in 1985 to almost 35% in 1999 (cf. Fig. 4.2).

¹ In Vietnam this means households in particular, with a share of about 30%, but also other private, collective and mixed forms.

Figure 4.1: Gross Domestic Product by Ownership (at constant 1994 prices; bill. VND)

Source: Own compilation

Figure 4.2: Gross Domestic Product by Economic Sector (constant 1994 prices; bill. VND)

Source: Own compilation

Since 1994 industry has had a higher share than agriculture; in proportional terms the two sectors almost reversed positions between 1985 (25% industry to 35% agriculture) and 1999 (34% to 24%). This speaks for the fact that industrialisation has been a driving force behind economic development and that in the 1990s the reduction in the number of employees in this sector (in particular in the SOE) has mainly served the cause of rationalisation and higher

efficiency and is not attributable to a fall in industrial output. Nevertheless, the development of GDP growth rates by sector in the 1985-1999 period show that Vietnam too suffered setbacks in industry at the beginning of the 1989/90 transformation, and that there were also falling growth rates in connection with the Asian crisis starting in 1997. It has been precisely in these periods that agriculture has proven itself to be a relatively stable growth factor.

Furthermore, industry itself is strongly linked to agriculture both in its structure and in its development. Those branches of industry that mainly process agricultural products thus had a total share of more than 40% of total industrial output in 1999. (These branches included foods and beverages – 23.6%, cigarettes and tobacco – 3%, textile products – 5.6%, leather tanning and processing – 4.7%, wood and wood products – 1.7%, rubber and plastics – 3.1%, furniture – 1.9%). If the 'chemicals' branch (5.4%) with its high proportion of fertilisers and insecticides/herbicides is added, approximately one half of total industrial production is dependent upon agriculture for either raw materials or sales. Moreover, industrial production is mainly concentrated in local SOE (14.7% in 1999) and in the non-state sector (21.8%).

Compared to the high proportion of traditional branches with relatively small and usually private companies, modern (high-tech) branches along with FDI enterprises play a rather minor role in Vietnamese industry in absolute terms, despite their above-average growth rates (cf. Tab. 4.1).

Machinery, computers, radio/TV/telecommunications equipment, etc. have shares of total industrial output that amount to only 1-2% each. Taken together, they only increased their share between 1995 and 1999 from 4.6% to 5.8%, even though they display above-average growth (all of them together by 205%, with tenfold expansion within four years in the case of computers). Similar statements may be made regarding the FDI sector, which exhibits the greatest growth of all with an increase of 224% (from 1995 to 1999), its share of industrial output thus increasing from 25% in 1995 to 35% in 1999. Yet even in this sector, oil/gas and food/beverages still have a share of over 50% in 1999, as opposed to the previously mentioned 'modern branches', which total only 9%. Yet even at that, the FDI sector has reached a share of over 50% of total production in these "modern" branches, in the area of radio/TV/telecommunications ca. 80% and in that of computers even 100%. This means at the same time that in this sector, more sophisticated in terms of S&T, the requisite know-how is mainly imported by way of technology transfer and need not be developed in Vietnam itself.

Table 4.1: Industrial Gross Output: Volume and Structure

Industrial Output	1986	1990	1995		1999		1999/1995 %
			absolute	%	absolute	%	
Total (at constant 1994 prices) (1,000 million VND)	(ca. 44,600)	(ca. 56,000)	103,374.7	100	166,965.3	100	161.5
of which							
. Machinery and equipment			1,345.1	1.3	2,428.8	1.5	180.6
. Computer and office equipment			27.9	0.0	300.5	0.2	1,077.1
. Electric and electronic products			1,087.6	1.1	2,860.2	1.7	263.0
. Radio/ TV/ telecomm. equipment			2,064.8	2.0	3,571.2	2.1	173.0
. Medical and precision instruments			202.6	0.2	547.3	0.3	270.1
= 'Modern branches' altogether			4,728.0	4.6	9,708.0	5.8	205.3
Structure by ownership (%)	(100)	(100)	(100)		(100)		
Domestic Economic Sector	100	100	74.9		65.3		140.7
- SOE	56.3	67.6	50.3		43.5		139.6
. Central	60.0	67.9	65.2		65.8		141.4
. Local	40.0	32.1	34.8		34.2		136.2
- Non-State	43.7	32.4	24.6		21.8		142.8
. Cooperative	64.3	28.2	2.5		2.6		132.1
. Private)		3.0	9.0		10.0		148.6
. Households)	35.7	68.6	71.5		62.4		114.5
. Mixed)			17.0		25.0		192.3
Foreign Investment Sector			25,933.2	25.1	58,019.0	34.7	223.7
of which:				(100)		(100)	
. Oil/gas			10,811.3	41.7	20,036.8	34.5	185.3
. Food/beverages			5,157.9	19.9	9,707.6	16.7	188.2
. 'Modern branches' (see above).			1,288.7	5.0	5,064.9	8.7	393.0
. <i>in which radio/TV/telecomm. equip</i>			<i>(948.9)</i>	<i>(3.7)</i>	<i>(2,787.4)</i>	<i>(4.8)</i>	<i>(293.8)</i>

Source: Nien giam Thong ke [Statistical Yearbook] 1996: 115, 1999: 167.

Vietnam's specific economic structure is also reflected in the enterprise structure, in particular with regard to the number and size of industrial enterprises. In 1998 there were almost 600,000 industrial 'producers'². Of these, however, only

- 881 were foreign enterprises, with an average turnover (industrial gross output) of 54.9 bill. VND (ca. 3.9 mill. USD) per enterprise;
- 575 were SOE under central government control, with an average of 1,723 employees and 79.4 bill. VND turnover (5.7 mill. USD) per SOE; this corresponds to only 3,300 USD/employee;
- 528 were SOE under local government control, with an average of 528 employees and 19.1 bill. VND turnover (ca. 1.4 mill. USD) per firm, corresponding to ca. 2,650 USD/employee.

In 1998 the remaining 592,067 'non-state' industrial producers (= 99.5% of all firms) were responsible for only 22% of total industrial gross output, i.e. 33,042 bill. VND (or 56 mill. VND, i.e. ca. 4,000 USD per firm per annum).³ It is no doubt clear that given their limited economic power, with few exceptions these non-state producers are not in a position to raise funds for importing modern equipment or even for comprehensive R&D based innovation of products and technology. The latter problem is probably also common to most SOE.

One can conclude from this that at most 2,000 industrial enterprises in the whole of Vietnam are even potential partners for R&D facilities. In fact, the number of real R&D partners is likely to be much lower when one considers that most of the foreign firms were only founded in the last few years (in 1995 there were only 439) and hardly use Vietnamese R&D at all. In addition, even in 1992 of the then 2,270 SOE, only ca. 10% had more than 500 employees. The ca. 600 firms in branches such as 'equipment and machinery', 'electrical/electronics industry' and 'chemical industry' only averaged between 200 and 300 employees each (cf. Tab. 4.2). It must, however, be noted here that employment figures in Vietnam certainly cannot be treated as equivalent to those in technologically advanced enterprises in Germany or other industrialised nations! The assessment presented here is also supported by the fact that despite political efforts being made to transfer R&D capacities, so far in all only 58 firms have their own R&D facilities.

² In the Vietnamese Statistical Yearbook they are named 'industrial establishments'. In the following we use the term 'producer'.

³ Own calculations based on Statistical Yearbook 1999, pp. 8-12 and 150-204.

Table 4.2: State-Owned Enterprises by Branch (1992)

Branch	No. of SOE (1 June 1993)	Employees		Number of SOE by Size of Workforce					
		1,000 persons	Persons/ enterprise (average)	<100	110-500	501-1,000	1,001-3,000	3,001-5,000	>5,000
Total	6,544	1,822	278	3,050	2,811	422	209	24	22
Industry in total	2,271	743	327	813	1,117	165	94	12	10
in which:									
Equipment and machinery	282	71	252						
Electrical/electronics industry	104	20	192						
Chemistry, incl. fertiliser and rubber	183	54	295						
Construction	1,034	270	261	369	549	85	27	4	-
Agriculture	661	273	413	311	225	74	40	5	6
Transport	236	.	.	63	134	25	10	1	3
Trade	1,774	.	.	1,068	614	62	29	1	-
Telecommunication	3	.	.	1	1	-	-	-	1
Others	142	.	.	109	22	3	5	1	2

Source: Nien giam thong ke [Statistical Yearbook] 1993, p. 247-249, 253

This preliminary analysis thus indicates first that the industrial sector in Vietnam is on the whole only weakly developed; second that it consists of a large number of small and undercapitalised companies that work at a fairly low technological level in traditional branches; and third that the few existing modern enterprises are usually subsidiaries of multinational companies or joint ventures with their participation.

This means that there are only a limited number of potential users for R&D in the industrial sector, and that even they usually need either "turn-key projects" or rather modest incremental improvements to presently existing (outdated) technologies and products.

When one considers the basic economic conditions in Vietnam, a situation is revealed that is on the whole rather unique due to the overlapping of transformational and development/industrialisation-related contexts. Against this background, essential aspects of the dynamics of S&T potential will now be outlined.

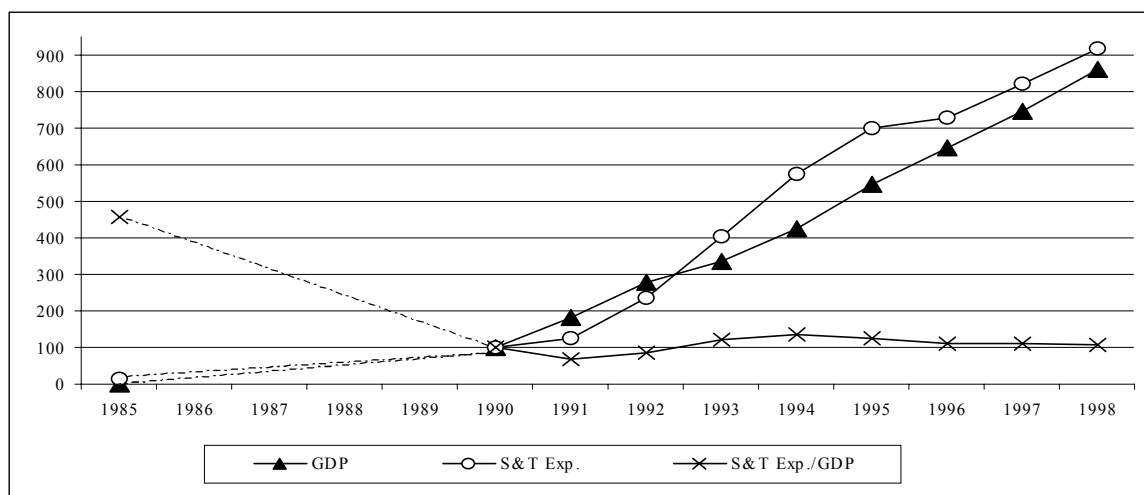
3. S&T Input-Indicators

One declared policy aim was to remove from the state the burden of (excessively) high R&D expenditures. An analysis of the changes occurring since 1985 in (real) R&D expenditure reveals stagnation and partly a decline up until 1991. In any case, a conflict arose in the second half of the 1980s between the growing needs of scientific institutions for funding and the funding that was actually possible (cf. Ch. 2, Tab. 2.12). From 1992 to 1994 the growth rates of S&T expenditures were actually relatively high, but they subsequently dropped again (cf. Tab. 4.3). The nominally high growth rates shrink further when inflation is taken into account. In fact, (at least) from 1990 to 1991 there was even a drop in (real) R&D expenditure. In order to assess the real significance of S&T expenditure it is therefore opportune to compare it with the size and development of economic indicators, in this case national income and GDP. In the period from 1965 to 1987 R&D expenditure made up between 0.4 and 0.7% of national income (NI). As the NI at that time was largely based on international aid, in 1985 nearly 1% of GDP was spent on S&T. Due to the stagnation of the economy at the end of the 1980s and the beginning of the *doi moi* policy era, the share of S&T expenditure within the GDP fell to 0.14% in 1991. Although it had doubled to 0.28% by 1994, it has since dropped back to 0.22%. In other words, the share of S&T expenditure within the GDP has practically not risen (cf. Fig. 4.3).

Table 4.3: S&T Expenditures and GDP

	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
1 S&T Expenditures - Billion VND; (current prices)	1.1	86.4	107	203	349	497	605	630	710	794
-%/a	.	.	124	190	172	142	122	104	113	112
2 GDP - 1,000 billion VND; (current prices)	0.12	42.0	76.7	116.5	140.3	178.5	228.9	272.0	313.6	361.0
-%/a		.	183	152	120	127	128	119	115	115
3 S&T Exp./GDP - Relation (%)	0.92	0.21	0.14	0.18	0.25	0.28	0.26	0.23	0.23	0.22
- Changes (%) (1990 = 100)	456	100	68	87	121	136	126	112	112	107

Own compilation based on Ch. 2 and Nien giam thong ke [Statistical Yearbook] 1999: 19

Figure 4.3: Development of GDP and S&T Expenditure (%; 1990 = 100; basis: current prices)

Source: Own compilation based on Tab. 4.3

Accordingly, the share of R&D funding that comes from the state budget has remained fairly stable (ca. 1% in the 1990s). This still represents an approximate share of between 60-80% of R&D funding coming from the state budget, despite the political aim of reducing this amount in conjunction with an increase in the amount of funding from industry (cf. Ch. 2). So there is a visible tendency for the (absolute or relative) reduction of state S&T expenditure to in fact not to be compensated for by increased expenditure on the part of the productive sector. The fiscal relief of the state was thus paid for with a cutback of S&T personnel.

Organisational changes within the R&D system, in particular since the mid-1990s, must be regarded as even more significant for functional changes than the fluctuations in S&T expenditure and employees. There has been a substantial increase in the number of R&D facilities, from 170 in 1985 to 264 in 1990 and 785 in 1998 (cf. Tab. 4.4).

Table 4.4: Number of R&D Facilities

Year	R&D Facilities		Tertiary Institutions	of which:	
	Total Number	%		Enterprises	Private Institutes
1985	170	100	19		
1987	165 (+ 69 Info.Centres)			23	
1989			40		
1990	264	155	58		
				(1994) 30	(1993) 50
1995	334	196	82		
1996	590	347	87	35	
1997					
1998	785	462	115	58	25

Own compilation, based on Ch. 2

Not only has the number of R&D facilities more than quadrupled since 1985 and doubled between 1995 and 1998, but the spectrum of the 785 facilities has also substantially diversified in various respects. Noteworthy here are the proprietary structures (cf. Tab. 2.15): Ownership of the total of 785 R&D facilities with 29,285 employees was as follows:

- state or public sector 472 facilities (60%) with 23,414 employees (80%)
- (state-owned) enterprises 29 " (4%) with 2,165 employees (7%)
- cooperatives 259 " (33%) with 3,430 employees (12%)
- private sector 25 " (3%) with 276 employees (1%).

Although the last three groups together represent only 20% of employees, they already represent 40% of institutes. As these institutes are precisely the ones that are involved in company innovation processes, either directly or by way of contract relationships, we also view them as expressing a functional transformation in the R&D system. Moreover, in the state or public sector too, clear qualitative and quantitative changes have taken place within the institutional spectrum and are still underway (cf. Tab. 4.5 and 4.6).

Table 4.5: Changes in the Organisational Structure of R&D

	1996		1998	
	abs.	%	abs.	%
Number of R&D facilities of which affiliated to:	590	100	785	100
- Universities	87	14.7	115	14.7
- NCNST	18	3.1	20	2.5
- NCSSH	24	4.1	17	2.2
- Large institutes	116	19.7	121	15.4
- Branch institutes	98	16.6	121	15.4
- Enterprises	35	5.9	58	7.4
- Associations	96	16.3	154	19.6
- Provinces	116	19.6	179	22.8

Own Compilation, based on Ch. 2

Table 4.6: Personnel in the R&D Facilities (1998)

R&D facilities affil. to:	Total		of whom		Average Staff (persons/institute)
	Persons	%	Scientists and engineers	% of total	
Universities	2,666	9.1	2,379	89.2	23.2
NCNST	1,917	6.5	1,528	79.7	95.9
NCSSH	678	2.3	624	92.0	39.9
Large institutes	4,164	14.2	2,611	62.7	34.4
Branch institutes	10,911	37.3	7,384	67.7	90.3
Enterprises	4,282	14.6	2,678	62.5	73.8
Associations	2,188	7.5	1,953	89.3	14.2
Provinces	2,479	8.5			19.4
Total	29,285	100	(19,157)	(65.4)	37.3

Own compilation, based on Ch. 2

Although their share has substantially diminished, the branch institutes controlled by the ministries and the similar facilities that belong to the so-called 'large institutes'⁴ still represent the main focus of the R&D system – in terms of both the number of facilities (over 30% altogether) and, above all, their workforce (with over 50% of all R&D employees). It is nevertheless striking that in the industrial sector too the number of facilities directly controlled by enterprises has risen from 30 in 1993 to 58 (1998) and that they, with their 4,282 R&D employees, incorporate almost 15% of Vietnam's total R&D potential. On the other side of the spectrum, the number of special research units within universities has grown from 19 in 1985 to 115 in 1998, with nearly 10% of R&D staff. By way of comparison, the significance of the traditional National Research Centres for Natural Sciences and Technology (NCNST) and for Social Sciences and the Humanities (NCNST) has waned, and their share of R&D personnel has fallen to below 9%. Additionally, there is now a large number of facilities that belong to associations financed through contract research (including state projects) or that are under the jurisdiction of the provincial authorities and thus primarily oriented toward regional demand.

The considerable structural changes in the number and types of facilities, above all in the second half of the 1990s, only very superficially indicate the actual changes occurring in their activities. The various (official) types of facilities shown in Table 4.5 often have very different structures. This not only concerns the (normal) breakdown of the individual institutes in different research departments (cf. Ch. 5), but also the formal or informal integration of different types of facilities in the official R&D institutes (via interlocking directorates, financial and other relations). Thus, for example, the NCNST (with its officially listed 20 institutes) directly controls 17 research units, which in turn control 16 independent units, 9 laboratories and even 15 enterprises (cf. Ch. 2, Fig. 2.6). The situation is similar in the branch institutes, which frequently have special service units and even manufacturing plants alongside the actual research departments - often with no clear internal division between them with regard to personnel and finances (cf. Ch. 6; this has also been confirmed to the author in several interviews conducted in 1996/97). It can therefore be presumed that the officially acknowledged increase in the structural diversity of research organisations will continue through the (organisational and functional) diversification in progress within these facilities.

Table 2.14 in Chapter 2 also indicates that virtually all basic forms of scientific activities (from basic to applied research, to experimental development and services) are present in all

⁴ Large R&D institutes are the research centres formerly under the governance of the Prime minister, e.g. NINE and NIFT, now under the MOSTE.

types of facilities. At the same time, the proportions in the case of basic research indicate that the National Research Centres (NRC) – contrary to political demands – continue to be the real main performers of basic research (cf. Nguyen Van Hieu 1998), while the universities, despite the potential they amassed in the 1990s, still play no more than a minor role (cf. also HRK 1998). This is underscored by the publication activities of the NRC, which despite the rapid increase in publications stemming from universities, still produce the greatest share of all SCI publications (cf. Tab. 4.13).

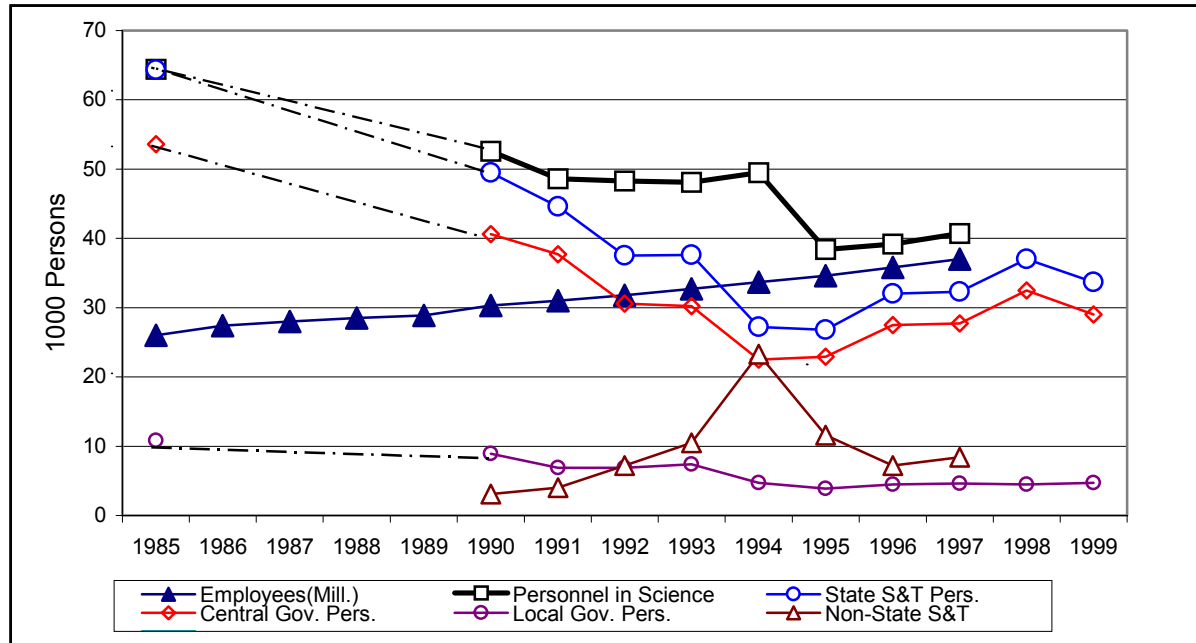
If one attempts – despite all reservations arising from the obvious gaps in our knowledge – to arrive at a summary assessment of the functional effects of the structural changes within the R&D system in Vietnam during the 1990s, a somewhat inconsistent picture emerges. On the one hand, reorganisation and the reduction of state funding along with a more competition-oriented approach to awarding it – via research programmes and projects – have led to a clear transition toward more diversified, smaller and more application-oriented R&D institutes with good prerequisites for flexible and market-oriented behaviour. This has to some extent already brought about changes in the spectrum of activities and to the (necessary) acquisition of additional sources of income. Nevertheless, the formation of new research profiles certainly involves longer-term processes that only follow organisational changes with some delay. This project was therefore able to observe only the first signs of changes at the mesolevel. On the other hand, the activity profiles described above, and especially the statements made in the case studies, indicate that the ultimate aim of getting R&D more heavily involved in enterprise innovation processes has only been achieved to a relatively minor extent, if it at all.

When employees in S&T are considered, different and even conflicting trends are clearly revealed. The Vietnamese population increased from 60 million in 1985 to 76.3 million in 1999 (or by 27%) and there was simultaneous growth in the total number of employed (wage-earners and salaried employees) - from 26 million in 1985 to 30 million in 1990 and 37 million in 1997 (a more than 40% increase since 1985). At the same time the number of employees in S&T⁵ fell from 64,400 in 1985 to 52,500 in 1990 and 38,400 in 1995, just 60% of the 1985 figure. It subsequently rose only slowly, reaching 40,700 in 1997 - 77% with respect to 1990 and only 6% more than in 1995 (cf. Fig. 4.4/Tab. 4.7). In other words, since

⁵ It must be noted at this point that incomplete statistics, not compiled by uniform methods, often make conclusive statements more difficult to make. Experience in transformation countries shows that data on S&T personnel comes closest to providing comparable figures over longer periods of time. Yet in Vietnam there are problems even in this regard. There was, for example, a 'Science' category in the employment statistics

the mid-1990s the situation has stabilised again, but there has been no significant increase in S&T personnel – in contrast to general developments in employment.

Figure 4.4: S&T Personnel in Vietnam



Source: Own compilation

The reduction in S&T personnel following the introduction of *doi moi* policy is mainly attributable to top-down processes in the reorganisation of R&D institutes. In the 1990s they were augmented by bottom-up processes involving the voluntary withdrawal of scientists from R&D institutes. This 'drain' was a result of incessant reorganisation, relatively low pay (cf. Tab. 4.7) and the more favourable prospects in (mainly private and foreign) business enterprises that were opening up for qualified personnel. The reduction in R&D employees can be regarded as an important effect of the transformation processes, with their pressure to rationalise. The reduction by 40% within the ten years from 1985 to 1995 is not fully comparable to the dissolution and fragmentation of the S&T system that occurred in the former socialist countries in Europe: Here the regression involved a drop in absolute terms to ca. 20 to 50% of the former number of employees (cf. Ch. 8). However, compared with the increase in total employment (unlike what the relevant Central and East European countries/CEEC experienced) it means a sharp reduction in the share of S&T personnel within total employment from 24.8 per 10,000 (1985) to now about 11 per 10,000 or a decline to 44% - similar to the changes in the CEEC!

compiled in the Vietnamese Statistical Yearbook until 1994, whereas since 1995, and in part retroactively to 1990, data is provided under the label 'Scientific Activities and Technology'.

Table 4.7: Personnel in S&T

	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
S&T Personnel in Science* (1,000 persons)	64.4	52.5	48.6	48.3	48.1	49.5	38.4	39.2	40.7		
- of whom in non-state sector (own compilation)		(3.0)	(4.0)	7.2	(10.5)	(23.3)	11.6	7.2	8.4		
S&T Activities - State sector											
- Personnel (1,000 persons)	64.4	49.5	44.6	37.5	37.6	27.2	26.8	32.0	32.3	37.0	33.7
- under central govt.	53.6	40.6	37.7	30.6	30.2	22.5	22.9	27.5	27.7	32.5	29.0
- under local govt.	10.8	8.9	6.9	6.9	7.4	4.7	3.9	4.5	4.6	4.5	4.7
- Income/month (1,000 VND) in current prices							361.2	504.9	554.5	673.2	543.0
% of average income in state sector							75	93	86	97	78
Relation:											
- S&T staff/ 10,000 employees	24.8	17.3	15.7	15.2	14.7	13.5	11.1	11.0	11.0		
- S&T in state sector as % of all state-sector personnel	1.67	1.45	1.42	1.26	1.29	0.93	0.88	1.02	0.99	1.09	1.00

* prior to 1994: Science; after 1995: Scientific Activities and Technology (changes to the methodology of data collection have presumably also occurred here).

Source: Own compilation, based on Nien giam Thong ke [Statistical Yearbook] 1993, 1995, 1996, 1998, 1999

Development of scientific personnel in particular is a matter that must once again be given more attention. The main reason for that is a qualification structure that is still relatively "weak", especially when seen in connection with the age structure. As for the qualification of S&T personnel, not only are the low shares of 2.2% professors and associate professors, and 9.7% PhDs and PhD candidates a cause for concern, but especially the low absolute number of only 1,263 PhD (candidates) and around 500 (associate) professors. If this number is broken down according to scientific discipline (cf. Tab. 4.8) or by institutions (cf. Bezanson et al. 1999: 163), it becomes clear that Vietnam's total research capacity, with only around 500 highly qualified individuals in each of the major fields of science, has no more than the minimum size necessary to constitute a qualified national scientific community. This is also true of individual institutes. For example, the whole NCNST, with 20 institutes, has only 600 PhDs, the NCSSH with 17 institutes has only 270. On top of that, in 1997 41.3% of PhDs were already 56 years of age or older (which means that in 2002 they will have reached or exceeded the Vietnamese retirement age of 60). The same is even true of 19.3% of PhD candidates (cf. Tab. 4.9). In 1997 persons below the age of 40 comprised only 7.4% in the former case and 14.3% in the latter within these qualification groups.

.This critical situation with respect to the size and age structure of the scientific elite in Vietnamese research⁶ is alleviated somewhat by the growing number of postgraduates within the faculties (cf. Tab. 4.10). However, it must be emphasised that it has still not changed fundamentally, since even a body of 10,000 scientists in all scientific fields in the country – who are also relatively young and have little international and research experience (cf. HRK 1998: 26-33 and Section 4 in this Chapter) – possess at best no more than a minimum of scientific competence, experience and competitiveness.

Table 4.8: Structure of Personnel with Higher Academic Degrees by Age (July 1, 1997)

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

Data compiled from Vietnamese ministry sources.

Source: This table has been taken from Bezanson et al. 1999: 163.

⁶ This is equally true for teaching staff at universities and other tertiary institutions, as their German cooperation partners have reported (cf. HRK 1998: 27-28).

Table 4.9: S&T Personnel by Qualification (July 1, 1997)

Type of S&T Personnel	Total		By scientific field (persons)				
	Persons	%	Natural Sciences	Agricultural, Forestry, Aquatic Sciences	Medical Sciences	Technological Sciences	Social Sciences and the Humanities
Postgraduates	2,509	11.2	616	419	201	573	700
- PhD*	186	0.8	91	26	13	35	21
- PhD candidates*	1,977	8.9	501	285	157	499	535
- MSc/MA	346	1.5	24	108	31	39	144
Graduates (Higher Education) – BSc/BA	11,447	51.3	1,392	2,197	1,615	4,388	1,855
Others	8,357	37.5	530	2,768	2,210	2,465	384
Total	22,313	100.0	2,538	5,384	4,026	7,426	2,939
of whom:							
- Professors	123	0.5					
- Associate professors	390	1.7					
• Female	9,420	42.2					

Source: Bezanson et al 1999: 160. (This data was compiled from Vietnamese ministry sources.) It may be presumed that this data corresponds to that contained in the Statistical Yearbook concerning the total number of S&T employees in the 'state sector under central government', which is indicated as 27,000 for 1997. It has not been possible to account for the difference. [W.M.]

* It is apparent that alongside PhD degrees in the proper sense, the 'Doctor of Sciences' degrees once acquired in the formerly socialist countries (Dr. sc., comparable to Dr. habil. in Germany), have been counted in the PhD category. It is presumably the doctorates (Dr.; these were referred to as 'Candidates of Science' in the USSR) that are counted in the category of PhD candidates. [W. M.]

Therefore, alongside adequate funding of S&T, the future development of staffing levels in R&D is closely related to the preservation or restructuring of Vietnam's educational system, which was once relatively well-developed, due in part to both tradition and socialist education policy. On the other hand, gradual transition to a free market and simultaneous retention of much of the political system appear to offer good prospects for the education system. Thus, the number of employees in the education system rose from 803,000 in 1990 to 999,000 in 1997. (This is growth of around 25%, while the population increased by ca. 13% over the same period.)

In general, relatively high level of education and low levels of illiteracy were maintained in Vietnam. The tertiary level of the education system - crucial for S&T - was further strengthened. However, given the relatively high number of young people, the proportion of ca. 5.9% students in the age group 20-24 is relatively low, even in comparison with Indonesia and Thailand (cf. HRK 1998: 27-28).

The number of R&D facilities in universities and other tertiary institutions rose to 115 (in 1998). With 2,666 employees in this sector, or 9.1% of all R&D employees, the role of universities in R&D is, however, still relatively weak. In addition, research in the tertiary sector tends to be concentrated in specialised units and is still not an integral component of the activity spectrum in all facilities - alongside the pre-eminent teaching activities (cf. HRK 1998: 32).

In view of the aforementioned problems in S&T personnel development and qualifications structure, we specifically considered this aspect too in our analysis of the development of the *universities* using statistical data (cf. Tab. 4.10). One result is that from 1986 to 1990/91 the number of professors increased slightly, while student and graduate numbers decreased slightly. The student-to-professor ratio thereby fell from 6.6 in 1986 to 4.9 (or 83.1%) in 1991. But beginning in 1992 the picture changed fundamentally (cf. Fig. 4. 5).

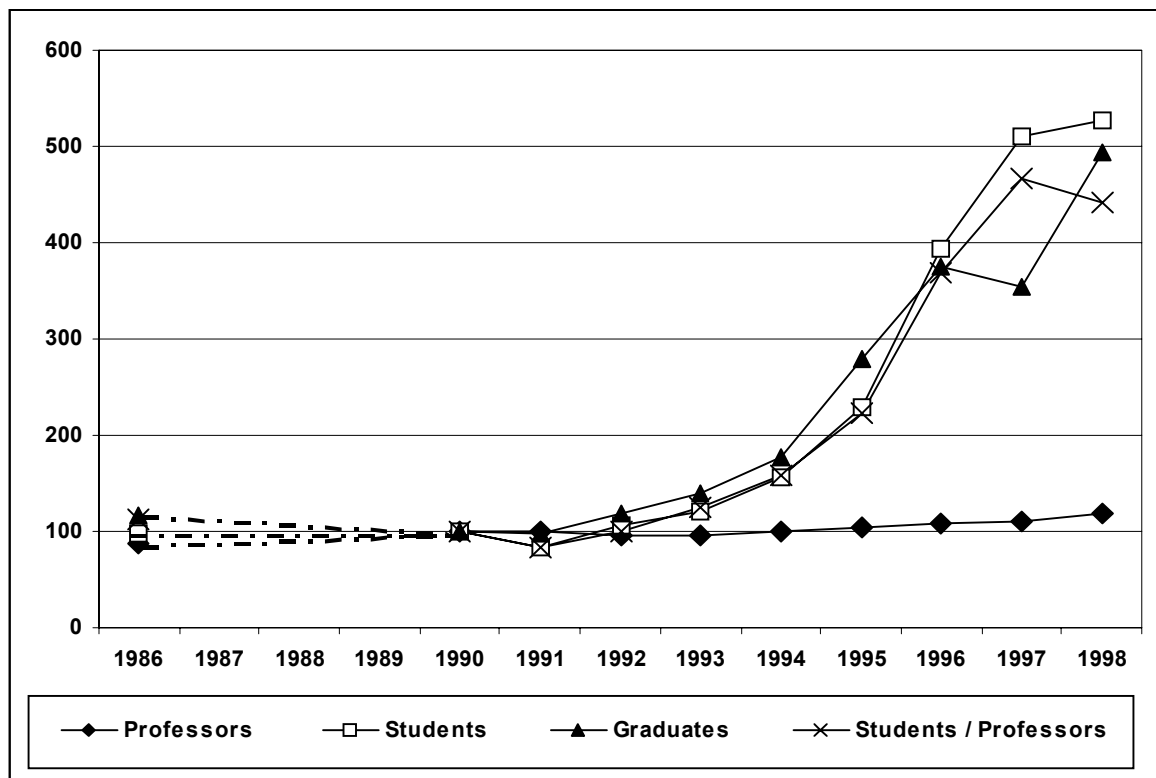
The number of students and graduates has jumped to a level that in 1998 was five times what it was in 1991. In contrast, the number of professors actually decreased until 1992, and then increased only slowly, by 20%, until 1998. By 1998 this had placed a burden on teaching staff that was five times what it had been in 1990 (15.4 full-time students per professor and 4 graduates per professor). In addition, there is a growing number of students in specialised supplementary and in-service training.

Table 4.10: (State) Universities

	1986	1990	1991	1992	1993	1994	1995	1996	1997	1998
Number of Universities	96	106	108	109	109	109	109	96	110	123
- Research Units.	19	58					82	87		115
- Personnel										2,666
- Scientists and Engineers										2,379
Professors and Teachers (1,000 persons) in persons / %	19.2	21.9	21.8	21.0	21.2 21,184 / 100	21.7	22.8 22,750 / 100	23.5	24.1	26.1 26,120 / 100
of whom:										
- Female					6,549 / 30.9		7,706 / 33.9			8,894 / 34.1
- Postgraduates	*				3,071 / 14.5		4,850 / 21.3			7,433 / 28.5
- Graduates					17,561 / 82.9		16,670 / 73.3			18,160 / 69.5
- in centrally governed univ.					17,388 / 82.1		18,366 / 80.7			20,176 / 77.2
- in locally governed univ.					3,796 / 17.9		4,384 / 19.3			5,944 / 22.8
Students (1000 persons)	126.2	129.6	107.0	136.8	157.1	203.3	297.9	509.3	662.8	682.3
of whom:										
- Full-time	91.2	93.0	90.1	116.9	122.9	136.9	173.1	236.3	357.6	401.7
- Specialised suppl. training	9.0	7.0	4.5	7.1	6.6	6.6	14.1	14.7	11.7	15.5
- in-service training	26.4	16.2	12.4	12.8	27.6	59.8	110.7	258.3	293.3	265.1
Graduate students (1,000 pers.)	24.3	20.9	20.5	24.8	29.1	36.9	58.5	78.5	74.1	103.4
Ratios:+ Students/Professors	6.6	5.9	4.9	6.5	7.4	9.4	13.1	21.7	27.5	26.1
- Full-time students/Prof.	4.8	4.2	4.3	5.6	6.0	6.3	7.6	10.1	14.8	15.4
+ Graduates/Professors	1.3	0.9	0.9	1.2	1.4	1.7	2.6	3.3	3.1	4.0
<i>Changes (%; 1990 = 100)</i>										
- Professors and Teachers	87.7	100	99.5	95.9	96.8	99.1	104.1	107.3	110.0	119.2
- Students	97.4	100	82.6	105.6	121.2	156.9	229.9	393.0	511.4	526.5
- Graduates	116.3	100	98.1	118.7	139.2	176.6	279.9	375.6	354.5	494.7
- Students/Professor	111.9	100	83.1	110.2	125.4	159.3	222.0	367.8	466.1	442.4

* 1,780/ 9.2

Sources: Nien giam Thong ke [Statistical Yearbooks] 1993, 1996, 1999.

Figure 4.5: Development of Universities (%; 1990 = 100)

Source: Own compilation based on Tab. 4.10

The rise in student number would appear to lie in the interest of preparing qualified personnel for a modern economy and society in Vietnam, and also corresponds to international trends. However, given the unfavourable ratio that has appeared in the short term, it is improbable that the required high educational level of graduates on the one hand, and the equally necessary permanent ongoing education of professors and other academic teachers – especially through their own research activity – on the other hand, can be guaranteed. Rather, it must be feared that now hardly any R&D, or even less than before, is being performed at the universities outside of the special research units, and that it is therefore difficult to guarantee the necessary rejuvenation and renewal of the body of scientists at research institutes. Positive tendencies are visible, however, in the growing proportion of women in faculties (1998: 34.1%) and in the rapidly rising level of qualification within the faculties. The number of postgraduates has increased two-and-a-half fold between 1993 (3,071) and 1998 (7,433). It has thereby reached a share of almost 30% within the whole faculty – as opposed to just 10% in 1986. The greatest number of these postgraduates, however – unlike the years before 1990 – may be presumed to have passed through their studies and postgraduate training only in Vietnam, and to have therefore acquired little international experience.

Given growth in demand due to the age structure of scientists and unstable prospects in science, it is a very important task to educate and recruit a sufficient number of young scientists of satisfactory quality for the R&D system in the next decade.

4. R&D Output: Publication Activities and International Co-authorship

The analysis of research activities reveals, among other things, a small proportion of (explicitly) basic research (cf. Ch. 2). The analysis of technology transfer (cf. Ch. 3) indicates, for example, that the quality of imported equipment and technology usually fails to meet international standards, but cannot be adequately examined or judged by the Vietnamese side. These findings raise questions about the extent to which international standards of research and technology are met in Vietnam and about the integration of Vietnamese scientists into international scientific communities. As one – certainly very rough – indicator of R&D output and of research standards in Vietnam, we analysed the publication activities of Vietnamese scientists in international journals (basis: Science Citation Index/SCI)⁷ and the active involvement in international collaboration evident from this (on the basis of co-authorships).⁸

The absolute number of SCI publications by Vietnamese scientists rose from 62 in 1985 to 197 in 1999; an increase of ca. 320%. This figure has grown especially rapidly since 1995, whereby this growth is parallel to an increase in publications produced in collaboration with foreign authors. Their share in the total number of publications is generally high, but nevertheless climbed from 30–40% in the 1980s to reach an unusual 70–80% in the 1990s (cf. Fig. 4.6 and Tab. 4.11). In contrast, the number of SCI publications with only Vietnamese authors fell from a peak of 58 in 1996 back to 36 in 1999 – even less than during the 1980s.

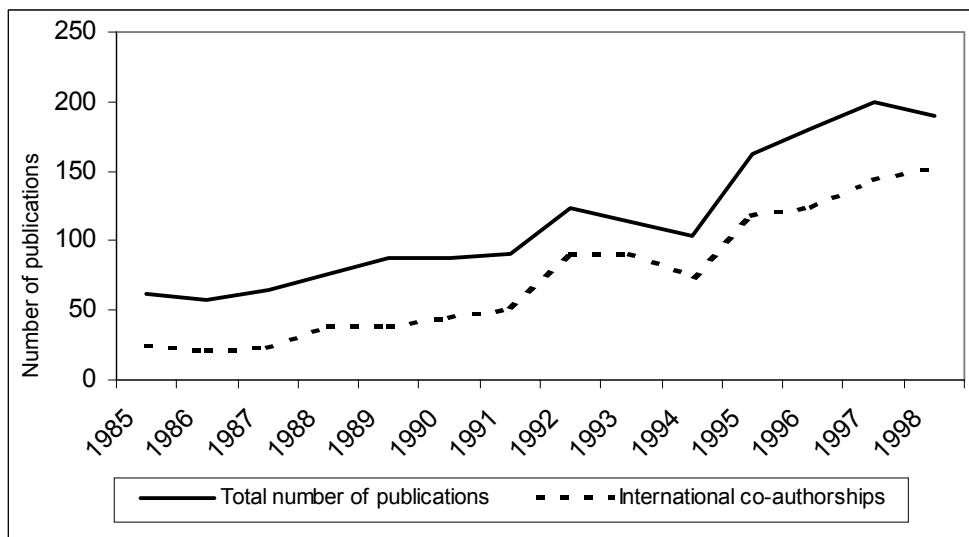
The rise in the number of international co-authorships must be seen to indicate an intensification of Vietnam's international opening and acceptance within the scientific communities. The extraordinarily high proportion of co-authorships alongside a stagnation in the number of publications by only Vietnamese scientists also seems to indicate, however, that in Vietnam itself the prerequisites for research results of international standing are still in their infancy and did not improved significantly during the 1990s.

⁷ All tables and figures in this section are the author's own compilations, based on data supplied by H.-J. Czerwon, using the SCI Data Base (cf. Czerwon 2000). Data source: Science Citation Index 1985-1999 (CD-ROM versions, 1985-1999). The following publication types ('citable items') were taken into consideration: (1985-1996) articles, letters, notes, reviews, (1997-1999) articles, letters, reviews.

⁸ Methodological hint regarding the assignment of papers to countries: A paper was assigned to Vietnam in those cases where at least one author (co-author) came from this country. International cooperation: A paper is deemed internationally co-authored if at least two corporate addresses are from different countries; in many cases more than two countries contributed to internationally co-authored publications.

Table 4.11: Vietnamese (SCI) Publications: Number and Structure by Authorship

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
Total number of publications	62	58	65	76	87	87	91	123	114	104	162	181	199	190	197	
- Vietnamese authors only	38	37	42	37	48	43	41	33	24	30	44	58	55	38	36	
- international co-authorships	abs.	24	21	23	39	39	44	50	90	90	74	118	123	144	152	161
	%	39	36	35	51	45	51	55	73	79	71	73	68	72	80	82

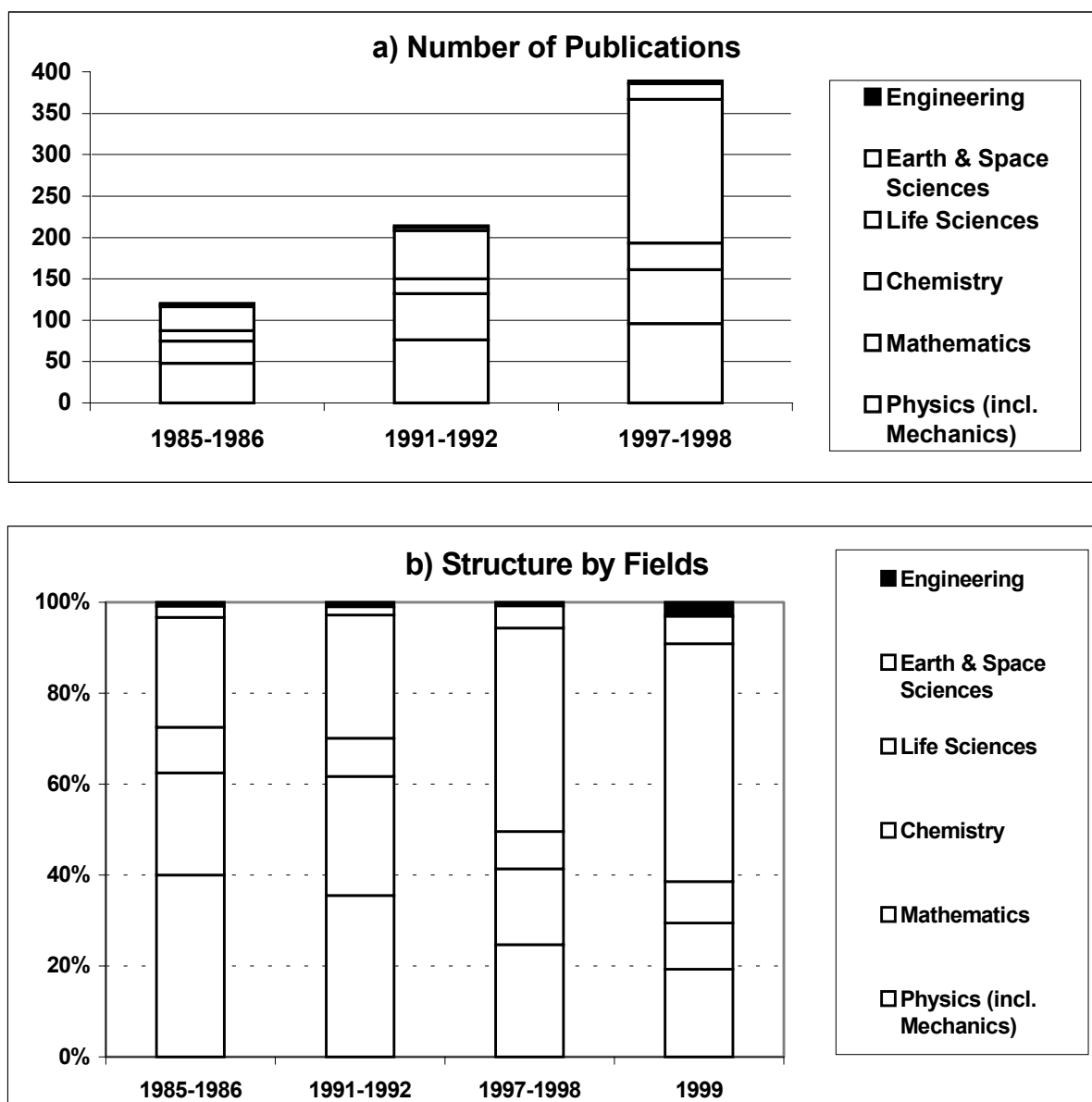
Figure 4.6: Vietnam's Publication Activity (basis: SCI)

This supposition is supported by the fact that the increase in publications has predominantly been in the life sciences (with an increase in their share from 24% in 1985/1986 to 45% in 1997/1998) and the earth and space sciences (an increase from a 2.5% to a 4.9% share during the same period), i.e. in two fields in which the utilisation of Vietnam's natural, climatic and geographical conditions and thus the country's involvement in the corresponding international research networks is very significant. In contrast, in those research fields that had previously been strong in Vietnam, such as physics, mathematics and chemistry, publication activity has increased considerably more slowly; their (combined) share thus dropped from over 70% in 1985/1986 to below 50% by 1997/1998. This trend continued in 1999 (cf. Fig. 4.7 and Tab. 4.12).

Engineering sciences, especially significant for technological change, are virtually invisible, with only between one and three publications per year until 1998; in 1999, however, this figure "jumps" to six. This view is also supported by an analysis of the distribution of Vietnamese authors by their affiliation. In 1985 almost two thirds of all SCI publications came from institutes within NRC, one third from universities and other tertiary institutions and only 5 (or less than 10%) from branch institutes and other facilities. In 1992 a further group appeared when the authors of almost 10% of SCI publications were affiliated to hospitals or other medical facilities; in 1998 the structure had further shifted in favour of this group and their share rose to over 20% (cf. Tab. 4.13).

Table 4.12: Vietnamese Publication Activity by Fields

	1985-1986 (120 Publ.)		1991-1992 (214 Publ.)		1997-1998 (389 Publ.)		1999 (197 Publ. = 328% to 85/86)		
	No. of Publ.	Rel. share %	No. of Publ.	Rel. share %	No. of Publ.	Rel. share %	No. of Publ.	Rel. share %	to average 1985/86%
Life sciences	29	24.2	58	27.1	174	44.7	103	52.3	710
Mathematics	27	22.5	56	26.2	65	16.7	20	10.2	148
Chemistry	12	10.0	18	8.4	32	8.2	18	9.1	300
Engineering	1	0.8	2	0.9	3	0.8	6	3.0	1,200
Earth & space sciences	3	2.5	4	1.9	19	4.9	12	6.1	800
Physics (incl. mechanics)	48	40.0	76	35.5	96	24.7	38	19.3	158

Figure 4.7: Vietnam's Publication Activity by Fields**Table 4.13: Publication Activity by Affiliation of Authors**

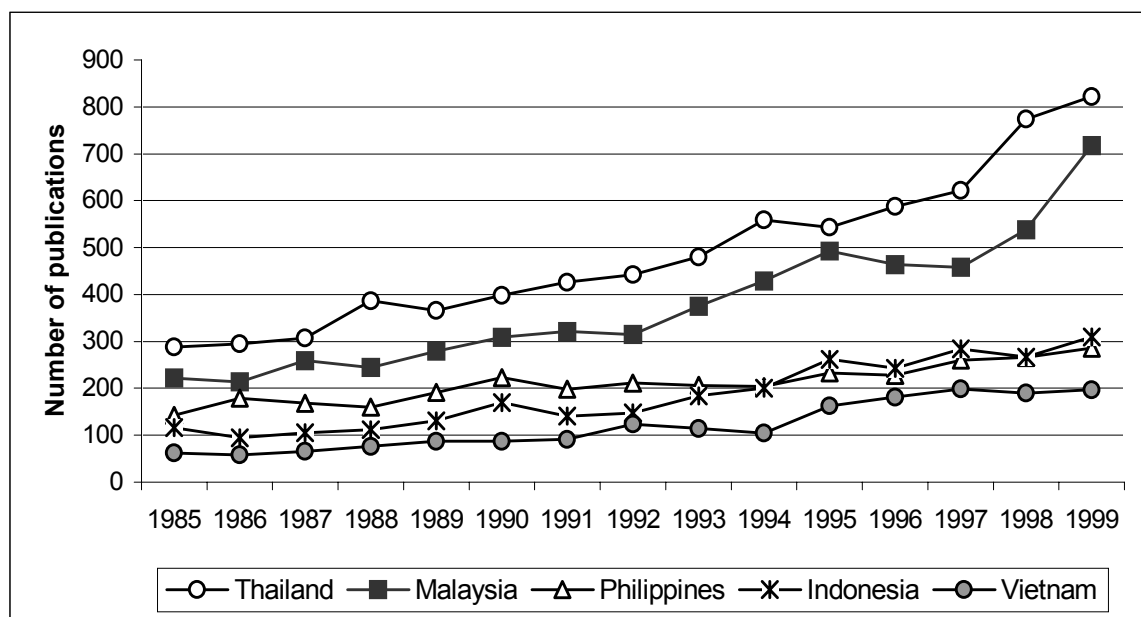
	1985	1992	1998
Number of publications from:			
- Universities	20	43	63
- National Research Centres	37	65	70
- Branch research and similar institutes	5	16	24
- Hospitals/medical institutions	-	12	45
Sum of publications	62	136	202
<i>(those counted more than once due to co-authorship within Vietnam)</i>	-	<i>(13)</i>	<i>(12)</i>

These changes in Vietnam's publication landscape are thus primarily caused by the emergence of the 'life sciences' and the involvement of Vietnamese clinics and similar facilities in international projects in this field. They are less the result of changes in the traditional

research institutions. In these institutions, however, a notable shift has been the increasing appearance of authors from the tertiary education sector (in some cases also in the field of medicine) as well as from various types of industrial institutes. This is also an indication of their more intense diversification, occurring alongside the growth in their international acceptance.

Vietnamese publication activity must be seen in even more relative terms when compared with neighbours in Southeast Asia. Despite the above-mentioned rise, even in the 1990s Vietnam lagged behind in terms of both the absolute number of publications and the rise itself. Thailand and Malaysia in particular - despite their smaller populations - not only exhibit higher publication figures, but also a considerably more rapid increase (cf. Fig. 4.8 and Tab. 4.14).

Figure 4.8: Publication Activities of Vietnam and ASEAN-4



This means that Vietnam could hardly improve its international position in science in the course of the 1990s. With only 2.6 SCI publications per million inhabitants in 1999, Vietnam did lie ahead of Indonesia (1.5), but behind the Philippines (3.8) and far behind Thailand (13.3) and Malaysia (31.6 publications/million population).

Finally, country preferences in international cooperation and their changes must be mentioned here (cf. Tab. 4.15).

Table 4.14: Publication Activities in Vietnam and Other Southeast Asian Countries (ASEAN-4), 1985-1999

Country	Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999			
		Number of Publications					% to 1985	Number of Publications					% to 1990	Number of Publications				% to 1995	
Vietnam	(76.3)*	62	58	65	76	87	87	140	91	123	114	104	162	186	181	199	190	197	122
Indonesia	(211.8)*	116	94	105	112	131	170	147	141	147	184	200	262	154	243	284	267	310	118
Philippines	(74.7)*	142	179	168	160	191	223	157	198	211	206	204	233	104	228	260	266	286	123
Malaysia	(22.7)*	222	214	259	244	279	309	139	321	315	375	429	493	160	464	458	538	718	146
Thailand	(61.8)*	288	295	307	387	366	398	138	426	442	480	559	543	136	588	622	774	822	151

* Population in millions, 1999

Table 4.15: Vietnam's Main Foreign Partners in Publications (Cumulative Data)**1985-1989 Period**

Rank	Country	Number of Joint Publications
1	German Democratic Republic (GDR)	24
2	Netherlands	21
3	USSR	21
4	Poland	19
5	France	18
6	Hungary	10
7	Federal Republic of Germany (FRG)	7
8	Austria	5
9	Czechoslovakia	4
10	USA	4

1990-1994 Period

Rank	Country	Number of Joint Publications
1	Germany*	80
2	France	55
3	Netherlands	39
4	USA	34
5	Russia**	31
6	United Kingdom	25
7	Italy	23
8	Japan	20
9	Hungary	15
10	Thailand	15

*1990: GDR + FRG

**until 1991: USSR

1995-1999 Period

Rank	Country	Number of Joint Publications
1	France	116
2	Germany	104
3	Japan	79
4	USA	76
5	United Kingdom	70
6	Netherlands	60
7	Australia	49
8	Thailand	44
9	Sweden	43
10	Italy	37

In the period from 1985 to 1989, formerly socialist countries (GDR, the USSR, Poland and Hungary) dominated joint publications; only the Netherlands and France had a comparable numbers of co-authorships. In the period from 1990 to 1994, the absolute number of joint publications with the formerly socialist countries remained relatively constant, but their share sank due to the increase in Vietnamese co-authorships with scientists from other countries, in

particular from (now united) Germany, France, and the Netherlands, but also from USA, the UK and Japan. This trend continued in the period from 1995 to 1999, so that none of Vietnam's ten main partners is now a formerly socialist country; instead the main partners are leading science nations and, alongside Japan, Australia and Thailand as further countries in this region. This regional aspect is evidence of Vietnam's successful efforts to establish better relations with countries in Southeast Asia, greatly facilitated in particular by membership in ASEAN.

In general, the international opening has resulted in the circle of countries in which Vietnamese scientists' co-authors worked being extended from 9 (in 1985) to 23 in 1990, 33 in 1995 and 46 in 1999. This is, however, partially due to the previously mentioned involvement of Vietnamese scientists in life science networks and in publications with a large number of authors. This is evident in the high proportion of (alternating) countries with only one co-authorship. The relation between the total number of publications produced in co-authorship and the number of countries providing co-authors has thus also risen from 1.04 in 1985 to 1.39 in 1990 and 1.48 in 1999. Also noteworthy is the fact that France is rapidly becoming very influential again. Since the middle of the 1990s it has even overtaken Germany as Vietnam's main partner in scientific cooperation. In contrast to Germany, the new French strength in co-authorships seems to be a further example of how very long the relations built up previously (despite the special context of colonialism!) continue to have an impact on scientific relationships (cf. Nagtegaal and Renger 1994). However, current political relations presumably play an even more significant role here. French president, F. Chirac, for example, referred to "Vietnam as France's natural gate to Asia" and actively implemented this policy both by promoting growth in FDI and by participating in the 1997 Hanoi summit, with 49 nations in which French is spoken (Krupp 1997). For the Federal Republic of Germany, on the other hand, throughout the 1990s Vietnam was by no means of key interest. In Germany's overall Asia concept it is mentioned only in the context of "endeavouring to win new attractive cooperation partners" (Asienkonzept 1995).

Germany still profits from the language proficiency and other diverse links established by the GDR. Conspicuous is the fact that in 1985/86 co-authors were only affiliated to East German facilities (cf. Tab. 4.16). Of these facilities, the former 'Institut für Biochemie der Pflanzen' ('Institute for Botanical Biochemistry') of the Academy of Sciences (AoS) and present-day 'Leibniz-Institut für Pflanzenbiochemie' ('Leibniz Institute for Botanical Biochemistry') in Halle/S. in particular has continued to maintain and even intensify its close cooperative relationships, especially with the Institute of Chemistry of the NCNST.

Table 4.16: German Facilities Involved in Co-Authorships in Vietnamese Publications

Nr.	Facility	East	West	1985	1986	1991	1992	1997	1998
1	Padagog Hsch NK Krupskaja, Sekt. Math Phys, Krollwitzer Str 44, 4020 Halle/S.	x		1					
2	Inst.-Plant-Biochem, [(AoS) Institut Für Biochemie der Pflanzen], Weinberg 3, Halle	x		3		5	6	8	6
3	Cent.-Institut.-Molec.Biol., (AoS) Zentralinstitut für Molekularbiologie, Berlin	x		1			1		
4	Acad Sci GDR, Zent Inst Opt & Spect, Rudower Chaussee 6, 1199 Berlin	x		1					
5	Res Inst Lung Dis & TB, 1115 Berlin, Ger-Dem-Rep Inst Appl Virol, Berlin	x			1				
6	Univ. Greifswald, Sekt Pharm, 2200 Greifswald	x			1				
7	Inst Appl Virol, Berlin	x			1				
8	Cent-Inst-Phys-Chem, 1199 Berlin,	x				2	2		
9	Karl-Marx-Univ, Dept Math, 7010 Leipzig	x				1		1	3
10	Martin-Luther-Univ, Dept Math, 4010 Halle	x				1		1	
11	Zent.-Instit-Elektronenphys., [(AoS) Zentralinstitut für Elektronenphysik], Berlin	x				1	1		
12	Univ-Munich, Sekt Phys, 8046 Garching		x			1		1	
13	Univ-Bonn, Inst Physiol Chem, 5300 Bonn		x			1			
14	Univ-Mannheim, Fak Math & Informat, 6800 Mannheim		x			2	1		
15	Univ-Cologne, Inst Math, Weyertal 86-90, 5000 Cologne		x			1	1		
16	Univ-Trier, 5500 Trier		x			1	1	1	
17	Max-Planck-Inst-Quantum-Opt, 8046 Garching		x			1		1	
18	Univ-Ulm, Theoret Phys Abt 3, 7900 Ulm		x			1		2	
19	Univ-Bonn, Inst Organ Chem & Biochem, 5300 Bonn		x			1	2		
20	Univ-Osnabruck, Vechta Naturwiss Abt, Fachbereich Math, 2848 Vechta		x			1		1	
21	Inst Für Biotechnologie, Permoserstr 15, 7050 Leipzig	x					1		
22	Univ-Essen-Gesamthsch, Fachbereich Math 6, 4300 Essen 1		x				2	1	
23	Ergo-Forsch-Gesellsch-MBH, Hamburg		x				2		
24	North-Rhine-Westphalia, Fed State Control Lab Food & Environm. Chem, 4400 Munster		x				1		

25	KFA-Julich- GmbH, RES CTR, Inst Appl Phys Chem, Ich4, Pob 1913, 5170 Julich 1		x				1		
26	Univ-Bayreuth, 8580 Bayreuth		x				1		
27	Humboldt-Univ-Berlin, Fachbereich Phys, Invalidenstr 110, 1040 Berlin		x				1		
28	Univ-Freiburg, Inst Macromolec Chem, 7800 Freiburg		x				1		
29	Freiburg-MAT-RES-CTR Stefan Meier Str 31a, 7800 Freiburg		x				1		
30	Inst-Biophys-&-Radiat-Biol, W-7800 Freiburg		x				1		
31	Ruhr-Univ-Bochum, Inst Mech, 4630 Bochum		x				1		
32	Univ-Stuttgart, Inst Theoret Phys, 7000 Stuttgart 80		x				1		
33	Univ-Frankfurt, Inst Theoret Phys, Robert Mayer Str 8, 6000 Frankfurt/Main		x				2		
34	Univ-Munich, Inst Organ Chem, 8000 Munich 2		x				1		
35	BASF-AG, 6700 Ludwigshafen		x				1		
36	Max-Planck-Inst, 5300 Bonn		x				1	1	
37	Free-Univ-Berlin, Div Radiochem, Inst Inorgan & Analyt Chem, 14195 Berlin		x					1	
38	Univ-Stuttgart, Inst Mech B, 70550 Stuttgart		x					1	
39	Univ-Konstanz, Fak Phys, 78434 Constance		x					1	
40	Univ-Heidelberg, Dept Biochem 2, 69120 Heidelberg		x					1	
41	Inst-Pflanzengenet-&-Kulturpflanzenforsch, Corrensstr 3, 06466 Gatersleben	x						2	
42	Univ-Hamburg, Inst Expt Phys 2, 2000 Hamburg		x					1	
43	Univ-Wurzburg, Inst Organ Chem, 97074 Wurzburg		x					1	1
44	Hsch-Tech-&-Wirtschaft-Dresden-FH, SG Chem Ingenieurwesen Umwelttech, PF 120701, 01069 Dresden	x						1	
45	Univ-Giessen, Tropeninst, Abt Phytopathol & Angew Entomol, 35390 Giessen		x					1	
46	Free-Univ-Berlin, Inst Kristallog, Takustr 6, 14195 Berlin,		x						1
47	Univ-Jena, Inst Theoret Phys, Max Wien Pl 1, 07743 Jena,	x							1
48	Tech-Univ-Chemnitz, Inst Phys, 09107 Chemnitz,	x							1

The 'Institut für Pflanzengenetik und Kulturpflanzenforschung' (Institute for Botanical Genetics and Research into Cultivated Plants) Gatersleben (Sachsen-Anhalt), formerly within the AoS, also appeared as co-author affiliation in 1997. All other East German institutes (with the exception of universities in Jena, Chemnitz and Dresden) only appear again in 1991/1992; in 1997/1998 they are no longer present. On the other hand, it is striking that several West German facilities only appear as co-author affiliations in 1991/1992, but in 1997/1998 they are hardly present. This may be a coincidence, but it could correlate with former East German scientists transferring to these facilities for a limited period. But then again, in 1997/1998 a wide spectrum of both East (5) and West German (15) facilities appear as the co-authors of Vietnamese scientists. The summarising of the joint publications of German and Vietnamese scientists between 1985 and 1999 confirms that the scientific relations between the two countries have tended to intensify rather than weaken during the 1990s (cf. Tab. 4.17).

Table 4.17: Joint Publications of German and Vietnamese Scientists

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
GDR	5	2	12	3	2	7									
FRG	-		1	5	1	5									
Germany	(5)	(2)	(13)	(8)	(3)	(12)	16	26	14	12	21	21	25	13	24

However, in comparison with the more considerable endeavours of other countries in this respect, German efforts remain slight. One is left with the impression that 'united' Germany is still not sufficiently utilising the potential for S&T cooperation with Vietnam that is part of the legacy of the GDR. This opinion was also expressed by those institutions cooperating with Vietnam at a workshop held by the national body representing higher education institutions (Hochschulrektorenkonferenz) in 1998 (cf. HRK 1998). The changes in the cooperative relationships between German and Vietnamese scientists and their causes appear to be an interesting field of investigation, they could, however, only be touched upon in the context of this project. One important source of influence clearly lies in the changes occurring within the German research landscape.

In conclusion, Vietnam's international publication activity can be said to offer an inconsistent, even contradictory picture. On the one hand, progress has clearly been made with regard to the number of publications - in particular in the field 'life sciences', the number of cooperating countries and the number of publications with international co-authorship, especially since the mid-1990s. On the other hand, in the early 1990s there was even a decline and, in total, there has been a stagnation in the number of publications by only Vietnamese authors. A further source of concern are the facts that there has only been a minor increase in publications in the traditionally and economically significant fields of 'physics/mechanics' and 'chemistry' and that publications in the field of 'engineering' are still very infrequent. These points suggest problems in Vietnamese research.

On the whole, however, the total increase in publication activity, the greater scientific breadth, the involvement of a steadily growing number of Vietnamese facilities and, above all, the

expanding diversity of international relations alongside a shift into the Pacific region all indicate that an effective change or a fresh start has taken place during the 1990s with regard to Vietnam's integration into the international scientific community.

References

- Asienkonzept, 1995: Bildungs- und forschungspolitische Schwerpunkte in der Kooperation mit Ländern des asiatisch-pazifischen Raums. Initiative des BMBF zur Konkretisierung des Asienkonzepts der Bundesregierung, 27. 10. 1995, o. O.
- Bericht, 2000: Zur technologischen Leistungsfähigkeit Deutschlands. Zusammenfassender Endbericht, Gutachten im Auftrag des Bundesministeriums für Bildung und Forschung (Vorgelegt durch Zentrum für Europäische Wirtschaftsforschung, Mannheim, Niedersächsisches Institut für Wirtschaftsforschung, Hannover, Deutsches Institut für Wirtschaftsforschung, Berlin, Fraunhofer-Institut Systemtechnik und Innovationsforschung, Karlsruhe, Wissenschaftsstatistik im Stifterverband für die Deutsche Wissenschaft, Essen) Jan. 2000; www.bmbf.de/veroef01
- Bezanson, K./ J. Annerstedt/ K. Chung/ D. Hopper/ G. Oldham/ F. Sagasti, 1999: Viet Nam at the Crossroads: The Role of Science and Technology. Ottawa: Intl Development Research Centre.
- BMBF, 2000: Bundesbericht Forschung 2000; Bundesministerium für Bildung und Forschung, Berlin; www.bmbf.de/veroef01
- CEC (ed.), 1997: Second European Report on S&T Indicators 1997; European Commission, DG XII, Brussels, December 1997, EUR 17639
- Czerwon, Hans-Jürgen, 2000: Vietnamese scientific production as reflected by publication indicators, 1985-1999, unpublished report for the Social Science Research Centre Berlin (WZB)
- Edquist, Charles (ed.), 1997 : Systems of Innovation. Technologies, Institutions and Organizations, Pinter Publishers, London/Washington
- Freeman, Christopher, 1987: Technology Policy and Economic Performance. Lessons from Japan, University of Sussex, Science Policy Research Unit; Pinter Publishers, London/New York
- HRK (ed.), 1998: Stand und Perspektiven der Zusammenarbeit mit Hochschulen in Vietnam; Materialien zur Hochschulkooperation 13/1998, Hochschulrektorenkonferenz, Bonn
- Krupp, Kerstin, 1997: Werben um Asien. Frankreich verstärkt seinen Einfluss in Vietnam, Berliner Zeitung, Nr. 266. Fr., 14. November 1997, p. 10
- Nagtegaal, Luc W and Renger E. de Bruin 1994: The French connection and other neo-colonial patterns in the global network of science, in: Research Evaluation, Vol. 4, No. 2, pp. 119-127.
- Nelson, Richard R. (ed.), 1993: National Innovation Systems. A Comparative Analysis; Oxford University Press, New York/Oxford
- Nien giam Thong ke [Statistical Yearbook] 1993, 1995, 1996, 1998, 1999: Nha Xuat Ban Thong ke [Statistical Publishing House], Hanoi
- NSB, 1999: Science & Engineering Indicators; National Science Board/NSF, Washington
- OECD (ed.), 1992: Technology and the Economy. The Key Relations; OECD, Paris
- OECD (ed.), 1993: Proposed Standard Practice for Surveys of Research and Experimental Development – Frascati Manual; OECD, Paris
- OECD (ed.), 1997: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data – Oslo Manual; OECD/Eurostat, Paris
- OECD (ed.), 2000: Science, Technology and Industry Outlook 2000; OECD, Paris
- Porter, Michael E., Scott Stern, 1999: The New Challenge to America's Prosperity: Findings from the Innovation Index; Council on Competitiveness Publications Office, Washington

Industrial R&D and Innovation in Vietnam

Chapter 5: Development and Reorganisation of the R&D System in Industry

Nguyen Thanh Thinh / Dao Duy Tinh

1. Industrial Development in Vietnam

Before 1954, during colonialism, Vietnam was a country with a backward agricultural economy and handcraft manufacturing. Industrial production was limited. Between 1950 and 1955 there were only about 200 enterprises in the entire country, employing 90,000 workers, including some mining companies with 30,000 miners. They were mostly involved in extracting natural resources for the benefit of foreign consumption. During the early 1960's, following the liberation of the North and in the period after unification of the country in 1975, the government of Vietnam put special emphasis on the development of self-reliant industry. Goal was the creation of the preconditions for national industrialisation through the establishment of a number of (heavy) industries, industrial complexes and the construction of key projects. But the socialist transformation after colonialism aimed at turning most economic entities, particularly in industry, into state-owned enterprises (SOE). As a result of this and the central-planning mechanism, there was virtually no private business and firms were subordinate to and dependent on their ministries and government agencies. In addition, the long wars and heavy bombing also contributed to weakening the young industrial sector. Most enterprises, especially those catering to people's basic needs and supplying the army, had to maintain production at all costs.

After 35 years of construction and development in the centrally planned economy, Vietnamese industry has got underway with some reconstructed and a few newly built factories. The factories engaged in heavy industry suffered from a lack of capital and outdated technology; they were producing for a limited domestic market and were not exposed to competition in an open market. Outdated technology and equipment, poor quality materials and inadequate labour skills were typical features. Even today many firms are working with equipment that was imported and installed prior to 1975, often under conditions of war, and cannot produce even average quality goods. In addition, investment in heavy industry was lower than in other branches, such as, for example, light industry. In spite of some achievements, Vietnam's industry has undergone many ups and downs, especially since the economy as a whole began its transition to market mechanisms in the second half of the 1980s.

However, since 1991, Vietnam's industry has entered a new stage - gradually stabilising and developing with an average growth rate of 13.3 % between 1991 and 1998 (cf. Tab. 5.1 and 5.2).

Table 5.1: Annual Growth Rate of Industrial Output (%; 1989 prices)

	1965	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*
Growth	6.0	10.4	17.1	12.7	13.7	14.5	14.2	13.8	12.5	10.4	14-15

* Estimated data

Sources: Nien giam Thong ke, 1985-1999 [Statistical Yearbook], Hanoi;
 Tap chi Cong nghiep VN [Vietnam Industry Review] 9/2000
 A Guide to Vietnamese Industry, 1998

Table 5.2: Average Annual Growth Rate by Branches (%)

	Heavy Industry	Consumer Goods Industry	Power Industry (Electricity)	Fuel Industry
1991-1998	15.4	13.6	16.5	22.6

Source: The Development of Vietnam's Industry, Hanoi, 1998.

In 1996 there were about 2,000 industrial SOE operating in Vietnam, of which 528 (25%) were operating at the central level and the remaining 1,474 (75%) at the regional and local levels. Most of the enterprises were small and medium sized.

From 1988 to the end of 1997 1,012 foreign direct investment (FDI) projects were licensed in heavy industry, light industry, food industry, oil and gas sector, and the construction of export-processing and industrial zones, with a total of 13 billion USD investment capital. Industrial projects comprised 53% of all projects and 41% of total FDI capital in Vietnam. In heavy industry there were 404 projects with 5,555 million USD total FDI capital, in light industry 440 projects with 3,331 million USD and in the food industry 121 projects with two million USD capital.

In 1997 and 1998 all important products with a potentially strong impact on national economic balances also developed well. Electricity output increased at an average 14% per annum, coal by 9.8%, crude oil by 10%, cement by 25%, rolled steel by 17% and other processed industrial products also increased satisfactorily. The estimated level of development investment in the national economy during 1997 and 1998 was about 14-15 billion USD, accounting for 34-35% of the five-year plan for 1996-2000. The annual growth rate of investment had doubled compared with the previous five years. The allocation of implemented capital is now generally more in line with plan projections. Mobilisation of domestic capital accounted for 51% of total investment during these two years (capital from

the state budget accounted for 20%, from private savings for 24%, 7% from the cooperative sector). The remaining 49% capital was raised from foreign sources, including official development assistance (ODA), FDI (26 %) and capital borrowed by SOE from foreign sources for investment.

Until the late 1980s all economic decisions were centralised via a large number of ministries and other central and regional administrative facilities for the direct control of almost all economic units. Doi moi policy brought about substantial changes during the 1990s. On the one hand central administrative facilities were gradually merged and reduced in number, on the other hand, the SOE were conceded more independence, usually associated with the formation of larger corporations for certain economic branches; In addition, private enterprises were permitted. On April 30th, 1990 the Ministry of Heavy Industry (MOHI) was formed by merging the Ministry of Mechanical Engineering and Metallurgy with the state headquarters for chemistry, geology and mineral oil/natural gas. The MOHI was in turn merged with the ministries of light industry and energy and further central government agencies to form the Ministry of Industry (MOI) on November 1st, 1995. Apart from other tasks, the MOI was responsible for the organisation of scientific and technological R&D and the strengthening of S&T progress in the industrial sectors under its control, as well as the management of the research institutes under its control.

In order to relieve the merged ministries of operative tasks, SOE were simultaneously merged or in some cases shut down. Larger economic enterprises or combines (called 'corporations') were formed, which were often also affiliated with subordinated R&D institutes relevant to the respective branch¹. In 1995 nine corporations, eight firms, one information bureau and six (of the 23 formerly centrally managed) R&D facilities were still directly subordinate to the MOHI. In turn, each of the nine corporations covered a certain economic branch together with a series of firms and usually several R&D facilities.

After the MOI was established at the end of 1995, further reorganisation followed and in 1997-1998 ten corporations, six R&D institutes and a few central offices (e.g. for geology and mineral resources) with their own enterprises were directly subordinated to it. Further 21

¹ These changes within SOE and R&D institutes were mainly based on the following decrees: Decree No. 324-CT dated 11 September 1992, of Ministerial Council and Decision of VN Prime Minister: No. 782 dated 24 October 1996, for the Reorganisation of the National R&D Network in Vietnam; Decrees No. 90 and 91 of Prime Minister dated 7 March 1994, for restructuring the companies in production and business to form various national 'corporations'.

industrial R&D institutes or centres belong to the 26 industrial corporations. In 1999-2000 MOI continued to restructure R&D institutions in the industrial sector. At the end of 2000, seven R&D institutes (with new names) were directly affiliated to MOI as were a total 26 corporations or SOE, including 21 R&D institutes (cf. Overview 5.1 below).

Many engineering plants were built between 1960 and 1980 with what were then the latest technologies and equipment, far ahead of many regional countries at that time. Annual production of engineering products met 50% of domestic demand. Engineering was considered the pride of Vietnam's infant industrial sector. But by the 1990s, the equipment had already fully depreciated and new equipment was not purchased. 95% of equipment in use today is a hodgepodge of incomplete devices.

All these conditions have contributed to weakening the potential of Vietnam's engineering sector. In the past, due to outdated technologies and high production costs, Vietnam's engines and agricultural machinery held only about 10% of the domestic market share while Chinese products accounted for 75% and second-hand Japanese engines comprised the rest. Statistics show that the annual import value of engineering products accounts for 50% of the nation's total production value. In 1998, Vietnam spent over 2 billion USD on imports of complete equipment. If the domestic engineering sector could cover for 40-50% of this, it would save a considerable amount of hard foreign currency for the state budget and create jobs for over 24,000 Vietnamese employees in the 4,827 companies, plants and enterprises existing at that time (Statistics 1999; Ha Nghiep 2000).

On January 9, 1999, Prime Ministerial Decision 29/QD-TTg entered into force, announcing that the government would grant a one trillion VND preferential loan to the engineering sector for the renovation of technology and equipment.

2. The Chemical Sector

During the five-year development plan of 1986-1990, the chemical industry grew by 5.2% per annum. During *doi moi*, the economic renovation, with the introduction of productive state policies and mechanisms, this sector steadily developed despite facing many challenges. Sector growth during that period averaged 20% annually, higher than that of the industrial sector. During the last five-year development plan of the 20th century, the sector recorded fairly high growth. Of the sector's total production value in 1998, local state-run units accounted for 24%, central state-run units 44.8%, units funded by foreign investment 20.9% and others 10.3% (private and collectively-owned enterprises). Despite comprising only a

modest numbers of enterprises, the newly established foreign investment sector has performed remarkably well. Joint ventures (JV) are, for example, producing detergents (P&G Vietnam and Unilever Viso). In other areas of chemical related production, such as batteries, rubber, basic chemicals, fertilisers and pesticides, foreign investment has also been active.

State enterprises were mainly small and medium-sized. In the course of the second five-year development plan of 1991-1995, the state founded two large corporations with the authority for self-control (fertiliser and basic/industrial/consumptive chemicals). On December 20th, 1995 the state decided to establish the Vietnam National Chemical Corporation by merging the Fertiliser Corporation and the Basic/Industrial/Consumptive Chemicals Corporation with the aim of enhancing competitiveness and being able to generate capital. This capital would then be invested in technological innovation or macro-scale projects requiring modern technology.

The year 1999 was notable for the Vietnam National Chemical Corporation. The sector's total production value was 5.24 trillion VND, of which the portion directly managed by the corporation was 4.52 trillion VND, an increase of 15.5% over 1998. Forty of the forty-one enterprises in the sector exceeded annual goals; ten recorded particularly high growth rates, ranging from 29 to 84%. The corporation had a total revenues of 6.5 trillion VND, up by 12.35%. Its budget contribution was 310 billion VND in 1999, of which the portion directly managed by the corporation was 241.2 billion VND, an increase of 16.2% over 1998. Net profit was 180 billion VND.

The corporation will be intensively investing in future development - approximately one billion USD (56.5 trillion VND) from 2000 until 2015, of which 600 billion VND will be invested in 2001, 24 trillion VND from 2001 to 2005 and 31.4 trillion VND from 2005 to 2015. The emphasis will be on serving important strategic targets: Production is to be more closely linked with R&D institutes and universities to apply technological innovations, preclude wastage of materials and energy, improve product quality, lower production costs, assure competitiveness on the domestic market and promote export. To realise its strategic targets, the corporation has developed diverse instruments to secure capital, such as state loans and mobilising capital within businesses. Corporate affiliates have gradually implemented environmental management systems in accordance with ISO 1400 standards (cf. Nguyen Xuan Thuy, 2000).

3. Formation and Development of R&D Institutions in Industry

Industrial R&D institutes were gradually founded in the centrally planned economy, mainly in heavy industry. They were to function as scientific hinterland, supporting industrialisation and technological change in Vietnam. Thus, as early as 1965 the Ministry of Machinery Construction and Metallurgy created the following R&D organisations:

- The Industrial Planning Institute
- The Design Institute for Industrial Machinery
- The Design Institute for Mechanical Constructions
- The Research Institute of Technology for Machinery
- The Design Institute for Agricultural Machinery
- The Institute for Metallurgy

Later six further R&D institutes were formed under this Ministry:

- The Institute for Tools and Instruments.
- The Institute for Tractor and Automobile Engines.
- The Institute for Electrical Engineering Equipment
- The Institute for Ferrous Metallurgy.
- The Institute for Non-Ferrous Metallurgy.
- S&T Information Institute for Mechanical Engineering and Metallurgy.

These twelve institutes were brought into the new Ministry of Heavy Industry (MOHI) in 1990. There were also six R&D facilities from the Vietnam Department of Chemistry, four from the Department of Mines and Geology and one institute from the Transport and Communication Authority. Following the reorganisation of several institutes, in 1992 the heavy industry R&D system consisted of eighteen R&D organisations (cf. Tab. 5.3). There were also five further geological facilities involved in raw materials exploration and subordinated to the Department of Geology and Mineral Resources within the MOHI.

Following further changes in the tasks, organisation and financing of R&D facilities, the Vietnamese industrial R&D system encompassed 32 R&D organisations in 1998: Six R&D institutes were directly controlled by the MOI, 19 R&D institutes and 7 R&D centres were managed by MOI corporations. The workforce of this industrial R&D system comprised approximately 3,300 persons, including 157 scientists with PhDs (4.75%) and 1,636 engineers (49.6%). About 1,838 of these people (55.7%) received their salary from the state budget via institutional funding, the others from contract earnings.

Table 5.3: R&D Facilities in Heavy Industry, 1992

R&D Facilities	Employees (Persons)	of whom:			Fixed Assets (Mill. VND)	of which - Equipment (Mill.VND)
		PhDs	Engineers	Technicians		
Mining and Metallurgy Research Institute	300	14	200	67	6,717	5,325
Instit. of Ferrous Metallurgy*	204	5	169	39	2,571	2,102
Institute for Machinery & Industrial Instruments*	182	5	102	10	12,767	10,639
Institute of Electrical Engineering*	52	5	30	8	8,988	101
Institute of Electronics, Informatic Technology & Automation	85	8	55	5	3,795	1,677
Institute of Technology*	177	4	88	19	2,146	1,048
Institute of Agric. Machinery Design and Manufacture*	129	6	63	26	649	141
National Research Instit. of Mech. Engineering (NARIME)	200	10	150	30	2,000	1,600
Institute for Ind. Chemistry*	372	33	164	60	3,447	937
Petroleum Institute*	228	7	148	35	2,780	2,039
Research Instit. of Geology and Mineral Resources	436	20	250	158	3,500	2,000
Chemical Engineering Design Company*	200	7	129	29	3,359	41
Centre for Chemical S&T Information*	36	1	21	4	215	184
R&D Incorporation Chemical Technology*	121	3	47	4	3,285	1,085
S-P Union for New Technology and Informatics*	48	8	29	5	230	230
Centre for the Exploration and Application of S&T in Ho Chi Minh City*	32	1	21	4	500	300
Economics Institute	21	2	15	2	200	100
Institute of S&T Information	36	1	21	4	3,285	1,085
Total: - absolute	2,859	140	1,702	509	60,434	30,634
- %	100	4.89	59.53	17.80	100	50.69

* These institutes are now (2000) under the direct control of corporations, the remainder are under the administration of the MOI

At the end of 2000, there were 7 R&D institutes (with new names) directly affiliated to MOI:

1. Institute for Industrial Strategy and Policy (This institute was founded in 1996 when the following three institutes were merged: Economics Institute, Institute of S&T Information and the Industrial Planning Institute)
2. Institute of Electronics, Informatic Technology & Automation
3. Mining and Metallurgy Research Institute
4. National Research Institute of Mechanical Engineering
5. Research Institute of Geology and Mineral Resources
6. Food Industry Institute
7. Vegetable Oil, Flavouring and Cosmetics Research Institute (prior to 1999 this institute had been under the direct control of the Vegetable Oil, Flavouring & Cosmetic Company)

In addition, in 2000 a total of 26 corporations or SOE belong to the MOI, including 21 R&D institutes (Overview 5.1).

Overview 5.1: R&D Facilities Administered by the MOI, 2000

Ministry of Industry	
Corporations	(affiliated R&D Institutes)
Electricity of Vietnam (EVN) ¹	- Institute of Energy
Vietnam National Coal Corp. (VINACOAL) ¹	- Institute of Mining Science
Vietnam Steel Corp. (VSC) ¹	- Institute of Ferrous Metallurgy
Vietnam National Chemical Corp. (VINACHEM) ¹	- Institute of Industrial Chemistry - Chemical Engineering Design Company (an institute until 1996) - Centre for Chemical S&T Information - Chemical & Microbiological Company (until 1996: Chemical Science-Production Union)
Vietnam Textile and Garment Corp. (VINATEX) ¹	- Research Institute of Textile Industry - Institute of Fashion Models (new)
Vietnam National Tobacco Corp. (VINATABA) ¹	- Tobacco Economic and Technical Research Inst.
Vietnam Paper Corp. (VINAPIMEX) ¹	- Research Institute of Paper
Vietnam National Alcohol-Beer-Beverage Corp. (VINABECO) ²	- Alcohol-Beer- Beverage Research Institute
Power and Mining Mechanical Corp. (POMIMECO) ²	- Design Institute for Power and Mining Machines
Vietnam National Minerals Corp. (VIMICO) ²	- New Technology and Informatics Centre
Vietnam Electronics and Informatics Corp. (VEIC) ²	
Vietnam Engine and Agricultural Machinery (VEAM) ²	- Institute of Technology - Institute for Research, Design and Manufacture of Agricultural Machines
Machinery & Industrial Equipment Corp. (MIE) ²	- Institute for Machinery and Industrial Instruments (IMI) - Centre for Industrial Exploitation and Application of S&T (in Ho Chi Minh City)
Vietnam Electrical Equipment Corp. (VEC) ²	- Institute for Electro-Technical Engineering
Vietnam Plastic Corp. (VINAPLAST) ²	
Vietnam Ceramic and Glass Corp. (VINACEGLASS) ²	- Industrial Ceramic-Porcelain and Glass Research Institute
Vietnam National Leather and Footwear Corp. (LEAPRODEXIM) ²	- Leather and Footwear Research Institute
Vietnam National Gold and Gemstone Corp. (VIGECO) ²	
Vietnam Industrial Construction Corp. (VINAINCON) ²	
Further Directly Affiliated Units (SOEs)	
- Vietnam Dairy Products Company (VINAMILK)	
- Vietnam Food Industries Company (VIFON)	
- Hai Ha Confectionery Company (HAIHACO)	
- Industry Foreign Investment Service Consultants (INFISCO)	
- Investment Consultancy for Development and Construction Company (THIKECO)	
- Foreign Industrial Investment Consultants (FORINCON)	
- Vietnam Vegetable Oil & Flavouring & Cosmetic Company (VOCARIMEX)	

¹ established under Government Decree No 91-TTg, 7th March, 1994

² established under Government Decree No 90-TTg, 7th March, 1994

Source: Own compilation based on MOI information: Technology & Product Quality Management Dept.; Organisation and Personnel Dept., Hanoi, 2000

The workforce of the seven R&D institutes under MOI's direct control comprised 980 people (49.3%) and the 21 R&D institutes administered by the MOI corporations employed 1,008 people (50.7%) in 2000. These figures refer, however, only to permanent employees; when market mechanisms were introduced, many institutes also entered into limited employment contracts (long and short-term) with young scientists (10-30%).

The intention is to establish an R&D system with some central national R&D institutes. These are to excel in applied research as well as in teaching. The work carried out there is to be directed to the needs of industry as a whole or to important branches. These national institutes are to be supplemented by many different R&D institutions within corporations or enterprises, which are to support production processes and technical change.

4. Functions and Financing of Industrial R&D

When founded, the R&D institutions in Vietnamese industry had two basic functions: Scientific research and technological design for specific branches. They received financial resources from the state for research activities, but were supposed to be self-accounting in design activities. However, during the period from 1975 to 1985, most industrial R&D institutions were not in the production sectors, and were, in fact, part of the administrative sector. Their activities therefore depended on state funding. The property used by these institutions was state-owned, their facilities were financed by the state, their activity profiles were determined by the state, the R&D workforce was trained by the state. The management style of these R&D organisations was the same as in an administrative organisation and not adequate to scientific activities. Their activities were not linked with production and business. Therefore, their capabilities met the demands of neither enterprises nor society in general. Links between them had to be organised vertically through ministries. This was a serious obstacle in the way of the transformation of scientific results into successful innovations. The most important constraints on the industrial R&D institutions in Vietnam during this period were: Their limited freedom to enter into R&D contracts with industrial enterprises; an absence of any pecuniary incentives to encourage cooperation between them and the production sector or to encourage the application of new research results; no encouragement to carry out R&D activities in the private and collective sector; reduced effectiveness of the use of budget investment for R&D activities in industry.

The economic interests and burgeoning entrepreneurship within both enterprises and R&D institutions led to a number of illegal, underground research contracts being made. This type

of research contract became so widespread and so successful that in 1981 the Vietnamese government permitted R&D contracts. This can be seen as a milestone in the industrial sector, and was to have great impact on the reform discourse. The development of diversified and wide ranging activities in R&D institutions resulting from this decision led to new and more important regulations in 1983. These acknowledged the diversification of the R&D institutions' functions. In addition to research and development, they were allowed to undertake S&T services and to organise the manufacturing of products based on their scientific results and technology. R&D institutions were also permitted to retain part of their income, either to reinvest in research and/or production or to reward their staff. It gave the R&D institutions the status of specific enterprises producing a special type of goods and proposed treating them as industrial manufacturing enterprises. But the results were ambivalent. Many R&D organisations were simply involved in 'money-making' and lacked scientific knowledge. The strategic tasks and functions of the institutes in terms of the interests of industrial branches were therefore not realised.

The adoption of economic reform policies in 1986 further contributed to the development of economic entrepreneurship in S&T. In addition, in many R&D institutes, government grants merely covered the water and electricity bills, basic equipment costs and minimal salaries. This forced scientists to turn to entrepreneurial activities to financially support their institutes, their work and themselves. Many R&D institutes established their own units specialising in further training and other S&T services. Since 1988, when the Vietnamese government encouraged the development of the private sector and the establishment of private and non-public enterprises, many more units emerged and were given various names, such as "S&T Education and Service Centre", "S&T Service Centre" or "Centre for Transfer of Technology", etc.

Not confined to the development and transfer of R&D results to production, entrepreneurial scientists also increasingly became involved in production based upon their research. One interesting example is the Mining and Metallurgy Research Institute. In 1988, this institute established a workshop to produce tin for export. By 1990 its sales were twenty times higher than in 1988 and the director of the institute stated that it is important to walk on two legs, scientific research on the one side and production on the other. Because, for society, production is an end, and research - a means. The differentiation that resulted from such changes in the financing of R&D facilities can be seen in Table 5.4.

Table 5.4: Funding of R&D Facilities According to Sources (in million VND)

Facility	State Funding		Contract Funds (Market Economy)	
	1986-1990	1991-1993	1986-1990	1991-1993
Institute of Industrial Chemistry	721	1,878	5,052	20,954
Mining and Metallurgy Research Institute	367	640	816	49,288
Institute of Electronics, Informatic Technology and Automation		407		81
Institute of Technology	174	584	1,449	2,264
National Research Institute of Mechanical Engineering (NARIME)	108	636	2,75	9,762
Centre for the Exploration and Application of S&T in Ho Chi Minh City	20	0	0	1,617

Source: Own compilation by Nguyen Thanh Thinh (MOSTE) and Nguyen Ngoc Lien (MOI)

Not least in order to be able to better control the rapidly expanding diversity of the R&D facilities and their activities again, from 1992 onwards two parallel strategies were implemented: First, the institutional structures were further reorganised, in particular by allocating R&D facilities to enterprises and corporations. Second, a stricter system of state funding was introduced, involving the set-up of national and branch R&D programmes and the allocation of or rather competitive invitation of tenders for projects. Since 1996 R&D activities and organisations have been outside of the state monopoly. They belong to various sectors, governmental and non-governmental, as well as the private sector. In 1996/97, for example, the R&D organisations in the industrial sector worked on 16 governmental research projects, six experimental pilot-projects in various national S&T programmes, 20 basic research topics in the natural sciences, 285 research projects initiated by the ministry, hundreds of projects initiated by the institutes themselves and thousands of technological transfer contracts to the enterprises.

The institutes' R&D activities were financed by governmental, non-governmental and private as well as internal sources. The R&D results and S&T achievements primarily involved the development of commercialised processes for R&D activities, such as technological services. Links began to be forged between the activities of the heavy industry R&D organisations and the corporations and enterprises involved with production and trade and attention shifted to the study of economic problems, specifically R&D marketing. The R&D organisations were now permitted to enter into business contracts, R&D contracts for production and, since 1996, they have gradually begun to be active in setting up their own "research-implementation" plans.

5. Processes of Restructuring Industrial R&D Institutes

To illustrate the restructuring of industrial R&D, changes within eleven key R&D institutes from different branches were analysed in more detail for the period from 1991-1998 (cf. Tab. 5.5–5.9) (cf. Nguyen Thanh Thinh and Dao Duy Tinh, 1995-1999). These eleven institutes employ ca. 60–70% of the total industrial R&D workforce.

Changes in functions and organisation

In period from 1991 to 1998, all eleven institutes were changing their functions, tasks and directions of activity to some extent (cf. Overview 5.2). For example, the functions and tasks of the Institute for Machinery & Industrial Instruments have changed from basic to applied research on the scientific and technological aspects of machine manufacturing and to designing and manufacturing machinery more economically. The focus has shifted to the research of advanced techniques in welding, pressing processes, treatment, creating new materials, multilayer and composite materials and applying research results to production.

Overview 5.2: Changes in the Functions and Activities of Industrial R&D Institutes

Before 1986	1986-1990	1992-2000
- Scientific Research - S&T Information	- Scientific Research - S&T Information - Technological Development - Pilot-production - S&T Application in Production	- Scientific Research - S&T Information - Technological Development - Pilot-production - Other S&T Services (Consulting, Technology Transfer, Training) - Profit Production

Besides its research activities, the Mining and Metallurgy Research Institute is involved in finding solutions to some of the environmental issues in the field of mining and metal production, and is offering investment and consulting services for investment partners in Vietnam. The Institute of Industrial Chemistry is engaged in research on technologies and applies advanced and clean technologies to processing natural resources. The Institute of Electronics, Electrical and Automation Engineering has changed its name (to the Institute of Electronics, Informatic Technology and Automation), at with it its functions - to research, application, the organisation of pilot-productions with high-tech qualification, technology transfer on electronics, electrical engineering technologies and automation. The Food Industries Research Institute is now involved in the research, development and experimental production of new commodities and the marketing of technologies for food processing, biotechnology and the equipment used in those fields.

In conjunction with these changes in the profile of tasks, the internal organisational structure of the institutes was often also modified (cf. Tab. 5.5). In some cases this involved the reduction of the management/administrative divisions. The research divisions were often either further split up or expanded to include experimental laboratories, pilot plants or semi-industrial workshops, in order to be able to better respond to client demands and to support technological transfer in enterprises. Sometimes a marketing group was established on the administrative level with the new function of finding contracts to transfer and apply new technologies in industrial enterprises, especially in MOI corporations.

Workforce and fixed assets of R & D institutes in Vietnamese industry

As a whole, by 1993 the workforce of the eleven R&D institutes had decreased to 95.7 % and by 1998 to 94.3% of the 1991 level (cf. Tab. 5.6). This was an effect of the transition to a free market economy. There was, however, at the same time, differentiation between the institutes: Two institutes increased their workforces (e.g. the Institute for Machinery and Industrial Instruments by 51% and the Institute of Mining Science by 35%), in one institute staff levels stagnated, and in all other institutes it declined by between 9% and 41%. Besides these basic tendencies, fluctuations can also be observed in the individual institutes during those eight years – a sign of emerging flexibility in employment. However, the proportion of highly qualified scientists (with PhDs) within the total workforce of the R&D institutions remains very low, about 5-10%. In most of the institutes there was a new growth of employment in 1999, leading to an overall increase of 7% from 1998 and to 101% compared with 1991.

The capital value of the fixed assets of all these institutes increased from 1991 to 1998 (cf. Tab. 5.7). Substantial differences can also be observed between the institutes in this regard. For example, the capital value of the National Research Institute of Mechanical Engineering (NARIME) increased by 60% from 1991 (1,580 million VND) to 1997 (2,480 million VND) and by 1998 its capital value was five times higher than in 1997 (12,644 million VND). With the objective of becoming a leader in its field, this institute is endeavouring to upgrade its workforce potential as well as its infrastructure, especially by improving the equipment of its laboratories. The capital value of the Institute of Technology grew rapidly from 598 million VND in 1991 to 11,960 million VND in 1995 (i.e. 20 times higher than in 1991). Over the same period of time the capital value of the R&D institutes that belong to corporations has increased even more. For instance, the capital value of the Institute of Electro-technical Engineering grew from 75 million VND in 1991 to 3,480 million VND in 1995 and 3,500 million VND in 1998 - a more than 46-fold increase.

Table 5.5: Organisational Structure of R&D Institutions: Number of Divisions

R&D Institutions			1991	1992	1993	1994	1995	1996	1997	1998	1998/91 (%)
1	National Research Institute of Mechanical Engineering (NARIME)	a)	18	18	18	18	16	16	16	16	90
		b)	11	11	12	12	11	11	11	11	100
2	Institute of Technology	a)	18	18	12	12	12	8	8	9	50
		b)	13	13	8	8	9	5	5	6	46
3	Institute of Electronics, Informatic Technology & Automation	a)	9	9	8	8	8	8	8	9	100
		b)	6	6	6	6	5	5	5	6	100
4	Institute of Industrial Chemistry	a)	11	11	13	13	16	16	12	13	118
		b)									.
5	Institute of Energy	a)	18	18	18	18	20	20	21	21	117
		b)	12	12	11	11	14	14	15	15	125
6	Institute of Electro-technical Engineering	a)	6	6	6	6	7	7	7	6	100
		b)	4	4	4	4	5	5	5	5	125
7	Research Institute of Geology and Mineral Resources	a)	14	14	23	23	21		22	22	157
		b)	9	9	18	18	16		17	17	189
8	Mining and Metallurgy Research Institute	a)	23	23	22	22	27	27	27	28	122
		b)	17	17	18	18	19	19	20	21	124
9	Institute of Mining Science	a)	14	13	17	17	17	17	17	18	129
		b)	10	9	13	13	13	13	13	14	140
10	Food Industries Research Institute	a)	15	15	14	14	15	15	14	16	107
		b)	11	11	10	10	11	11	11	13	118
11	Institute for Machinery & Industrial Instruments	a)	14	14	15	15	16	16	14	14	100
		b)	9	9	10	10	11	11	10	10	111
Total		a)	160	159	166	166	175	171	170	173	108
		b)	102	101	110	110	114	110	112	118	116

a) = Total number of divisions; b) = Number of research divisions

Source: Nguyen Thanh Thinh and Dao Duy Tinh, 1995-1999.

Table 5.6: Workforce of the R&D Institutions (persons)

R&D Institutions		1991	1992	1993	1994	1995	1996	1997	1998	1999	1999/91 (%)
1	National Research Institute of Mechanical Engineering (NARIME)	301	296	265	257	260	262	265	274	294	97.7
2	Institute of Technology	216	200	200	200	180	175	172	171	177	81.9
3	Institute of Electronics, Informatic Technology & Automation	81	81	81	81	81	81	81	81	85	104.9
4	Institute of Industrial Chemistry	411	376	372	339	320	320	320	300	372	90.5
5	Institute of Energy	211	190	183	187	187	188	195	194	175	82.9
6	Institute of Electro-technical Engineering	61	62	57	55	47	45	44	36	52	85.3
7	Research Institute of Geology and Mineral Resources	376	365	351	388	387	376	368	358	386	102.7
8	Mining and Metallurgy Research Institute	387	398	408	356	374	366	360	354	381	98.5
9	Institute of Mining Science	141	135	145	201	202	198	195	191	201	142.6
10	Food Industries Research Institute	196	183	183	182	183	186	187	185	183	93.4
11	Institute for Machinery & Industrial Instruments	178	190	200	220	243	260	265	269	276	155.1
Total: - persons		2,559	2,476	2,445	2,466	2,464	2,457	2,452	2,413	2,582	.
- %		100	96.7	95.7	95.2	96.3	96.0	95.8	94.3	101.0	

Source: Nguyen Thanh Thinh and Dao Duy Tinh, 1995-1999.

Table 5.7: Capital Value/Fixed Assets of R&D Institutions (billion VND)

R&D institutions			1991	1992	1993	1994	1995	1996	1997	1998	1998/91 (%)	
1	National Research Institute of Mechanical Engineering (NARIME)	a)	1.580	1.580	1.580	1.580	1.580	1.830	2.480	12.664	802	
		b)	25	25	37	37	37	39	55	51		
2	Institute of Technology	a)	0.598	0.720	1.207	2.862	11.960	11.750	12.000	12.000	2007	
		b)	60	60	60	60	60	60	60	58		
3	Institute of Electronics, Informatic Technology & Automation	a)	5.200	5.039	5.012	5.096	5.037	5.473	7.273	7.888	152	
		b)	37	35	35	36	70	65	80	80		
4	Institute of Industrial Chemistry	a)	5.200	5.039	5.012	5.096	10.910	9.448	9.448	15.019	289	
		b)	37	35	35	36	70	63	63	63		
5	Institute of Energy	a)	1.763	4.435	4.698	4.831	5.206	5.713	6.213	6.213	352	
		b)	47	47	47	47	47	51	55	55		
6	Institute of Electro-technical Engineering	a)	0.075	0.146	0.557	0.500	3.480	3.283	3.283	3.500	4667	
		b)	82	90	97	100	23	19	19	20		
7	Research Instit of Geology and Mineral Resources	a)	6.633	4.433	5.751	6.012	7.076	7.738	9.124	9.793	148	
		b)	45	50	44	45	39	44	52	58		
8	Mining and Metallurgy Research Institute	a)	2.064	3.342	3.367	3.395	3.459	3.459	3.459	3.459	168	
		b)	55	74	74	74	73	73	73	73		
9	Institute of Mining Science	a)	0.739	4.052	4.871	4.862	4.862	4.961	5.215	8.465	1145	
		b)	54	38	38	41	47	50	54	33		
10	Food Industries Research Institute	a)	0.501	0.501	0.501	3.022	3.913	4.111	4.111	8.741	1745	
		b)	38	38	38	89	70	72	80	41		
11	Institute for Machinery & Industrial Instruments	a)	4.400	4.700	5.800	7.500	19.800	19.800	20.400	20.600	468	
		b)	75	75	67	75	90	78	74	74		
Total			a)	28.753	33.987	38.356	44.756	77.283	77.566	83.006	108.342	377

a) Capital value total, b) Share of equipment in %

Source: Nguyen Thanh Thinh and Dao Duy Tinh, 1995-1999.

The institutes' outfitting with equipment has improved especially rapidly. In many cases, equipment makes up an increasingly high share of the fixed assets - generally between 50 and 80%. In three institutes, however, this proportion has dropped in the context of a substantial increase in fixed assets as a whole (presumably due to the construction of new buildings).

Institute Activities

Now, under market conditions, all eleven institutes are engaged in three main types of activity: R&D, the application of new technologies to production processes and the provision of S&T services (consultancy, training, information, technology transfer). Customers are the MOI, and its enterprises as well as various city and provincial authorities (see Tab. 5.8). The following examples illustrate these activities:

In the period from 1991 to 1997, the National Research Institute for Mechanical Engineering (NARIME) chaired three state-level programmes and several projects under other programmes. This institute has developed advanced techniques in the areas of machine dynamics, endurance, lubrication and friction. They have been applied to the design and manufacture of integrated and separate equipment for various sectors (textile, paper, cement, tea and sugar). The institute has realised many applied research projects and new technology transfer in machinery manufacture. Examples include exploded welding and pulled rolling to form band and bimetal wires, extrusion from metal pieces and tubes, automatic welding under the welding cinder layer, welding in CO₂ and inert gas, pulverised surface covers.

Between 1991 and 1995, the Institute of Industrial Chemistry implemented over 25 projects under seven state-level programmes and some ministerial-level projects concerning advanced techniques applied to the production and use of Vietnam's natural resources.

Over the last ten years, the Institute of Electronics, Informatic Technology and Automation has carried out 112 research projects (including 23 in which the results were published abroad) and manufactured technological products (for equipment systems) by applying advanced scientific-technological achievements in the respective fields.

The Food Industries Research Institute carried out 223 projects (172 projects financed by the government, 34 projects by the MOI and 17 projects initiated by the institute itself) in addition to applying technological advancements to 163 manufacturing processes. The S&T results of the institute have been applied and transferred to local enterprises and used for training technicians there.

Table. 5.8: Projects Carried out by Institutes (number)

R&D Institutions		1991	1992	1993	1994	1995	1996	1997	1998
1	National Research Institute of Mechanical Engineering (NARIME)	100	88	88	89	120	122	41	75
2	Institute of Technology	2	9	9	5	7	6	7	10
3	Institute of Electronics, Informatic Technology & Automation	18	20	18	18	18	22	19	25
4	Institute of Industrial Chemistry	10	53	38	55	67	73	56	70
5	Institute of Energy	37	40	46	55	66	79	108	104
6	Institute of Electro-Technical Engineering	11	14	9	6	7	12	9	8
7	Research Institute of Geology and Mineral Resources	26	26	26	26	23	22	20	23
8	Mining and Metallurgy Research Institute	10	10	11	8	6	7	13	19
9	Institute of Mining Science	28	28	27	32	30	43	57	43
10	Food Industries Research Institute	19	20	31	38	25	21	23	39
11	Institute for Machinery & Industrial Instruments	109	110	113	128	132	185	196	197

Source: Nguyen Thanh Thinh and Dao Duy Tinh, 1995-1999.

Table. 5.9: Domestic and International Contracts by Institute

	R&D institutions		1991	1992	1993	1994	1995	1996	1997	1998
1	National Research Institute of Mechanical Engineering (NARIME)	a) b)	103	86	86	87	117 1	116 1	38	74
2	Institute of Technology	a) b)	16	21 1	20	45	70 2	99 2	101 2	106 3
3	Institute of Electronics, Informatic Technology & Automation	a) b)	26 4	30 4	28 8	32 7	36 4	34 14	37 13	45 20
4	Institute of Industrial Chemistry	a) b)				20 12	42 14	45 6	43 5	43 5
5	Institute of Energy	a) b)	15 13	17 18	21 20	28 26	42 28	50 31	60 22	65 25
6	Institute of Electro-Technical Engineering	a) b)	9 1	6 1	8 3	7 0	6 0	6 0	6 1	6 1
7	Research Institute of Geology and Mineral Resources	a) b)	4 11	4 11	4 11	4 13	6 13	9 12	9 12	9 13
8	Mining and Metallurgy Research Institute	a) b)	27	29 1	31 3	36 4	44 6	44 8	51 10	52 11
9	Institute of Mining Science	a) b)	28 22	30 22	32 2	31 22	35 2	35 4	19 6	25 6
10	Food Industries Research Institute	a) b)	24 9	28 12	39 13	36 13	38 13	39 13	43 22	43 22
11	Institute for Machinery & Industrial Instruments	a) b)	-	-	3	4	196 12	188 13	176 13	186 13

a) Number of domestic contracts, b) Number of international contracts

Source: Nguyen Thanh Thinh and Dao Duy Tinh, 1995-1999.

Cooperation

In association with the (generally publicly funded) R&D projects or in order to supplement them, all institutes had close contact with many production and trading companies, other R&D institutes, universities both within Vietnam and abroad, and especially with international organisations (e.g. the United Nations Development Programme UNDP). They entered into hundreds of R&D and technical contracts (see Table 5.9 above). Examples:

The Institute of Industrial Chemistry collaborates with R&D institutions in many countries and with international organisations. It cooperates with institutions in Russia on the research of oil, lubricants and rubber; with institutions in France on petro-chemical catalysts; with institutions in Sweden, Finland and Australia on environmental issues; with institutions in China, Bulgaria and Taiwan on essential oils and fragrances. The Institute has successfully completed a UNDP-sponsored project on quality improvement in the utilisation of lubricants.

The Institute of Electronics, Informatic Technology and Automation has extensive links with industrial corporations. Many research results have been applied to production and had considerable impact. Examples are the implementation of a study on the assemblage of PC 16 bits; the design and production of a measurement equipment system with automatic controls in a textile enterprise; the design, manufacture and assemblage of automatic weight systems and out-put systems for small quantities of cement in a cement company; the design, manufacture and implementation of modern measuring equipment in a urea fertiliser company; the design and manufacture of a measuring and control system for a petrol drilling platform.

The Food Industries Research Institute is involved in large cooperative deals both locally and abroad. It successfully realised a project supported by UNDP and collaborates with companies and scientific institutions in Japan, USA, Australia etc., especially in the field of beer brewing.

6. Outlook

Vietnam is facing the difficult task of gradually moving toward increased industrialisation and modernisation by the year 2020. The contribution of industry to GDP is expected to rise from 24% in 1998 to 25-30% in 2000 and to 35% by the year 2010. Estimations regarding the share of the service sector in GDP project a rise from 40% in 1998 to 45% by the year 2010. The share of agriculture is estimated to slide from more than 30% in 1998 to 20-25% in 2010. Government policy sees socio-economic efficiency as the most important criterion and

guiding principle for industrial development and for the selection of new technologies. The following are some of the important factors in this process:

- *Developing industry as a substitute for import.* This strategy can be described as export-oriented and will be realised by placing more emphasis on products with a high technology content, which are capable of competing in the free market, both domestically and internationally. The focus on export orientation aims to create capital and technology for industrial development in general.
- *Taking advantage of the strengths and resources of the country* as a whole and of each region. Vietnam is rich in natural resources, e.g. oil, gas, iron ores, bauxite, gemstones, etc.
- The abundant *labour force*, well known for its ability to adapt to new technology, will play an active role in the development of industry.

In order to fully exploit all existing production and technological capability, efforts will also be made to combine traditional with advanced technologies. In the immediate future, priority should be given to labour-intensive industry with the potential to adapt to modern technology. In general, Vietnam's industry should open up to international cooperation. This policy prioritises the following industries:

- Industries providing infrastructure for the national economy, e.g. power generation and electricity utilisation, oil and gas, steelworks, mechanical engineering, chemicals, fertiliser.
- Industries processing agricultural products.
- Industries producing commodities for export and import substitution.
- Industries developing and processing minerals, insofar as they comply with the following guidelines: Transition from processing to production; catching up with state-of-the-art technologies; saving and efficiently utilising the mineral resources available; observation of environmental protection regulations.

In order to achieve the above-mentioned strategic targets, parallel with reorganising SOE to be economically powerful corporations, it is also necessary to encourage small and medium sized enterprises in all economic sectors, to mobilise domestic and foreign capital, and to promote international cooperation. This policy also includes some considerations for further restructuring R&D institutions and activities in the Vietnamese industry. It is directed to encouraging joint ventures, cooperation and integration between R&D and production and business. These can be organisational set-ups for the transfer and/or application of new

technologies or advances. Financial management tools will be improved by taxation policies providing tax exemption or deduction for R&D contracts, by experimental and/or pilot production being permitted to test newly developed technologies and by R&D institutions being able to apply for bank loans. Additional pilot/experimental production projects will be supported by MOSTE on a contract basis.

Scientific research and technological development are considered to be the basis of further industrialisation and modernisation. The R&D organisations and activities in industry will play a decisive role in determining the speed of economic development. They must have the potential for domestic development in modern economic fields, such as micro-electronics, electronics, mechanical engineering, information technology, automation, production of new materials and the exploitation of local natural resources. Furthermore, it is crucial to carry out this development in ways that will not pollute the environment, but will rather contribute to the health and wellbeing of the Vietnamese people. A more rational network of R&D institutions involved in innovation activities in industry, systematically improved and enhanced R&D and transfer activities as well as closer relationships between the R&D institutions and enterprises, can make S&T the driving force behind Vietnamese industrial development.

References

- A Guide to Vietnamese Industry, Hanoi, 1998.
- Ha Nghiep (Chairman of Vietnam's Engineering Association), 2000, Discussion in Hanoi, 12 October.
- Nguyen Thanh Think and Dao Duy Think: Survey of Potential and Organisational Change in Eleven Selected Vietnamese Industrial R&D Institutes. Reports compiled 1995, 1996, 1997, 1998, 1999.
- Nguyen Xuan Thuy (General Director of the Vietnam National Chemical Corporation), Vietnam Economic Review, No 10, 2000.
- Nien giam Thong ke [Statistical Yearbooks], 1985-1999, Statistical Publishing House, General Statistical Office, Hanoi, 1986-2000.
- Sach Thong ke ve nen kinh te Vietnam tu 1930-1984 [Statistical Book of the Vietnamese Economy from 1930-1984], Hanoi, 1985.
- Statistics 1999: Vietnam Engineering Association, Vietnam Economic News, No 48, October 1999.
- Tap chi Cong nghiep VN [Vietnam Industry Review] 9/2000
- Tap chi Phat trine cong nghiep Viet nam [The Development of Vietnam's Industry], Hanoi, 1998.

Chapter 6: R&D in Enterprises' Innovation Activities

- Results of Case Studies in Chemical, Food Processing and Electronics and Electrical Industries

Tran Chi Duc

To implement the doi moi policy, a number of reforms were introduced and a new environment was created in which the potential of the R&D institutions could be better exploited (cf. Tran Ngoc Ca and Bo Goransson 1999). Interaction with industrial firms was now possible and it was hoped that they would thus increase their technological capability accumulation. As a result of these changes, many companies now have access to information, consultancy and training sources provided by scientists, who are now able to work closely with enterprises, or even to create their own spin-off firms.

Case studies were carried out to investigate the situation in more depth. They focussed on the R&D activities and functions of selected enterprises in three important economic branches: the chemical, food processing and electronics industries. The linkages of these enterprises with leading R&D institution in the economic branch were also investigated. We expected to ascertain specific features on the structure and function of R&D in enterprises in the transition of the Vietnamese S&T system.

In the following case studies, terms such as technical improvements/innovation, new technologies do not have the same meanings as in the OECD conception (e.g. Frascati Manual, 1993); they in fact refer to initiatives to make improvements in the production lines, to add some new features to product designs, etc. That is, the novelty or the newness must be seen in comparison with the studied enterprises' past, and in fact they have not made basic changes in their technologies.

1. Chemical Industry

Although it did not really get started until 1960, the chemical industry has now become very important in Vietnam, providing other industries and daily life with basic and industrial chemicals, fertilisers, pesticides, chemical-electric sources (e.g. batteries), etc. and making important contributions to the development of many other sectors. There are ten specialised

production areas, comprising about 100 important production units now in operation. These production areas are as follows (MOI 1997):

1. *Raw materials for the chemical industry*: Comprising mining and mineral selection units to supply chemical plants with raw materials;
2. *Basic chemicals*: Mostly inorganic chemicals such as sulphuric, hydrochloric and phosphoric acids, ammonia, potassium, minerals, etc. Production of organic chemicals has recently begun; they are used as detergents and in plastic production.
3. *Fertilisers*: NPK (Nitrogen/Phosphorus/Potassium) fertilisers, organic and bio-fertilisers
4. *Pesticides*
5. *Industrial gas and welding materials*
6. *Chemical electricity sources*: Batteries, accumulators, etc.
7. *Industrial rubber products*: Comprising production units producing tires and tubes for many kinds of vehicles (automobiles, bicycles, motorcycles, etc.), technical rubber tubes, transportation bands, etc.
8. *Paint, ink, plastic utensils*
9. *Detergent, soap, perfumes, cosmetics*
10. *Oil chemistry products*: This production area is still at its starting point, mostly steam-down (condensation) products for the petrochemical industry

The rate of total industrial production is only about 23% of GDP and the chemical industry is rather weak in comparison with that in other ASEAN countries. Production units are generally small in size. They contribute about 8.5% of total industrial production per year.

Due to the fact that there are few private enterprises in the Vietnamese chemical industry, the selected cases in this branch are all state-owned enterprises:

- a) Van Dien Phosphate Fertiliser Corporation (under the Ministry of Industry, MOI)
- b) General Paint Corporation, Hanoi (under the MOI)
- c) Biological and Chemical Industry Corporation, Ho Chi Minh City (under the MOI)
- d) Hanoi Paint Chemical Corporation (under the Industrial Department of Hanoi)

In addition to this research, we also investigated the

- e) Industrial Chemical Institute,

which is considered to be the leading R&D institute in this industry.

***a Van Dien Phosphate Fertiliser Corporation – VDPFC
(Congty Phan Lan Nung chay Van Dien)***

General overview

This is one of the top corporations in Vietnam specialised in producing melted phosphate fertiliser, various kinds of mixed NPK fertiliser, multi-element fertiliser, nitrogenous fertiliser, potash fertiliser and materials for chemical fertiliser production. In May 1993, the Ministry of Heavy Industry (MOHI) decided to transform the company (which was formed in September 1960 and specialised in producing phosphate fertiliser) into the new Melted Phosphate Fertiliser Corporation (which has autonomy in innovation, production and marketing without depending on the state-owned distribution network as had been the case previously). From 1991 to 1998, while the company's staff fluctuated between 450 and 600 people, mostly due to the change of the number of unskilled temporarily recruited workers by short-term contract. The university graduate staff are, however, quite stable, fluctuating between 22 and 29 people; the technical workers vary from 315 to 380; and the administrative staff is quite small, only 6 to 8 people. At present (1999), the company is working well. The average salary is 1.5 million VND per month, which is considered a better rate than other domestic companies pay.

The company has markets in both North and Central Vietnam, the largest being in Tay Nguyen (the West Highlands). Soil and plants there are quite suitable for the fertilisers produced by the company. Mekong River Delta, a large agricultural area of Vietnam, has not been the company's main market yet because the farmers there are more familiar with US fertiliser. The company's products are distributed through the shops run by local agricultural material corporations. Promotion activities are conducted mainly via the Farming Promotion Programme run by the government's Agricultural S&T Institutes. The agricultural scientists have played an important role in guiding farmers to use appropriate techniques.

Main difficulties faced from a technology and product point of view

- It is very difficult to find or buy advanced technology appropriate to the conditions and characteristics of raw materials available in Vietnam from foreign countries. Technological improvements therefore need to be done by the company's staff themselves and as a result, the process of technological improvement is relatively slow.
- The company's products face rigorous competition from imported products. The domestic products are at a disadvantage because they are more expensive even though they are more appropriate to the local soil and cultivating conditions.

R&D organisation and functions

Having developed from a factory fully specialised in production under the old centrally planned mechanism, the company now has all the functions of an enterprise. A business department has been set up to deal with the tasks of planning, procurement, marketing, accounting and financing. The technical department has been upgraded to handle technical management, safety and the industrial environment and has been put under the leadership of a vice-director. None of the staff are specialised in R&D; almost all innovation was recommended by executives based on their own knowledge and experience. In fact, the concept of R&D generally shared by almost all companies in Vietnam, and the VDCFC in particular, is not the same as the OECD (Frascati) concept; most R&D activities in Vietnam are technical solutions, technical improvement and specific technological innovations. This means that there is little novelty or basic change in the production technologies. The following tables illustrates the company's R&D expenditure and human resources directly involved in R&D activities.

Table 6.1: Fertiliser Corporation (VDPFC): R&D Expenditure

		1991	1992	1993	1994	1995	1996	1997
Absolute amount (million VND)	m.d	255	381	374	738	496	774	700
Percentage of turnover revenue	%	1	1	0.9	1.3	0.6	0.8	0.7

Source: Own compilation

It should be noted that these amounts do not represent the actual R&D expenditure as it is usually understood; they are in fact the payments made to those company staff members who recommended useful solutions, technological and product improvements. It can be seen that expenditure in 1997 was 2.75 times higher than it was in 1991 and that the average annual growth rate is 1.18%.

Table 6.2: Fertiliser Corporation (VDPFC): Staff Members Directly Participating in R&D (persons)

Staff Qualification	1995	1996	1997	1998
Postgraduates	0	0	0	0
Graduates	6	7	7	7
Technicians	5	4	4	4
Total	11	11	11	11

Source: Own compilation

Following are the results of R&D activities that have been carried out by the company itself:

Table 6.3: Fertiliser Corporation (VDPFC): R&D Output

	1991	1992	1993	1994	1995	1996	1997
New Technologies		1					
New Products						5	1
Useful Solutions	2	1				1	
Incremental Benefit (million VND)	5.1	11.2	19.3	21.3	33.9	49.4	50.0

Source: Own compilation

Almost all research carried out is guided by the demands of production. The following are some important technical innovations developed in the company:

- Use of inorganic glue pressing smooth ore for production. This allows the full use of materials and energy for production, reducing energy costs by 20%.
- Modification of a blast furnace so that anthracite coal can be used instead of coke, while productivity and energy expenditure is maintained (1992).
- Technical innovation allowing the production of high quality phosphate fertiliser from low quality apatite ore and anthracite coal. This has enabled the company to produce high quality phosphate fertiliser and thus meet domestic and export demand.

Relationship with R&D institutes and issues of technology transfer

The role of R&D institutes for chemical technology in the company's activities is not very clear and they do not in fact have much impact. So far, activities conducted by these institutes have not appeared very useful to VDPFC. The company considers that these institutes simply assist the higher-ranking authorities in their appraisal of the future of technologies in Vietnam. The institutes should change their direction, focussing much more on urgent issues in production, providing production units with information on new technologies and technology transfer consultation services.

Due to market demand, the company cooperated with the Agricultural University and some agricultural scientific research institutes in researching different kinds of plants and soils in order to provide farmers with appropriate fertilisers. This is an important direction that the company is taking and also provides the basis for developing new products and technologies.

At the present time VDPFC does not have any plan to import foreign technology due to the fact that many advanced technologies are not suitable for the material conditions in Vietnam.

Requirements of R&D organisation

The company argues that establishing a separate R&D department in a small enterprise is not appropriate. In fact, it is the executive staff who can identify problems in production technology and this is the root of technical improvement projects. The R&D institutes in industrial chemistry should be strengthened in the field to provide new technological solutions and information focussing on enterprise demand.

b. Biotechnological and industrial chemical corporation – BICICO (Cong ty Cong nghiep Hoa chat va Visinh)

General overview

From 1984 to January 1995 this company was called 'Ho Chi Minh City Scientific Association of Chemical Products', the successor of 'Ho Chi Minh City Chemical Technique Corporation'. During this period the company was assigned tasks such as promoting scientific-technical advances within the industry, transferring new techniques and technological processes to enterprises, making S&T forecasts, helping the enterprises by providing them with information regarding new technological achievements. In fact, it was an engineering organisation for the chemical industry, and played the role of bridging the gap between science and production. It met with several difficulties in the role of an S&T institution, for example, the lack of rights of production or the possibility of borrowing money from the bank to expand its activity spectrum, etc. As a consequence the company was transformed again in 1996 and renamed BICICO.

The company now has the following functions:

- Production of chemical goods (glue, paint, varnish, essential oils, etc.)
- Production of biological goods for agriculture, with 'environmentally friendly' features
- Production of packing cases made of paper, plastic and metal
- Conducting applied research and transferring technology of biotechnical and chemical products
- Providing consultancy and investment services on constructing industrial chemical buildings, biological and environmental protection projects
- Production of detergents and cosmetics
- Providing services on installing machines, maintenance, and improving operations of chemical and biological equipment.

R&D organisation and functions

The distinguishing characteristic of the company is the fact that it has strong research staff. The company's organisational structure encompasses the following separate departments:

- Technical and International Relations Department
- Chemical Centre
- Biological Centre
- Viet-Russia Biological Laboratory (established in cooperation with Russia)

In 1997 the total staff comprised 236 people, including two with PhDs, 37 other university graduates, 168 technicians and workers and 29 administrative staff. From 1992 to 1997, the total staff numbers increased from 156 to 236 people. During the same period the number of staff members with university degrees decreased from 54 to 37, and the number of technicians and workers increased from 85 to 168. The human resources in R&D have fluctuated as illustrated in Table 6.4.

Table 6.4: Biotech. Corporation (BICICO): R&D Staff Structure (persons)

	1992	1993	1994	1995	1996	1997	1998
Doctoral Degree	2	2	-	2	2	1	1
University Degree	30	20	-	20	18	15	15
Other	40	25	-	30	30	30	30
Total	72	47	-	52	50	46	46

Source: Own compilation. Note: "-": not available

The R&D units are operating under the two centres. However, the R&D workforce has been reduced because the focus of the company's functions has shifted from R&D and pilot production to production and trade.

Scientific and technological activities

Expenditure for scientific research increased from 1991 up to 1995 and then dropped dramatically as a consequence of the organisational changes occurring (see Table 6.5).

Table 6.5: Biotech. Corporation (BICICO): R&D Expenditure (in million VND)

Year	1991	1992	1993	1994	1995	1996
Total Expenditure	23	35.6	30	530	1,720	405

Table 6.6: Biotech. Corporation (BICICO): Results of Scientific Research

	1991	1992	1993	1994	1995	1996
Number of Projects	1	2	2	2	2	
Number of New Technologies			1		1	1
Number of New Products					1	1

It should be noted that the scientific quality of the projects was low. The newly developed technology and products were not significant in terms of the whole industry, either locally or internationally.

The company's transition from a research and pilot production organisation to an enterprise came about as a consequence of the obstacles faced in the light of government policies and mechanisms; S&T institutes have no right to do business but simultaneously urgently need to not only survive but to also be productive under the given conditions.

The company's scientific and technological activities lack links with other Vietnamese research institutes, such as the Institute of Industrial Chemistry or the National Centre for Natural Sciences and Technology (NCNST).

***c. Hanoi General Paint Corporation – HGPC
(Cong ty Son Tong hop Hanoi)***

General information

The company was established in 1970 in line with a decision by the former General Department of Chemistry. Its tasks are the production of different kinds of paint and printing ink for the domestic market as well as export. Since 1986, the company's activities have included the sale of paint and printing ink as well as anti-rust paint.

Difficulties and advantages in production and technology

The company has highly skilled staff capable of mastering new technologies. Due to the small scale of production and the limitations of its R&D budget, it is nevertheless difficult for the company to carry out any technological innovation.

R&D organisation and functions

The company's staff is now quite stable. On average, it increased at the rate of 3% per year from 1991 to 1997 (from 277 people in 1991 up to 380 people in 1997 and 1998). The structure of the workforce has changed slightly, as shown in Table 6.7.

Table 6.7: Paint Corporation (HGPC): Staff Structure (%)

Year	1995	1996	1997	1998
University Graduates	17.8	18.0	15.8	16.6
Workers and Technicians	64.4	63.4	64.5	63.7
Administrative Staff	17.8	18.6	19.7	19.7
Total	100	100	100	100

Source: Own compilation from HGPC Report, 20 Oct. 1998.

Over recent years there has been an increasing demand for in-house research, leading to a substantial increase in R&D staff with university degrees in 1998.

Table 6.8: Paint Corporation (HGPC): Staff Participating in R&D (part-time, persons)

	1995	1996	1997	1998
University Graduates	4	6	16	25
Others	2	2	2	2
Total	6	8	18	27

Source: HGPC Report, 20 Oct. 1998.

A technical and R&D department was established and put under the leadership of the company's director. Four to five R&D specialists are permanently employed in this department. In addition to this stable and separate group, the company also forms ad hoc groups to implement particular projects. These are made up of many people from different departments.

The company has spent a large sum on R&D in recent years, the total expenditure for each year amounting to 0.5-1% of annual turnover. Its expenditure on R&D is increasing each year.

Table 6.9: Paint Corporation (HGPC): Expenditure on R&D

	1995	1996	1997	1998
Total expenditure (million VND)	100	250	400	800
% of turnover	0.5	0.75	0.8	1.0

The output of the company's S&T activities has mainly been concentrated in the launching of new products to meet market demand at a lower price than imported ones.

Table 6.10: Paint Corporation (HGPC): R&D Results

	1995	1996	1997	1988
Research Projects (modification of some sections of the production line)	1	2	2	2
New Technology	1	1	1	1
New Products	2	4	4	4
Utility Solutions*	10	15	20	20

Source: HGPC Report, 20 Oct. 1998.

*: A utility solution, according to Art. 783 of The Civil Code of Vietnam, is a technical solution that is new in terms of present technical development and is applicable to different social and economic fields.

Relationship with R&D institutes and issues of technology transfer

Until now the company has carried out all technological and product improvements itself for two reasons. Firstly, the research institutes in this industry lack adequate research equipment.

Secondly, they are weaker than the company in terms of technological capability. The company can now produce almost all kinds of paint available on both domestic and international markets (about 20 main products). It has imported advanced machinery, such as a mixing machine, crusher, packaging machinery. It usually obtains technological information from foreign chemical suppliers. The main source of changes in the company's technology is via importation of foreign equipment and material and not by special technology transfer.

Neither the NCNST nor the research institutes provide any help in terms of technology innovation. At the moment, due to the development in paint producing technology, the company is in a better position than the research institutes in terms of new technology and products.

d. Hanoi Chemical and Paint Corporation – HCPC
(*Tong cong ty Son va Hoa chat Hanoi*)

General overview

Hanoi Chemical and Paint Corporation was established in 1959 by the Hanoi People's Committee. The company produces different kinds of paint, colour powder, glue and varnish serving both domestic and foreign markets. It has the right to export its products and import the equipment and material necessary for their production.

The company has capable staff with a structure favourable for production based on technological improvement. The share of graduates in the total workforce (257 people) has increased gradually and reached 21.8% in 1998.

Table 6.11: Chemical Corporation (HCPC): Staff Structure (%)

	1995	1996	1997	1998
University Graduates	18.5	17.8	20.6	21.8
Technical Workers	79.6	80.6	78.2	77.0
Administrative Staff	1.9	1.6	1.2	1.2
Total Staff	100	100	100	100

Source: Own compilation

R&D organisation and functions

Two departments in the company are primarily involved in S&T activities: The Technical Department and the Product Quality Control Department. Two R&D units were set up - a laboratory and a pilot production unit within the Technical Department.

Moreover, the company also established ad hoc groups to develop new products such as:

- Flat wall paint of high quality
- Epoxy for covering tennis courts
- Reflectional paint for transport signal boards
- Paint powder for boats and bridges
- Varnish powder to decorate furniture and buildings

Table 6.12 shows the number of people involved in S&T activities and Table 6.13 shows the number of S&T activities completed.

Table 6.12: Chemical Corporation (HCPC): Staff involved in S&T activities (persons)*

	1995	1996	1997	1998
University Graduates	28	28	29	30
Others	27	24	24	24
Total	55	52	53	54

Source: Own compilation.

* It should be noted that many of these people work part-time.

Table 6.13: Chemical Corporation (HCPC): Results of S&T Activities (number)

	1995	1996	1997	1998
Research Results	3	4	4	5
New Technologies	3	4	4	5
New Products	3	4	4	5
Utility Solutions	3	4	4	5

Source: Own compilation

Relationship with R&D institutes and issues of technology transfer

HCPC has implemented several new technologies each year; they are the results of its own R&D as well as the know-how adopted from other sources.

Table 6.14: Chemical Corporation (HCPC): Number of New Technologies by Sources

Source	1991	1992	1993	1994	1995	1996	1997
HCPC	2	2	2	2	3	2	2
Research Institutes	1				1		1
Cooperation between HCPC and research institutes					1	1	
National Centre for Natural Sciences and Technology (NCNST)	1	1			1		
Universities	1	1			1		
Via Importing Equipment and Material		1		1	2	2	2
Total	5	5	2	3	9	5	5

Source: Own compilation.

It is clear from Table 6.14 that most technology and product innovations have been carried out by the company itself. However, the company also considers other sources to be very important and is of the opinion that government policies should encourage research institutes and the NCNST to cooperate with companies. Overseas sources are likewise seen as extremely important since they shorten the time required for innovation and the improvement of technological capability.

e. Institute of Industrial Chemistry - IIC
(Vien Nghien cuu Hoa Cong nghiep)

General overview

The institute was established in April 1964 by the Government Committee. Its tasks involved conducting R&D activities and applying research results at the levels of state, ministry and industrial authorities in order to meet the technology development demands of enterprises and regional areas. These tasks oblige the institute be guided by production reality and market demand. It has a large skilled workforce.

Table 6.15: Institute of Ind. Chem. (IIC): Staff Structure (persons)

Year	1991	1992	1993	1994	1995	1996	1997	1998
PhDs	31	35	33	31	29	26	20	19
Masters Degrees					1	2	3	4
Under Graduate Degrees	166	170	164	142	139	132	112	129
Technicians	83	79	78	65	63	53	46	80
Unskilled Workers	162	92	97	100	87	107	138	68
Administrative Staff	52	52	52	52	51	49	49	48
Total	411	376	372	339	320	320	320	300

Source: Own compilation

Since 1998 the institute has been made up of 11 research departments and centres, which conduct a wide range of activities - from R&D to production.

Table 6.16: Institute of Ind. Chem. (IIC): Departments and Personnel (persons)

1	Organic and Oil Refinement Centre	26
2	Environmental Analysis Centre	11
3	Material Centre	19
4	Oil Additive Centre	5
5	Fertiliser Centre	12
6	Experimental Production Association	82
7	Electric-Chemical Department	8
8	Non-Organic Department	9
9	Micro-Biotech Department	6
10	Detergents Department	9
11	Design Department	6
12	Library and Managerial Departments	49

Financing

The institute has important financial sources, namely its own production, business and service activities (via contracts with industry). This is illustrated in Table 6.17

Table 6.17: Institute of Ind. Chem. (IIC): Financial Resources (million VND)

Sources	1991	1992	1993	1994	1995	1996	1997	1998
State Projects and Programmes		1,026	1,051	1,312	1,341	1,869	183	160
Ministry Projects and Programmes	162	75	0	0	139	516	231.5	265
Industrial Contracts	250	1,045	1,970	1,297	1,353	1,694	1,912	2,100
Production and Business Activities	5,300	8,234	6,411	16,411	37,633	41,485	24,875	32,100

Source: Own compilation

Recommendations for development

- The Institute of Industrial Chemistry is a research institute. But it should be granted autonomy regarding its activities. Its customers are the state and enterprises.
- Nevertheless, state-funded investments should be made in its infrastructure and basic equipment supporting scientific and technological activities and not in the institute's business activities.
- It should organise its production around high technology and become the bridge for technology transfer into the field of industrial chemistry.

In the chemical industry, 'Vien Thiet ke Hoa chat' - Chemical Engineering Institute provided technical services, investment consulting, designing new plants, expanding or rehabilitating old ones in this area in the period 1967-1993. It became a corporation in June 1993 and is now called 'Congty Thietke Hoachat' (Chemical Engineering Corporation - CECO). Its activity has not in fact changed much, but it has become much more autonomous, has established much closer links with the market in response the demand of enterprises and has become much more successful in terms of revenue and technological contribution (Bach Tan Sinh, 1999). However, CECO has also changed its objectives; as a company, R&D activity has now been reduced to a minimum and is no longer deemed such an important task.

Conclusions

Based on the above case studies, the following conclusions could be drawn about the relationship between R&D and the chemical industry.

1. All case studies involved small and medium-sized enterprises (SME) that concentrate on serving the domestic market with relatively unsophisticated products. Most products require imported materials. Following a few simple manufacturing processes, they can be marketed. Demand for R&D is thus not vital and the enterprises can do it by themselves. Almost all of these activities focus on the development of a new product for the domestic market that is already available on the international market. Most innovative activities were carried out within the enterprises without any cooperation with other institutes.
2. The enterprises' main requirements are the improvement of production equipment. The research institutes in the chemical industry do not in reality have the ability to meet these requirements. They also lack the ability to design and produce modern production lines for industry. Moreover, they lack modern research equipment, which in turn hinders the institutes in developing new products and technologies. This kind of equipment can only be afforded through importation.
3. As a consequence of these factors, it is very difficult to establish close cooperation between chemical enterprises and scientific institutes. To do so it would be necessary for the institutes to improve their research ability and modernise their equipment. Only then would they really be capable of conducting the sophisticated research that would meet the enterprises' future demands. At the same time, the institutes should be more involved in engineering activities to respond to the demand of enterprises for production design. It is recommended that the organisation of the institutes in branches of chemical industry should include the following sections:
 - R&D units equipped with modern laboratories
 - Engineering organisations
 - Pilot organisations
 - Consultant and technology transfer units

Unless they are organised in this way, it is very difficult to link the enterprises and the institutes. It is obvious that under market mechanisms it is not possible for the government to subsidise and organise this system. It is necessary to design an action plan, measures and policy instruments that could contribute to the establishment of such a network in the Vietnamese context; the CECO model could be the most suitable at this time.

2. Food Processing Industry

The food processing industry is an economic branch that produces foodstuffs for daily consumption and export. It is a large and complicated field. Foodstuffs are usually produced using two major technological processes:

- biological processes
- technologies with advanced equipment

The two different types of processes are usually combined in the food processing industry. Both require high level skills often missing in Vietnam. It can be said that very few kinds of (high quality) foodstuffs have been able to reach export standards so far. Most exported foodstuffs can be regarded more as raw materials than processed foods. This is due to the delay in development and the backwardness of food processing technologies in most Vietnamese enterprises.

Generally speaking, the Vietnamese food processing industry can be divided into three areas (Mai Van Nghe 1997):

1. *Beverages*. There are many kinds of drinks on the market in Vietnam (beer, juice, etc.). Most are produced using foreign technologies. However, the so-called "popular beer" is produced using Vietnamese fermentation technology and Vietnamese-made equipment. This is the most popular drink in the country, especially among the poor, i.e. the majority of the population. Nevertheless, Vietnam does have the technological capability to produce some high quality spirits, liquor and wine using domestic raw materials and a few of these products have already been exported.
2. *Starchy foodstuffs, Confectionery*: These products comprise mainly maize, rice, potatoes, wheat flour, etc. They are always available on the domestic market, in every province and city. However, only the following kinds of high quality goods have been produced recently:
 - Nutritious instant baby milk, instant powdered fruit, etc.
 - Canned fruit jams
 - Instant foodstuffs made of fruit, potatoes, etc. (e.g. potato chips)
3. *Meat or Fish products*: Only few kind of processed meats are marketed, e.g. bacon, ham and sausages made from pork, beef, etc. Fish products are generally limited to relatively small quantities of dried or canned seafood (e.g. dried squid).

Much attention has been paid to R&D and technological innovation in this area. The target is to catch up with other countries in the region and promote exports.

In July 1997 and November 1998, we carried out some case studies in the food processing industry as follows:

- a. Bao Ngoc Cake Workshop Ltd., Hanoi,
- b. Haiha - Kotobuki Joint Venture Ltd., Hanoi,
- c. Hanoi Foodstuff - Export Factory (a state-run company), and
- d. The Food Industries Research Institute (FIRI) (a leading research institute in this industry)

a. Bao Ngoc Cake Workshop Ltd.
(Xi nghiep Banh keo Bao Ngoc)

General overview

This small private enterprise was established in 1990. There are presently 28 employees, five of whom are university graduates (one food processing engineer from the Hanoi University of Technology, one from the Hanoi College of Law, one from the Hanoi University of Foreign Languages and two others specialised in business administration). The other 23 are workers and technicians. The enterprise has developed on its own, without any help from the government.

The average daily production is about 300-400 kg of 50 different types of cake. The products have earned considerable customer loyalty and high prestige in Hanoi and other provinces (e.g. Hongai and Phalai) due to their high quality and reasonable prices.

The enterprise has a quite simple organisational structure:

- Board of Directors (3 people)
- Executive manager, directly manages the Accounting Department (4 people)
- Three shops in Hanoi and others in Hongai, and Phalai.
- Workshop

The enterprise does not engage in research activities. Technology is handed down by family members.

Technological resources, know-how and technology transfer

Vietnamese and foreign specialists in the food processing industry transfer technology and new products to the enterprise along informal paths.

- The enterprise has consulted documents and catalogues from other countries in order to imitate the shapes, models, colours, patterns and main ingredients of their products.
- Via the importation of yeast, butter and milk.
- Learning from foreign specialists (e.g. French, Australian, and Dutch) when they come to introduce and sell their yeast butter, milk, etc.

The company has indirectly used the state control organisations (via informal contact with some people employed in these organisations) in order to control the quality of imported materials.

The production scale of the enterprise is still quite small. All internal and external contacts in S&T are informal and have not been extensively developed. The enterprise is content with this situation and does not think they should develop to a higher level. In the short term the enterprise does not expect to improve its technology but rather to establish a joint venture with foreign companies with the aim of increasing production based on modern technology lines.

***b. Haiha - Kotobuki Joint Venture Ltd., Hanoi
(Congty Liendoanh TNHH Haiha Kotobuki)***

General overview

The company was founded in December 1992 under the license of the State Committee for Cooperation and Investment (SCCI). The company's main product is confectionery. This is the first joint venture between a foreign company (Kotobuki, Japan) and a Vietnamese company (Haiha Confectionery Company). The joint venture's products have already won customers' loyalty within the country and abroad and are proving to be highly competitive on the market.

The greatest difficulty faced by the company is the rigorous competition among domestic and foreign confectionery producers; more and more both state-owned and private companies are jumping into this business area while illegal importation of the products are increasing. In addition, as a joint venture, the company does not receive much government assistance, especially in financial resources.

Company structure

- *The Management Department:* There is a General Director and two Vice-Directors, one of whom is in charge of the Technical Department and the other responsible for the Sales Division and the shop and warehouse system.

- *The Production Department* consists of all production lines (candy, chocolate, snacks, chewing gum, cookies, raw cakes), and the mechanics team.
- *The Technical Department* is responsible for production techniques, technology and product improvement.

Scientific and technology activities, innovation and technology transfer

The company's staff structure is quite favourable for technology and product innovation. The percentage of university and polytechnic graduates is quite high: 15.4% of staff in 1998.

Table 6.18: Confectionary Company (Haiha): Staff Structure (%)

	1995	1996	1997	1998
Graduates	12.3	11.2	12.4	15.4
Technicians and Workers	72.7	73.5	72.5	70.3
Administrative Staff	15.0	15.3	15.1	14.3
Total Workforce (persons)	100% (260)	100% (268)	100% (251)	100% (272)

Source: Haiha Kotobuki J.V. Report 1999

The Technical Department is in charge of all technical activities including technological control, quality control and other technical services in the production of the company. Almost their staffs (12 persons) are university (10) and polytechnic graduates (2).

The company has not set up an independent R&D unit. Its S&T activities focus mainly on the creation of new varieties of current products (confectionery) (see Tab. 6.19).

Table 6.19: Confectionary Company (Haiha): Innovations

	1995	1996	1997	1998
New Types of Products	4	5	4	6
New Technical Solutions	2	1	1	2

Source: Haiha Kotobuki J.V. Report 1999

Purchasing equipment and using the technological components appropriately for each product are the main issues for improvement of production lines after the complete basic equipment was imported. The product-research division of the Technical Department studied and created new types of products with the help of information provided by the Marketing Division's analysis of market demands and consumer tastes.

In opinion of the company, research institutes in this industry have done nothing to assist them with product and technology innovation in the last few years. In fact, the institutes are seen as being unable to design, manufacture or improve modern production lines appropriate to the company needs.

On the other hand, the company's products are various types of confectionery; the processing procedures are based mostly on experience and skill, with a little artistic flair and not much scientific content. Thorough research using exact quantitative methods to investigate mechanical, physical and chemical characteristics are not necessary. In the near future, the company will not need substantial improvement with high scientific content. It will only require, for instance, the replacement and improvement of some microbe types in fermentation. Therefore, the importance of the Food Industries Research Institute (FIRI) to the company will not increase in the near future.

c. Hanoi Foodstuff - Export Factory
(Xi nghiep Thuc pham Xuat khau Hanoi)

General overview

This state-owned enterprise (SOE) is a subsidiary of the Vietnam General Corporation of Fruit and Vegetables. It was founded in 1963 in line with the decision made by the Ministry of Agriculture and Rural Development. At that time its main focus was to produce and process canned vegetables and fruits; its products were exported to the former USSR and Eastern Europe. Following the collapse of the Socialist system, the company has redirected its external trade toward the Western European market (about 30% of their products). Their main products are now canned vegetables, bacon, canned meat, alcoholic beverages and instant noodles.

The company is currently facing many difficulties in its product orientation and is still in the process of seeking new markets. The domestic market is limited due to the Vietnamese population's negative attitude towards canned food. On the other hand they have not yet been able to broaden their foreign market due to the poor quality of their products and the lack of loyalty on the part of foreign consumers. Orders remain small and unstable. As far as the canned food industry is concerned, the government has not yet adopted any policy in orientation and investment to develop it. The company recently transferred some of the production lines (e.g. draught beer, instant noodles) to private use and has allowed other companies to rent its production site (e.g. a garment export company, a brewery company, and an instant noodle company). These companies have taken on part of the Hanoi Foodstuff - Export Factory's workforce, thus helping to solve the company's workforce problem to some extent.

Scientific and technological research and technology transfer

The company's machinery and equipment, some of which was imported in the 1960s to produce canned vegetables and food for export to the former Soviet Union and Eastern Europe, is now technologically obsolete and some stages in the production process must be carried out manually (such as peeling, washing, sorting). This results in products that are more expensive but of low quality.

With unstable market orientation, small orders and permanent changes of manufactured products, the company has to struggle to survive and is not able to carry out scientific research and equipment improvement. It has tried making new products that can directly supply the demands of local inhabitants, such as low quality draught beer and instant noodles. Under such conditions, not all of the existing machinery and manufacturing equipment can be fully used – the same is true for the transferred technology and capacities for industrial services or pilot production related to processing food and drinks.

In conclusion, this company is on the verge of ruin - it cannot adapt to the changes in market conditions. The most pressing need is not S&T but demand and a reorientation of products in line with the market as well as the further employment of the workers.

d. The Food Industries Research Institute - FIRI (Vien Nghien cuu Cong nghiep Thuc pham)

Overview

The FIRI was founded in July 1967 by the Prime Minister's Decision, and is subordinate to the Ministry of Industry. The FIRI is an entity specialising in research and application, especially applying biotechnology in the food industry. It is responsible for the following activities:

- Studying S&T development strategy and development policy in the food industry.
- Performing all R&D activities in the fields of microbiology, genetic engineering, fermentation technology, enzyme technology and food processing of agricultural products. It also carries out pilot production, design and manufacture of equipment, technology transfer and industrial services related to foodstuffs and beverages.
- Training workers, technical staff, tertiary and post-graduate students.
- Establishing a data base and information network for the food processing industry.
- Elaborating technological processes, taking part in formulating branch and state standards, quality control of foodstuffs.
- Educating post-graduate students, participating in economic, technical and scientific communication activities of the food processing industry.

The institute's range of activities is quite large and comprehensive. Its workforce has been stable since the beginning of economic reforms, and the staff structure is advantageous for scientific research.

Table 6.20: Food Ind. Research Institute (FIR): Staff Structure (persons)

	1991	1992	1993	1994	1995	1996	1997	1998
PhDs	14	15	15	15	15	15	17	18
Masters Degrees						3	4	7
Under-Graduate Degrees	85	88	82	85	95	100	104	102
High School Graduates, Technicians, Technical Workers	46	46	45	40	38	34	33	39
Unskilled Workers	20	19	15	14	12	12	12	12
Administrative Staff	8	8	6	6	6	6	6	7
Total	200	192	190	185	185	185	185	185

Source: FIRI Report, 1998 and 1999

R&D organisation and functions

In general, the organisational structure of the institute has not much changed since 1991.

In 1998 it encompassed:

- *Departments of scientific research:* (i) Microbiology, (ii) Biological Product-Processing, (iii) Biological Technology, (iv) Beverage-Processing Technology, (v) Protein Technology, (vi) Nutritious Foodstuff, (vii) Enzyme Technology and Application, (viii) Food Flavour, (ix) Foodstuff Analysis and Inspection, (x) Equipment.
- Foodstuffs and beverages production and experimental workshop.
- *FIRI Affiliate* in Ho Chi Minh-City.

The institute does not seem to conduct any basic research. Its workforce is mainly involved in applied research and experimental performances (this accounts for 60% of the total workforce). About 16% of staff are employed in designing and testing; others provide scientific and technical services (communication, consultancy, etc.) for production and do business to increase the income of the staff.

Table 6.21: Food Ind. Research Institute (FIR): Staff Activities (persons)

	1991	1992	1993	1994	1995	1996	1997	1998
Applied Research	93	93	95	97	96	103	100	110
Designing, Testing	42	44	40	42	42	40	41	29
Research Assistance	61	46	38	33	37	33	33	34
Production, Business		8	10	10	10	10	12	12
Total Workforce	196	191	183	182	185	186	186	185

Source: FIRI Report, 1998 and 1999

Table 6.22: Food Ind. Research Institute (FIR): Financial Resources (%)

	1993	1994	1995	1996	1997	1998
Salaries and Administrative Charges Funded by the State Budget	15	18	18	14	29	18
R&D Projects at State Level				5	20	9
R&D Projects at Ministerial Level	2	3	2	5	15	14
R&D Contracts with Industry	10	11	12			
R&D Contracts with Other Ministries, Provinces	66	47	50	62		30
Business Activities		18	13	12	26	20
Others	7	2	5	2	10	9
Total (million VND)	100% (4,489)	100% (4,279)	100% (6,746)	100% (9,195)	100% (4,505)	100% (6,812)

Source: Own compilation from FIRI Report 1998 and 1999.

Table 6.22 reveals the following tendencies in FIRI's financial structure:

- The share of revenue earned by doing business is increasing and represents about one fourth of the institute's total income.
- Income from research tasks funded by the state budget at the state and ministerial level was insignificant until 1996, when it increased and amounted to approximately 1/3 to 1/4 of total income in 1997 and 1998.
- Income from research contracts with other ministries and industrial enterprises was highest in 1996 (62.4% of total income) and dropped in 1997 and 1998 (ca. 30% in 1998).

From above results, we can draw various conclusions. The FIRI's *R&D* activities declined until 1996, while production and business activities developed. In 1997 and 1998 government policy began to promote S&T activities in R&D institutions and FIRI found a demand for its S&T activity. This shows the changes in the functional structure of the institute. However, in a discussion between our research team, FIRI's director and some department heads in January 1999, it was revealed the institute is not in a very good state at present, with many activities now only just covering staff costs. The institute cannot do much in the way of technology creation and transfer due to the lack of modern equipment and necessary financial support.

The following table shows the institute's expenditure for research, development, production and technology transfer contracts.

Table 6.23: Food Ind. Research Institute (FIR): Expenditure (%)

	1991	1992	1993	1994	1995	1996	1997	1998
Applied Research	100	57.0	56.6	67.9	37.6	34.1	42.5	15.8
Experimental Development		6.2	5.8	7.1	9.4	9.8	57.5	15.9
Production & Technology Transfer Contracts		36.8	37.6	26.3	53.0	61.1		68.3
Total	100	100	100	100	100	100	100	100

Source: FIRI Report 1998 and 1999

Recent tendencies in the institute's working mechanism can be seen clearly in the above table.

- The institute does not carry out any basic research work.
- The percentage of applied research is declining. There was an exceptional increase in 1997 due to urgent demands from the government.
- The share of experimental development is increasing, but remains low.
- The percentage covering production and technology transfer contacts is rising; it now accounts for more than 50% and continues to increase.

It seems that the institute is concentrating on diverse short-term activities to increase its earnings (and the staff's income), but its functions as an R&D institute serving the food processing industry appear to be fading into insignificance.

Conclusions

Based on the above case studies, the following conclusions could be drawn about the mechanisms and organisation of R&D activities in the food processing industry.

- Given that the market is small and unsophisticated, the enterprises have no wish (and no ability) to perform R&D thoroughly to improve the technology and products. Their biggest expectation is be able to afford to modernise their production lines by importing complete equipment. Aimed for is the upgrading of production and broadening of their market. They believe that the domestic R&D organisations are not able to assist them in improving technology and products. In fact, this mutual relationship is underdeveloped.
- The R&D organisations are in difficulty and need to be strengthened if they are to survive. Their R&D functions are declining and they are increasingly resorting to doing business to supplement incomes instead. Obviously, R&D organisations do not have adequate abilities to meet the businesses' technology transformation demands. This is a consequence of the decrease in infrastructure, lack of facilities and equipment for research and unsuitable organisational structures to perform these tasks (lack of consulting organisations, pilot production, etc.).

In order to create a desirable relationship between S&T organisations and the food processing industry, we must take their natural interaction into account: Businesses' real demand for innovation and their ability to adapt (as well as to be supplied with) appropriate technology from R&D organisations. These conditions are not currently present in Vietnam in general, and in the food processing industry in particular.

3. Electronics and Electrical Industries

Four case studies were completed for this industrial branch; two in the electrical industry (Nhat Linh Ltd and Tran Phu Electro-Mechanical Company), one in the electronics industry (Hanoi Electronics Company - HANEL) and one R&D institution (Vietnam Institute of Electronics, Informatics and Automation - VIELINA)

Both the electrical and electronics industries are quite young in Vietnam. Before 1990, the electrical industry mainly produced electric lighting (electric bulbs, tubes, neon lights, etc.), transformers and other electrical devices of low quality (e.g. fuses). Since 1990 some joint ventures and modern enterprises have been established. They are ABB Joint Venture Company, producing transformers with advanced technology; joint venture VINADAESUNG, producing communication cables; Electric Measuring Instrument Company (EMIC), which belongs to Vietnam Electric Equipment Corporation (VEC) under the MOI and specialises in electrical measuring instruments for medium and low voltages, etc. EMIC has transferred know-how from LANDIS&GYR - Switzerland and been equipped with state-of-the-art production machinery and high precision control equipment from Switzerland, Germany and Japan.

The electronics industry has only begun to be developed in Vietnam since 1980. The economic reform, transition from the centrally planned economy to the free market, has forced many economic branches to improve their technological capability. Among them, the electronics industry is one of the branches that has made substantial progress in production technologies. The market for electronic products has now become one of the most lively in Vietnam.

According to many sources, the average growth rate of the electronic products market is about 30% per year and could increase up to 50% within the next few years. In addition, electronic products imported illegally have made this market more rigorously competitive and have come to represent an urgent problem in Vietnam. The current structure of the Vietnamese electronic products market is as follows (MOI 1997a):

- Electronic utilities for daily life comprise 40%
- Information and communication equipment: 32%
- Information processors, software and services: 15%
- Specialised electronic equipment and services: 10%
- Spare parts and electronic materials: 3%

Following are some features of the production capacity of the electronics industry in Vietnam:

- There are about 40 assembly units in the country, producing electronic devices for daily life; 90% complete knock-down (CKD) and 10% integrated knock-down (IKD) assembly lines. They supply about 70% of domestic demand. Their annual production capacity is three million televisions (65% are colour televisions), 1.5 million radio-cassette recorders.
- Specialised electronic equipment (e.g. calculators, industrial devices, telecommunications equipment, etc.) is mostly assembled using semi-knock-down (SKD) assembly lines, some using CKD assembly lines with imported spare parts. Those products serve between 15 and 20% of domestic demand.
- Due to the inconsistency of most assembly lines, electronic products made in Vietnamese enterprises are not usually of high quality. No Vietnamese assembly units reach the ISO 9000 standard, while the products produced by joint venture companies and foreign electronic enterprises within Vietnam are of international quality and can be exported.

a Nhat Linh Ltd. Co.
(Cong ty TNHH Nhat Linh)

General overview

The Dong Da People's Committee licensed this business for operation in 1994. It was formed in 1992 from a small family production group. Its first products were transformers; it has now expanded substantially and produces many other products, such as desk lights, overhead projectors, etc. The essential reason for diversifying its product range is the struggle for survival under free market conditions. The company's average monthly revenue lies between 600 and 900 million VND, and sometimes reaches up to 1.1 billion VND.

- Organisational structure: An assembly workshop in Hanoi, with about 30 contract workers; a Managing Division, with one manager, one vice-manager and one clerk
- The company's products are marketed throughout the country and have satisfied consumers.
- Production methods: The company places orders with other groups or factories for the production of parts of their products (covers, bases, etc.). These also include state-owned factories (e.g. Z181 enterprise, under the Ministry of Defence, which makes transformer covers for Nhat Linh Ltd. Co.). Other materials, such as wire or gauges can be purchased on the domestic market. The company carries out only two stages of its production line itself - designing and assembling the end products and then marketing them. Their products are tested and registered by the State Quality Control

Units. Thus, the company has successfully set up a network for production. Its success is still a rare case in Vietnam.

Scientific research and technology transfer

- In product-design, Nhat Linh Ltd. Co. makes use of individual contacts in universities or research institutes to obtain technology.
- This is a small enterprise, actually, a family business. It has no R&D division. However, it has established close links with S&T institutions throughout the country for transferring knowledge and designing new products. It has made use of the facilities, machinery, etc. in other state-owned and private factories to produce high quality products, which are being accepted by consumers. This is the factor that determines the company's success while many SOEs that are larger in scale, better equipped and have more capital are operating at a loss.

It is believed that Nhat Linh Ltd. Co. is a typical successful business. It is well organised and has good links in the electrical and electronics industry. It has an effective combination of S&T and production. The company is concerned that private businesses are being discriminated against, frequently having difficulties in getting bank loans or dealing with foreign counterparts.

b. Tran Phu Electro-Mechanical Company (Cong ty Co Dien Tran phu)

General overview

This is a SOE, founded in 1985 under the license of the Hanoi People's Committee. It now belongs to the Hanoi Construction Department. The company has undergone substantial changes since it was founded.

Up to 1989, it had specialised in producing construction, irrigation and other equipment, such as 250 litre concrete mixers, brick makers, construction frames, vertical-spindle water pumps, etc. Since 1990, with the new technology transformation, the company's main products are bare or PVC-coated electric wires and cables.

From the point of view of technological innovation, the company has met with the following difficulties:

- Technology transfer and new equipment procurement require huge capital, both fixed and working capital. This is the biggest problem faced by the company at this time.

- The government policy regarding land rental and loans results in many difficulties for the company, e.g. unsuitable mortgage procedures, high interest rates, capital loans permitted only short term.

Present situation:

The company is doing business successfully.

- Turnover in 1996: 65 billion VND.
- Average monthly salaries paid: 1.1 million VND.
- Output in 1996: 1,000 tonnes aluminium cable over 1,000 tonnes copper cable
- New products released in 1997: (flat and main) bars in circuit breaker.

Staff numbers have slightly decreased, but the percentage of polytechnic and university graduates is rather stable.

Table 6.24: Electro-Mechanical Company: Staff Structure

	1991	1992	1993	1994	1995	1996	1997	1998
Polytechnic and University Graduates	15	17	17	17	14	13	12	12
Technician, Workers	-	-	-	-	177	169	169	166
Administrative Staff	-	-	-	-	22	22	21	20
Total	255	233	224	215	213	204	202	198

Note: - = data not available

Source: Tran Phu Electro-Mechanical Company Report (27 Feb. 1999)

R&D structure and technology innovation

The Technical Department is directly subordinate to the Board of Directors. It has been responsible for all production technology since 1991. Between five and eight S&T research staff, all polytechnic and university graduates, are employed in this department. They work in ad hoc groups on research projects based on production requirements. The company does not have a separate division for R&D and they cannot allocate a separate budget for R&D research.

In the past five years, funds amounting to ca. 60 million VND annually have been granted for research and technology improvement by the Hanoi City Department of Science, Technology and the Environment (DOSTE). Table 6.25 below shows the company's total expenditure on resolving technical problems in production. In fact, these are only the bonuses for those staff members who contributed technological innovations. Expenditure

on the production of new equipment is not included (this counts as production installation and preparation costs).

Table 6.25: Electro-Mechanical Company: Expenditure on Solving Technical Problems

	1991	1992	1993	1994	1995	1996	1997
Total Expenditure (million VND)	10	6.16	30.8	28	28	22	55
Percentage of Revenue (%)	0.14	0.05	0.25	0.18	0.04	0.04	0.7

Source: Tran Phu Electro-Mechanical Company Reports (1997 and 1999).

The expenditure varies greatly according to the actual needs of production. The company does not have regular plans regarding seeking new market or technological innovation.

Technology transfer

Since 1989 the company's business has been transformed from the production of construction equipment to the production of electric wires or cables. Research staff are expected to acquire new technologies by consulting with R&D institutes and universities. For example, the technological processes for moulding, flattening and stretching aluminium was developed from three sources: (i) The National Institute of Technology and Hanoi University of Technology sent design consultants for aluminium moulding, flattening and stretching; (ii) Tran Phu Electro-Mechanical Company learnt from the failures of other companies in the field, e.g. Yen Vien Engineering Factory; (iii) Experiences of the company's own engineering staff: They had formed two teams working in two different directions to fulfil the research projects and one team succeeded.

An aluminium moulding, flattening and stretching assembly line was created to produce the electric cable accepted by the market at that time. This helped the company survive through the difficult situation during the first steps of development. Now aluminium cable products have become obsolete. The company has bought a complete copper-moulding, flattening and stretching assembly line from a German firm; this is now the company's key production line. It has passed on its old aluminium moulding, flattening and stretching line to another company.

The purchase of equipment parts and selected materials is the principal source of technology transfer in a situation where there is a lack of capital for importing complete equipment. Apart from this, the company has not been getting acquainted with technological licensing procedures, dealing with foreign companies for new technology procurement and setting up joint ventures.

The following are comments made by Tran Phu Electro-Mechanical Company about the R&D structure of businesses, the relationship between businesses and state R&D institutions, as well as the regulations and policies in place to promote technology and product innovation in businesses.

- At the present time, the S&T results of R&D institutes in industry and universities cannot satisfy production requirements. For example: Tran Phu Electro-Mechanical Company must still import fire resistant bricks at high cost while these could be studied and produced in Vietnam.
- The relationship between R&D institutes, universities and businesses should be strengthened. The research units should try to meet the requirements of production.
- With regard to policies on technology and product innovation, the company has the following recommendations:
 - (i) The three-year term for capital loans to improve technology is too short; due to depreciation the company must then increase the prices of the products, resulting, of course, in a decrease in the competitiveness of the products.
 - (ii) A one-year tax holiday period for newly launched products is too short.
 - (iii) The proposed scheme to promote technological innovation in SMEs states that the government should provide 50% of R&D expenditure in SMEs and the other half should be paid by the enterprise itself. This will not be effective in SOEs since the money in fact comes from one source.

***c Hanoi Electronic Corporation -HANEL
(Congty Dientu Hanoi)***

General overview

This SOE was founded in December 1984 according to a decision by the Hanoi People's Committee. It is a large complex of domestic enterprises and joint ventures. Scope of business encompasses

- manufacturing and trading electric, electronic, computer and informatics equipment and other scientific products.
- Conducting construction and business infrastructure of industrial zones subject to the government's 192-CP Decree.
- setting up and organising trade centres, S&T and vocational training centres.

- carrying out joint ventures and cooperation with domestic and foreign economic organisations to develop business, to set up representative offices within and outside Vietnam.
- handling direct import-export activities subject to regulations imposed by the Ministry of Trade.

The organisational structure of the company comprises the following:

(i) Functional divisions of the company

(ii) Dependent self-accounting enterprises.

(iii) Independent self-accounting enterprises: These include domestic businesses, other companies in which HANEL is a share holder, joint ventures with foreign companies (100% foreign capital) located in Sai Dong Industrial Zone and under HANEL's control.

This project has carried out studies on HANEL's main divisions, i.e. the functional divisions and dependent accounting enterprises. Most of these core units are located in Hanoi.

The enterprise is composed of the following sections:

(i) *Technical Section*: This section has the main responsibility for R&D activities and pilot production. It has 40 engineers *distributed* in the following units:

- Information Technology Centre
- Automation Centre and Industrial Services
- Electronics Centre
- Pilot Workshop (this units brings together most the workforce in precision mechanics).

(ii) *Business Section*, comprising:

- Marketing Division,
- Import-Export Division
- 50 agencies throughout the country.

(iii) *Production Section*, comprising:

- Assembly factory (180 workers and 10 engineers).
- Surface Moulding Techniques (SMT) Workshop: To assemble electronic products using SMT techniques. This workshop was founded in 1990 with the latest technology. It is said to be more modern than ALCATEL, a joint venture with the French in postal services and telecommunications.

(iv). *Technical Assistance Section*, comprising:

- Material Division

- Quality Control and Warranty Division (with over 30 warranty agencies throughout Vietnam).

(v) *Management Section*, comprising, among others:

- Accounting Division
- Administration Division

Main product: televisions, with annual productivity of 100,000 items.

Turnover: 200 billion VND annually

Total workforce: 350 people, including 80 engineers, 2 post-graduates, 218 technical workers and high school graduates, 50 administrative staff.

The major difficulties the company now faces:

- The sale of electronic products is very difficult due to limitations in the domestic market (80% of the population in Vietnam are farmers with low income) and the company has to compete with illegally imported products.
- In joint ventures: Foreign companies control the input and output with price limitations. The company has earned only from prefabrication with fairly low rate, so they cannot afford to reinvest in equipment improvement and S&T activities.
- Their product will become expensive if they install new equipment, and in that case they will not be competitive on the market.
- The government's macroeconomic policies are unfavourable to the company's production and S&T activities.

Functional structure of S&T activities

The company does not have a separate R&D division. The Technical Section has to carry out R&D along with its main tasks in daily production. This section has been divided into provisional groups to solve technological problems when they arise or to carry out R&D projects funded by the government.

In addition to the funds granted by the government, the company has to provide more funds to cover all the expenditure on experiments and pilot production (Table 6.26)

Table 6.26: Electronics Corporation (HANEL): S&T Expenditure According to Sources
(million VND)

Income Sources	1992	1993	1994	1995	1996	1997	1998
Hanoi-City DOSTE	45	60	60	80		70	250
State Funding for Research Programme A	50	80	280	310			
Additional Internal Funding	10	50	140	100			
State Funding for Research Programme B					40	240	380
Additional Internal Funding						200	300
Total Expenditure	105	190	480	490	40	510	980

Source: Data from HANEL Report, 1998

In 1996-1997, the company had to build a centre for measuring and testing household electronic equipment, at a cost of 1.6 billion VND. The company provided its own capital of 1.35 billion VND and borrowed 250 million VND from the Hanoi DOSTE. There were research processes and experiments in which international experience was applied or the required equipment was manufactured using the company's own capacity rather than importing. However, these scientific activities could not contribute much to increasing the competitiveness of the products on the market or to launching new types of products because they could not reach the international standards of the electronics industry.

Relationship between the company and S&T organisations

HANEL has set up cooperative relationships with the Institute for S&T in Defence and the Department of Electronic and Telecommunication Technology at the Hanoi University of Technology to carry out the above-mentioned research programmes.

However, HANEL has not established any official contacts with leading institutes in the field of electronics-informatics in Vietnam (including the Vietnam Institute of Electronics, Informatics and Automation - VIELINA). Most of the contacts that do exist, were established on a personal basis between the company's researchers and individuals working in VIELINA and universities.

Modern technology has been transferred into the company through cooperation with foreign companies such as DAEWOO and ORION.

HANEL believes that in its production areas, domestic R&D organisations can neither create advanced technologies nor supply technical know-how for hardware production. It is seen as urgent that the government reorganises domestic R&D institutions, invest more in renovating their infrastructure and train their workforce to match international standards in this leading industry.

**d. Vietnam Institute of Electronics, Informatic Technology and Automation – VIELINA
(Vien Nghien cuu Dien tu, Tin hoc va Tu dong hoa)**

General overview

VIELINA was founded and developed on the basis of the Vietnam Institute of Electronics and Informatics, which was established in 1985. It is a state research institute under the MOI. Although its functions have undergone some changes since then, VIELINA has always kept to its main target - carrying out R&D, application and technology transfer in electronics, informatics and automation fields (of which, automation is the main focus).

There have been some changes in the organisational structure since 1991. In 1991-1992 VIELINA set up the Specialised Electronic Co. alongside the existing research divisions (e.g. informatics, communication techniques, systems techniques, applied electronics). In 1993-1994 that company was dissolved and two other centres established (Centre for Measuring and Cybernetics, Centre for Informatics Assistance and Development).

In 1995-1997 VIELINA thoroughly renovated its organisational structure. In addition to its existing electronics and informatics branch in Ho Chi Minh City (with 17 employees), other research units were merged to form the following centres:

- Information Technology Centre (14 employees)
- High-tech Centre (13 employees)
- Measure and Quality Centre (12 employees)
- Informatics Assistance and Development Centre (3 employees, founded 1994)

The activities of these centres ranges from R&D, pilot production and technology transfer through to production.

Organisational structure of R&D and its relationship with industry

Although VIELINA's staff remained constant at 81 employees in the period 1991-1998, there has been some fluctuation in the distribution of educational levels

Table 6.27: Institute of Electronics (VIELINA): Staff Structure (%)

	1991	1992	1993	1994	1995	1996	1997	1998
PhDs	8.6	8.6	8.6	9.9	9.9	11.1	11.1	10
Other Post-Graduate Degrees						2.5	3.7	7.4
Under-Graduate Degrees	76.6	76.6	76.6	75.3	75.3	71.6	70.4	69.1
High School Graduates, Technical Workers	2.5	2.5	2.5	2.5	2.5	2.5	2.5	1.2
Others	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
Total (persons)	100% (81)	100% (81)	100% (81)	100% (81)	100% (81)	100% (81)	100% (81)	100% (81)

Source: VIELINA Report (Feb. 1999)

The majority of graduates on the staff are specialised in automation, measuring and cybernetics. They can be classified according to specialities as shown in Table 6.28:

Table 6.28: Institute of Electronics (VIELINA): Staff Specialisation (%)

Main Specialisation	1991	1992	1993	1994	1995	1996	1997	1998
Informatics	20.3	17.7	18.8	19.4	18.5	21.2	21.2	21.2
Automation, Measuring and Cybernetics	28.8	29.1	31.2	35.5	35.4	37.9	46.9	46.9
Electronic Technology	35.6	38.7	35.9	29.0	33.8	30.3	25.8	25.8
Communication Technology	15.3	14.5	14.1	16.1	12.3	10.3	6.1	6.1
Total (persons)	100% (59)	100% (62)	100% (64)	100% (62)	100% (65)	100% (65)	100% (66)	100% (66)

Source: VIELINA Report (Feb. 1999)

The percentage of income received through contracts with industry has fluctuated considerably, peaking in 1992 and 1998. In 1998, VIELINA had made new progress in acquiring new markets; it designed and produced control systems for mixers in construction and agricultural product processing.

In 1996, the institute's operation was based on the funds provided by the government to cover salary and administration charges (these accounted for 85.1% of total funds). The institute also received an additional government subsidy in this year, about 0.6% of the total income.

Table 6.29: Institute of Electronics (VIELINA): Income Structure (%)

Sources	1991	1992	1993	1994	1995	1996	1997	1998
Salary/ Administration Charges Funded by Govt.	77	16	24	23	29	85	18	11
State, Ministerial Research Projects	2	28	54	42	28	13	32	20
Contracts with Industry; Application in Production	21	56	22	35	43	1.4	50	69
Others						0.6		0.0
Total (million VND)	100% (185)	100% (1316)	100% (1037)	100% (1913)	100% (1982)	100% (1415)	100% (5642)	100% (9550)

Source: VIELINA Report (Feb. 1999)

1996 was a year of big changes in VIELINA: They concentrated on applied research funded by the state budget. Income from the state budget basically covered only salary payments. State funds for research projects were reduced to 13%; Simultaneously, there was a sudden drop in contracts with industry. VIELINA was thus in an extremely precarious position.

Table 6.30: Institute of Electronics (VIELINA): Expenditure Structure (%)

	1991	1992	1993	1994	1995	1996	1997	1998
Applied Research: State and Ministerial Projects	9.3	32.0	71.4	54.5	39.6	90.1	19.0	30.3
Production and Business Contracts to Apply S&T Results to Production	90.7	68.0	28.6	45.5	60.4	9.9	81.0	69.7
Total (million VND)	100% (43)	100% (1088)	100% (784)	100% (1480)	100% (1398)	100% (202)	100% (3226)	100% (9322)

Source: VIELINA Report (Feb. 1999)

Some remarks on R&D structure in the electrical and electronics industries

These industries are considered development priorities for the technological orientation of the country. They still, however, suffer from a lack of investment, especially in S&T potential. Both the case studies presented here and other data sources (cf. Tran Chi Duc 1997) reveal the following gaps in their technology capability and R&D structure.

1. There is a substantial gap between the actual technology demand and the very poor state of existing machinery and equipment. The Vietnamese electronics industry continues to rely on simple assembly lines and both input and output of its production depend on foreign countries.
2. This gap is mirrored in the gap between the actual demand for industrial research and the outdated and poor conditions of R&D equipment in almost all R&D institutions. In some cases it would appear to be in a worse state than in the enterprises. In addition, Vietnamese scientists may be very competent with regard to theoretical knowledge but they are rather weak in terms of skills and practice, in designing and technology creation. This is why enterprises have little faith in them and do not want to utilise their new creations in technology, especially those that have not yet been proven in production.
3. The enterprises in these industries require modern and advanced assembly lines that R&D institutions cannot provide. Of course, in this situation, the linkages between R&D institutions and industry cannot be strong, and in effect they do not need each other. In addition, most enterprises are state-owned, were established under state subsidy conditions and are not open for incremental innovations. Like most enterprises in the former socialist countries, they do not care much about efficiency; they, therefore, want to import new machinery and equipment even at very high costs rather than conduct R&D to improve their own technology.

4. Conclusions

From these case studies of enterprises of various types (private, state-owned, joint venture) in three industries (chemical, food processing and electrical-electronics industries) and some results of the Project "Technology Capability Review in some Economic Branches" (cf. Proceedings 1997), the following features of their S&T activities and R&D structure in the transition period of Vietnam can be determined.

Enterprises' S&T activities from the point of view of technological innovation

The private (limited) companies are small enterprises in terms of staff size and gross product capacity; they have very weak S&T capacity. Their main technology transfer patterns are through informal paths. One path is the purchasing of equipment and raw materials for their production from abroad. The others are learning skills, gaining know-how and experience via sales people or foreign trainers; utilising Vietnamese experts and technicians via personal contacts; placing orders with other enterprises (even some SOE) for the production of some components of their products. These private companies do carry out not any R&D activities, they design their products by imitating industrial designs available on the market, etc.

Most SOEs are small and medium sized. Some have a very large workforce despite their rather small production capacity and market. They improve their technology by imitating machinery patterns and industrial designs that are available on the market when they lack capital to afford new technology. They can manufacture some pieces of machinery and replace some obsolete processes using their own R&D capabilities. Most S&T activities are enclosed within the enterprise; their links with R&D institutions are weak and generally limited to consultancy services and not R&D package contracts.

The joint venture medium-sized enterprises were set up by importing complete assembly lines. Those are mostly modern, advanced and automatically controlled. The endogenous capability is very limited; these enterprises can launch new products with some changes in design. Linkages between joint ventures and R&D institutions (within and outside Vietnam) are weak and inadequate.

HANEL is an electronics company with stronger R&D capability. It has set up a technical division comprising of 40 engineers and a good pilot unit. However, their electronic products are not competitive enough on the market.

Vietnam's R&D structure from the point of view of innovation in business

R&D activity in most Vietnam enterprises is not regular and occurs at a low level. Most enterprises lack an autonomous R&D division. They conduct R&D unprofessionally; technical issues in production are usually solved by ad hoc teams and they are not able to do much in terms of product and technological innovation to make their products more competitive. Enterprises engage in extremely limited S&T activity - they make some in-house technical improvements and do not have close links with public R&D institutions.

The R&D capability of public R&D institutions is not strong enough to serve business requirements in product and technology innovations. Many R&D institutes do not have enough equipment and what they have is usually more outdated than that in the enterprises. These R&D institutes have not been adequately invested in and suffer from poor infrastructure.

In addition, many R&D institutions do not have enough knowledge of the new technologies in their fields in comparison with the enterprises. They are also not sufficiently familiar with marketing measures to establish close links with enterprises (Nguyen Vo Hung 2000).

For the last few years, the Vietnamese government has been reorganising the national R&D system. Public R&D institutions were targeted first: Some excellent R&D institutes and some public services and multisectorial R&D institutes are to remain in the public R&D sphere. The others are to be merged to form state general corporations within the industrial sector. The government seeks to strengthen linkages between R&D and industries using these administrative means (cf. Dang Duy Think 1998).

However, these objectives have not been satisfactorily achieved. One of the reasons is that Vietnamese industries are too weak to have enough competitive capability in the domestic and foreign markets; they lack capital investment and their technologies are obsolete. In addition, the government continues to subsidise SOE even when they are operating at a loss. This policy environment makes SOE wait and seek additional investment from the state to import new technologies or to adapt them in joint ventures with foreign countries; they do not attempt to innovate their own products and technologies by strengthening their links with Vietnamese R&D institutions. In 1999, the government decided to privatise some SOE. This could prove to be a good solution, promoting production efficiency and technological innovation in enterprises.

At present, the government should create equitable opportunities for the development of every economic sector, public and private, making favourable conditions for all SME. It should, on the one hand, promote technology innovation in each enterprise, make enterprises link themselves to R&D institutions to acquire knowledge and new processes for their production. On the other hand, the government should upgrade the R&D system, providing institutes with good facilities and more investment for R&D, ensuring that they survive on the basis of their own creative capability to serve enterprises' demand and their links with production. Almost all Vietnamese R&D institutions are now managing to escape from their bad conditions. They carry out research contracts with enterprises and sometimes engage in business as a survival strategy providing them with more financial sources for their activities.

References

- Bach Tan Sinh, 1999: *Nghien cuu trung hop tai Cong ty Thiet ke Hoa chat Cong nghiep* [Case study in Chemical Engineering Corporation-CECO], RAPOGE Project. Hanoi, August 1999
- Dang Duy Thinh (1998) *From Plan to Market - S&T Policy Reform in Vietnam*. In: Werner Meske et al. (ed.) 'Transforming Science and Technology Systems - The Endless Transition?' IOS Press./Ohmsha; Amsterdam, Berlin, Oxford, Tokyo, Washington. Pp. 160-168.
- Frascati Manual, 1993. Paris
- Mai Van Nghe, 1997: *Danh gia nang luc cong nghe trong cong nghiep che bien thuc pham o Viet Nam- Hoi thao ve Nang luc cong nghe trong cong nghiep che bien luong thuc, thuc pham o Viet Nam*. Thang. [Evaluation of Technological Capability in Food Processing of Vietnam. Workshop on Technological Capability of Food Processing Industry of Vietnam] April.
- MOI (1997) *Bo Cong Nghiep - Lo trinh doi moi cong nghe trong Cong nghiep Hoa chat cho toi 2005*. Ha Noi, thang 11-1997 [MOI - Roadmap for Technological Innovation in Chemical Industry until 2005, Hanoi, Nov. 1997]
- MOI (1997a) *Bo Cong nghiep - Du thao Chien luoc va Quy hoach phat trien nganh Dien tu - Tin hoc o Viet Nam toi nam 2010*, Ha Noi, thang 1- 1997. [MOI - Strategy and Master Plan for the Development of Electronic - Informatic Industry in Vietnam until 2010]. Hanoi, January.
- Nguyen Vo Hung (2000) - '*Bao cao ket qua dieu tra khoi ha tang khoa hoc cong nghe*' [Report on the survey of the organisations composed in S&T infrastructure of Vietnam], June (Draft)
- Proceedings (1997): *Du an "Dieu tra Nang luc Cong nghe Mot so nganh kinh te"*. [Project "Technology Capability Review in some Economic Branches"]: *Bao cao Hoi thao "Nang luc Cong nghe trong nganh Dien - Dien tu o Viet Nam"*. Ha Noi, thang 3-1997. [Proceedings of Workshop "Technological Capability in Electrical-Electronics Industry of Vietnam"], Hanoi, March 1997. *Bao cao Hoi thao "Nang luc cong nghe trong Cong nghiep Che bien Thuc pham o Viet Nam"*. Ha Noi, thang 4-1997. [Proceedings of Workshop "Technological Capability in Food Processing Industry of Vietnam"], Hanoi, April 1997
- Tran Chi Duc, 1997: *Bao cao khoa hoc 1996 cua Du an "Dieu tra Nang luc Cong nghe Mot so nganh kinh te"*. Ha Noi, thang 6-1997. [Scientific Report 1996 of the Project "Technology Capability Review in some Economic Branches"], Hanoi, June 1997
- Tran Ngoc Ca and Bo Goransson, 1999: *Reforming the Science, Technology, Education and Training System in a Transitional Economy: The case of Vietnam*. In "Reconstruction or Destruction? Science and Technology at Stake in Transition Economies", Universities Press/India. Pp. 201-227

Chapter 7: Content and Organisational Forms of Innovations

- Some Comments on the Case Studies

Jochen Gläser

1. A Case for Case Studies

These comments are motivated by experiences gained conducting research on the GDR's science and innovation system (Gläser/Meske 1996; Gläser 1998). Both the confrontation with Western innovation theory and its hidden assumptions, and the in-depth investigation of a subject matter we believed we knew (GDR's science system) led to interesting frictions that could be useful for interpreting Vietnamese case studies. The three main lessons learnt that should be applied to the case studies are as follows:

Weak associations between content and the organisational forms of innovations

Our retrospective investigation of innovation processes in the German Democratic Republic (GDR) provided no clear pattern regarding the division of labour between academic research (as conducted at the GDR's Academy of Sciences - AoS) and industrial research (in enterprises). On the one hand, we found enterprises that were engaged in at least applied research for some innovation processes. On the other hand, AoS research tended to incorporate applied research, development and even production processes if the collaborating enterprises lacked the necessary capabilities. Similar tendencies of activities diffusing into all organisations can be observed in highly developed capitalist economies, where some firms do basic research (Rosenberg 1990) and part of academic science turns to production (e.g. Etzkowitz 1989, Roberts 1991). The general methodological conclusion from these tendencies is that organisational forms are poor indicators for the content of work on innovations.

Weak interactions between labels and content of innovative work

The labels 'basic research', 'applied research' and 'development' are used very frequently both within science policy and by scientists themselves. Today, the label 'strategic research' is often added to this classic canon in order to overcome the blurring of boundaries that is occurring. Independently of who applies these labels, they are misleading in most cases. Science policy cannot deal with the content of scientific work and is therefore confined to scientists' self-

classification or to weak indicators, such as organisational forms (see above). As our interviews with scientists revealed, the labelling of research by scientists themselves is hardly trustworthy for several reasons. Firstly, scientists sometimes apply the labels strategically in order to achieve political goals (e.g. funding). Secondly, scientists relate their research to both previous and planned work and label current research according to its place in this imagined 'innovation chain'. Thus, if some scientific work is expected to follow the research that is currently being conducted, the current work may be labelled as 'basic' and the future research as applied - even if both are phases of a product development. Finally, research labelling by scientists is influenced by the evaluation of the respective type of research, which, in turn, depends on the overall basic/ applied orientation of the field (Gläser/ Meske 1996: 36-54). Labelling a research as 'basic' certainly means different things in astrophysics and chemical engineering. Again, the methodological conclusion is that the labels provided by the object of study itself are poor indicators for what is actually going on.

Weak influence of science policy on innovation

An important lesson learnt from studying the GDR's innovation system is that it is almost impossible to facilitate innovations by increasing the political pressure on science. The GDR's science policy did certainly try this, and the country's 40 year history is one of inventing, testing and restructuring political instruments that aim to adapt science to innovation needs (Gläser/ Meske 1996: 70-135). However, since the most important hinderances lay outside the science system, policy did not succeed. The methodological conclusion to be drawn from this for the empirical investigation of innovation systems is that the side that generates demands and implements results (i.e. industry) merits as much attention as the science system that is commonly assumed to be the 'source' of innovations.

All three lessons suggest that formal investigations of innovation processes will not tell us very much. We must study the content of work on innovations in order to understand what is going on within and between the organisations that are engaged in innovations. This includes a close look at the demand side, i.e. at industry and agriculture. Only when we have identified the work that is actually done can we look for organisational forms that might support these innovations. Thus, we need case studies that tell us what is meant by the macrostructural data. The case studies presented here of Vietnamese enterprises and research institutes enable us to develop a perspective that links information about the national innovation system to the innovation processes.

The aim of these comments is to contribute to such a perspective by reanalysing the case studies provided by Tran Chi Duc (cf. Ch. 6) and Bach Tan Sinh (1996) with regard to the content and organisational forms of innovations. These case studies provide excellent empirical data about innovation processes in several branches of Vietnamese industry. The comments do not question the results presented in the previous chapters, but rather add a perspective that stems from organisational sociology and the sociology of science. This perspective can prove useful for identifying both facilitating and hindering conditions for innovation processes.

To establish a framework for this re-analysis, I will firstly discuss two implicit assumptions of modern (Western) innovation theory that seem to be somewhat misleading in the case of the Vietnamese innovation system (2.). Thereafter, I will provide a rough overview of the organisational forms of R&D and innovation processes and outline some typical governance problems (3.). On this basis, I will comment on the case studies by trying to identify typical patterns of innovation content and organisational forms (4.). In conclusion, I will challenge the politically motivated assumptions that science can solve Vietnam's economic problems and I will propose directions for further research (5.).

2. Misunderstandings Suggested by Innovation Theory

Whenever a specific innovation system is to be studied, the question arises whether the theoretical perspective fits the subject matter. Empirical research on innovations inevitably rests on theoretical assumptions that structure researchers' attention and influence the choices made in the course of their research. Whether the research leads to meaningful results depends to a great extent on the 'fit' between theoretical assumptions and the reality that is to be investigated.

Investigating the science systems of developing countries provides a good example of the problem of theoretical perspectives. Cultural conflicts caused by Western dominated scientific communities, language barriers and the under-representation of developing countries in the Science Citation Index (SCI) are but a few examples of additional factors that must be taken into account in investigations, and most certainly in the formulation of policy recommendations (Shrum/ Shenhav 1994).

Since the assumptions in question are built into the theories, the problem of a correct perspective is not solved when domestic researchers conduct the work. It is the knowledge

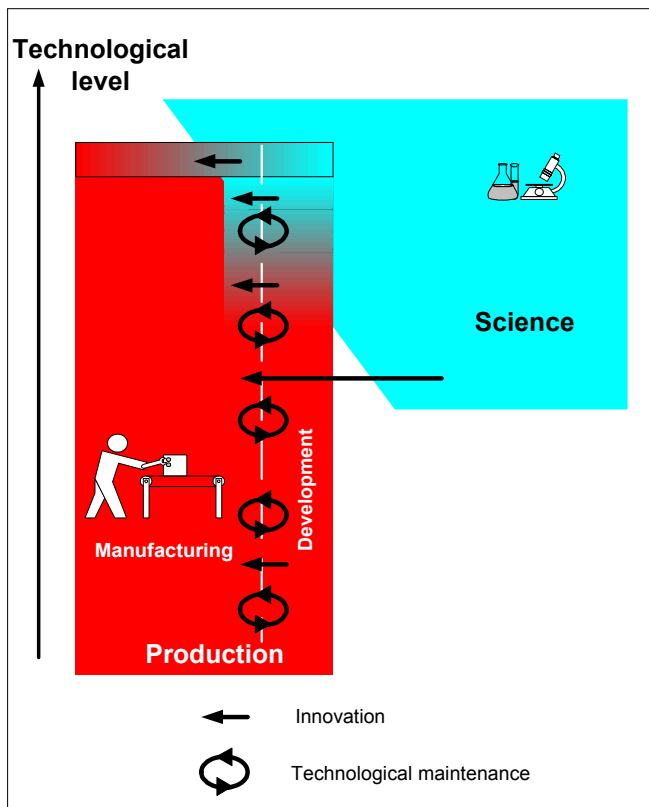
that is used to design an investigation that contains implicit assumptions, and whoever uses this knowledge must check it for such orientations. In the following, some implicit assumptions of current innovation theory relevant for evaluating the case studies will be discussed.

Current innovation theory is mostly concerned with new trends in science-industry (or science-technology) relations. It is common sense today that the older linear model of innovation no longer does justice to the complex character of many innovation processes. Several new models have been proposed, whose basic idea is a change from linear forms to networks (e.g. Rothwell 1992, 1994). The linear model and the various new forms have in common that they implicitly but strongly define scientific research as the source of innovations. None of these models differ with regard to the fact that they treat science as the source of innovation, they only vary with regard to the position they assign to scientific research. Research is either a first step (in the linear model) or an activity that accompanies all phases of the innovation process. This implicit assumption (that also guided a study on Vietnamese S&T, see Bezanson et al. 1999: 24-26) is well founded. It results from innovation theory's orientation towards the most advanced areas of science and technology: computer science, biotechnology, new materials, etc. However, the implicit assumption that all innovations have to do with science is wrong. 'Science-based innovations' are only part of the story. There is innovation without science as well (Kline and Rosenberg 1986; Rosenberg 1976, 1982; Basalla 1988; Roberts 1991; Mansfield 1995). Many innovations do not rest on current research, but on older scientific knowledge and/or not on scientific knowledge at all.

Obviously, this all depends on what is counted as an innovation. For reasons that will become clear later, a very 'soft' concept of innovation will be applied here that includes not only new but also improved technologies and products. Such innovations can be generated in different work areas (cf. Fig. 7.1). A very important source, generating many innovations, is the maintenance of technologies, i.e. the everyday 'tinkering' with production technology that secures its everyday functioning. These activities are seldom reflected by innovation theory, although they undoubtedly contribute much to the improvement of technologies. A second, more familiar source of innovation is developmental work, i.e. work that aims at improving technologies and products and inventing new ones. The sources of innovation that are more systematically dealt with in the above-mentioned models are basic and applied research. With regard to research, an important distinction must be drawn between erratic and permanent sources of innovations. Only if the scientific level of production technologies and products is

high enough, can it continuously incorporate research results and thus turn scientific research into a permanent source of innovations. Famous examples of such a permanent relation are semiconductor research and industry and genetic industry. In many scientific fields/ industries, however, research results turn into sources for innovation only under special conditions. If there is a gap between production and science, research results only fit coincidentally, and much additional work is required to adapt scientific results to the technological level of production.

Figure 7.1: Sources of Innovations



Which of the different work areas becomes the main source of innovations depends primarily on the technological level of production. Neither do innovations necessarily depend on scientific research, nor can sources of innovation be identified independently of the concrete technological level of the industry under investigation. Chemical industries in Germany, Russia and Vietnam are different, and the area of work that functions as the main source of innovations depends on the specific section of chemical industry involved as well as on national differences.

A second implicit assumption of current innovation theory is that of 'complete markets'. Innovations are assumed to take place within market economies that are 'complete' in at least

two respects. Firstly, it is assumed that actors are autonomous to an extent that gives them full jurisdiction over their innovation processes. This implies at least a guarantee of property, the right to decide over production, the right to enter into contracts with other economic actors (including the right to choose these partners), and the right to purchase the necessary resources.

A second, even more important assumption regards the capability of the market the given economic actor is participating in. Innovation theory seldom cares for the acquisition of goods that are needed to realise an innovation, i.e. to implement the ideas. In other words, innovation theory rests on an 'unlimited availability assumption' with regard to the new equipment.

Both assumptions do not apply to socialist and transformation economies. Autonomy is granted to economic actors step by step. Similarly, markets are created and opened in a longer term process, and the availability of goods improves only gradually, as do the enterprises' financial resources. In 1993, a manager responsible for his enterprise's technological development described the GDR's innovation system as follows:

If you had had a research result in the GDR, you had nothing yet. You had nothing because we lacked the money, the production capacity and the courage to turn the research result into steel and iron.

With regard to the current situation of the enterprise, he stated:

Currently we are doing basically the same as we did in the GDR: We are looking for new products that can be produced with our existing technology. The reason is that we don't have enough money to buy new technology.

Both comments illustrate that neither the GDR's nor the transforming East Germany's economy easily fitted the patterns presupposed by innovation theory.

It should be obvious by now that any application of innovation theory to industries and countries outside the high-tech sector is liable to misperceptions and misinterpretations of empirical data. That does not mean that these theories are useless. It is rather an argument for the careful scrutiny of the assumptions guiding both data collection and interpretation. The meanings of concepts such as "research", "R&D", "research institute" and "innovation" depend on the settings the concepts are applied to. To avoid distortions arising from improper uses of these concepts, the investigation should start on a lower level of abstraction, i.e. on the level of the work flows and organisational forms we will discuss now.

3. Organisational Forms of Innovation Processes

Organisations as hosts for research and development

In the previous section we have seen that research and development are not the only and often not even the most important source of innovation. Nevertheless, we must analyse the organisational forms of research and innovation processes because science remains the most important external source for innovations. For analysing successes and failures of innovations, it is useful to know where these external sources are located and what advantages and disadvantages the different locations have with respect to the governance of innovations.

A first question that must be answered is what organisational forms of R&D exist and how the different forms facilitate or hinder innovations. If we look at the organisations in which R&D is located today, two important distinctions can be made: With respect to the organisation's tasks, we can distinguish between 'complete' and 'partial' research organisations. In 'complete' research organisations, R&D is the organisation's only task, and all work conducted within the organisation is derived from this task and aims to support research processes. 'Partial' research organisations contain other tasks beside research processes. The mere fact that there are different tasks makes these organisations liable to internal goal conflicts. In many cases research is the task seen as less important to the organisation, thus losing the goal conflict and being subordinated to the organisations' main goals.

With regard to the organisational forms, we can roughly distinguish between commercial organisations that sell their products and public organisations that are financed by the state in order to fulfil tasks of public interest. Of course there are always transition forms because enterprises can be partly or completely financed with public money and public organisations can sell products to acquire additional resources. But even then the proposed distinction is useful because it enables us to understand these transition forms better.

If we apply these two distinctions to organisations that conduct R&D, we can construct four types of organisations that are possible scientific sources for innovations (cf. Tab. 7.1).

Table 7.1: Types of R&D Organisation

Organisational forms	Organisations' tasks	
	'Complete' research organisations	'Partial' research organisations
Commercial	R&D enterprises (firms that sell research results)	In-house R&D in industrial enterprises
Public	Research institutes, AoS, etc.	Universities, state-financed institutes that conduct routine analyses as well as research

Since our interest is focused on sources of innovations and university research does not differ much from pure research institutes in this respect, we can limit our further discussion to the other three types. From the perspective of an enterprise seeking sources of innovations, *research institutes* are a very convenient source because they are publicly funded, and even if the enterprise must buy the research, the price is always relatively low because the state finances equipment, overheads, etc. A second advantage is that research institutes are chiefly oriented to the international level of science and technology and can therefore generate advanced innovations that allow for significant improvements in products and technologies. However, this advantage is closely intertwined with a disadvantage that stems from the same source: Their independent goal setting and internal research logic leads research institutes to follow their own paths, and endangers their adaptation to user needs. This tension between the necessary autonomy of a research institute and the adaptation to user needs is a permanent challenge for science policy in that it creates specific governance problems.

The adaptation to user needs is a problem for all research units but is severely diminished if the research is carried out within the enterprise and thus under its jurisdiction. *In-house R&D in enterprises*, i.e. industrial R&D, constitutes most of the science system in highly developed countries. In Germany, industrial R&D makes up about two thirds of the science system. The distribution of R&D among enterprises is strongly size-dependent: Most R&D is located in the large multinational corporations. The highly innovative small and medium-sized enterprises (SME) that are favoured so much by Western science policy represent only a small portion of all SME and an even smaller portion of industrial R&D. A second variable that has a strong influence on the distribution of industrial R&D is technology. There are science-intensive industries (e.g. pharmaceutical industry), whose enterprises have significantly more in-house R&D than those in 'traditional' industries (e.g. construction industry).

As already mentioned, the main advantage of in-house R&D is that it can be adapted to the enterprise's innovation needs more easily. This is mainly due to the fact that source and target of an innovation are under the same organisational control. This advantage is, however, being paid for by the significant costs of in-house R&D. While an external source is paid for only when an innovation is needed, in-house R&D must be financed continuously. This is one of the main reasons while we find it in large rather than small enterprises.

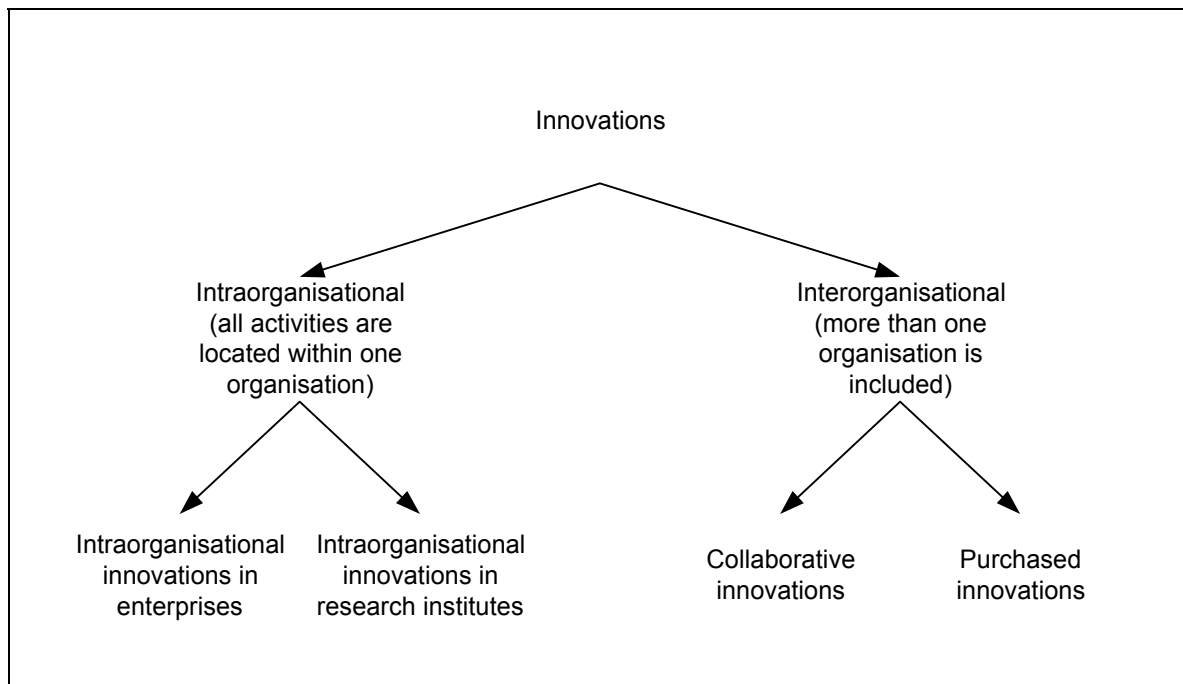
Beside these two main forms, a third form of organising R&D has emerged during the last decades. Especially in highly developed countries, *R&D enterprises* have made producing research results a specific business. These enterprises conduct research that is useful for

customers and sell it. The main domain of these enterprises is the production of research results for industrial needs, but there is also a tendency to sell research results to research institutes (Gläser/Melis/Puls 1995). Since R&D enterprises' existence depends on their meeting user needs, they are less problematic than research institutes with regard to adaptation and control. However, the costs are higher because the enterprises must finance themselves completely by selling the research results. Because of the advantages of other organisational forms, the market for research results is limited, and the R&D enterprises' share in industrial research is rather small. Generally, these are a by-product of highly developed national innovation systems under market conditions. Their emergence and continuous existence presupposes a 'complete' market (see the preceding section) and a stable demand for research results.

Organisational locations of innovation processes

On the basis of the overview of how research can be incorporated in organisations, we can ask how innovations can be located in the system of organisations. Innovations that are not rooted in R&D do not have special organisational forms because they include less different kinds of innovative work and therefore tend to include fewer organisations than science-based innovations.

Again, two main distinctions can be introduced to systematise organisational locations of innovation processes (cf. Fig. 7.2). Innovation processes are understood here as the system of actions that leads from an idea of changing a product or a technology to a changed production process. The respective actions can be located entirely within one organisation, or they can be distributed among at least two organisations. If only one organisation conducts all innovative work, we have an intraorganisational innovation. Many innovations are intraorganisational because they are located entirely within the enterprise whose production is to be changed. However, intraorganisational innovations also take place in research institutes. This is not only the case when research institutes are required to compensate for industry's innovation weaknesses, as it happened in the GDR (Gläser/Meske 1996). The acquisition of additional resources by selling innovative products may also be a motive for research institutes to engage in production. Finally, the scientists in research organisations who become entrepreneurs are often engaged in innovation processes located entirely within the institute and separate only when production is successful.

Figure 7.2: Innovations' Locations within and between Organisations

As we have seen, intraorganisational innovations in enterprises are not necessarily rooted in science. They may also be initiated in the area of maintenance and not be linked to any R&D activities. In every case, the target organisation has full control over the innovation process. This is the main advantage of in-house innovations in enterprises, and is paid for with an important disadvantage: All innovations that exceed small changes require systematic and specialised work. This work usually cannot be conducted by workers and engineers who are integrated into the everyday system of production. Thus, in many cases a specialised work unit is required for the innovative work. This unit might or might not be called an "R&D unit" – it fulfils the functions of in-house R&D in any case. Thus, the absence of in-house R&D severely limits an enterprise's opportunities to innovate. On the other hand, we have already mentioned that in-house R&D is costly and can therefore only be maintained if the enterprise is large enough in financial terms.

An intraorganisational innovation that takes place in a research organisation also has the advantage of being easier to control. An additional significant advantage of this kind of innovation is that it has the best scientific background possible because the innovation takes place within the science system. Since the research institute is both source and target of such an innovation, there seem to be no problems regarding the adaptation to user needs. This necessity to adapt is, however, only slightly changed because a research institute that tries to

realise an innovation is forced to adapt to market demands in order to make some profit. An important disadvantage of intraorganisational innovations often mentioned regards the resources expended on the innovation: Since there is a lot of non-research work included in activities of this kind, researchers and research institutes often feel distracted and regret the diminishing of the research potential.

Interorganisational innovations mostly occur due to an absolute or relative lack of in-house R&D on the part of enterprises.¹ Many SME do not have in-house R&D and therefore cannot conduct innovation activity except small changes in the context of production maintenance. But even large multinational collaborations are forced to (or want to) conduct interorganisational innovations because many innovations are too complex and too risky to perform alone. In-house R&D is always too small to span all possible sources of innovations.

With regard to interorganisational innovations, it is of specific interest whether all partners engage in the work or whether the enterprise that wants to innovate simply buys the complete innovation. The former type can be called 'collaborative innovation'. It rests on contracts between the partners (either only enterprises or enterprises and research institutes) that often lay the grounds for interorganisational innovation networks (Freeman 1991). Since all partners contribute to the innovation process, the respective potential is required on all sides. In other words, in order to collaborate with a research institute or with another enterprise's research unit, an enterprise must have a research unit of its own. If this prerequisite is given, the enterprise benefits from the lower costs (because costs are shared) and from the wider scientific background contributed by the other partners. Typical dangers involved in collaborative work that threaten collaborative innovations as well are goal divergence and communication problems.

If an enterprise is not able to (or does not want to) perform a collaborative innovation, it can attempt to purchase the complete innovation. This can, for instance, be done by buying complete assembly lines. The main advantage is that all internal restrictions are circumvented: Neither the former production's technological level nor internal work capacity limit the innovation. The most important disadvantage is, of course, that this solution may be very expensive. Moreover, the enterprise becomes dependent on the innovation suppliers regarding

¹ For example, a recent study of R&D cooperation in Germany showed that "firms that are engaged in R&D cooperation tend to be relatively large, have a comparatively high share of R&D employees, spend resources for monitoring external developments relevant to their innovation activities ..." (Fritsch/ Lukas 2001: 310).

the assembly line's maintenance and further improvement. Thus, control over one's own production technology is in danger of being lost.

These four types of innovations do not, of course, encompass all variations that can be empirically found. It is always a problem to draw boundaries. How much work on an innovation must take place within an enterprise in order to classify the innovation as collaborative? How should one classify an innovation that is based on ideas provided by external advisors but is conducted completely within an enterprise? These questions indicate that organisational forms of innovations vary to an extent that cannot be forced into a few categories. However, the classification proposed here appears useful as an instrument for analysing innovations, i.e. as guidance for an empirical analysis of the distribution of labour in innovation processes.

Governance problems

In the discussion of organisational forms of research and innovation processes, some governance problems became apparent. The most important governance problems involved in innovations can be summed up as follows:

1) With regard to innovation sources, problems arise when the sources follow goals that differ from the goal of the innovation. This is especially the case if collaborative innovations are conducted that include autonomous research institutes. As important as this autonomy is for successful research, it leads to tensions between the logic of research and the logic of innovation. Thus, one of the main challenges for innovation policy is to find mechanisms that guarantee both research institutes' autonomy and their adaptation to user needs. The following are some mechanisms that have been tried successfully:

- Giving research institutes autonomy to negotiate contracts with enterprises and to decide on how the money is spent, thereby allowing for prices that make it possible for research institutes to improve their technological basis with the money earned by contract research.
- Linking the state-financed budget to the amount of contract research conducted (Fraunhofer Society/Federal Republic of Germany - FRG).
- Offering additional funding for institutes if projects are approved by industrial enterprises that promise to engage in collaborative innovation after the project is finished (Federal Ministry of Education and Research - BMBF funding programmes/ FRG).
- Funding collaborative innovations by giving money to all partners (BMBF funding programmes/ FRG).
- Establishing governing boards for the institutes, in which enterprise representatives play an important role (AoS/ GDR and Helmholtz Society/ FRG).
- Appointing managers from enterprises as directors of research institutes (GDR).

2) On the target side of innovations, the main problem is how to increase the demand for innovations by improving enterprises' capabilities to innovate. It is presupposed here that enterprises' wishes to innovate are strong enough because their existence depends on market success. In other words, a market economy is presupposed that makes innovation to a matter of life and death for the enterprises. The history of the GDR has proven that no political pressure can compensate for this 'life and death' pressure. However, as the discussion of organisational forms has shown, there are certain barriers to successful innovations that often cannot be overcome by enterprises alone. That is why even in countries that are very proud of their market economy, political measures have been set up in order to increase enterprises' capabilities to innovate. Important examples are

- funding programmes aimed at the creation and maintenance of in-house R&D in SME (special funding programme for East German enterprises/ FRG),
- funding programmes that lower the costs of enterprises' in-house innovations (BMBF/ FRG),
- funding programmes that lower the costs of collaborative innovations by subsidising research institutes (BMBF/ FRG),
- institutional funding of associations that support innovations in SME (Federation of Industrial Cooperative Research Associations - AiF/ FRG),
- funding programmes that support "technology-oriented start-ups", among them firms whose foundation rests on innovations (BMBF/ FRG),
- funding programmes that provide scientists from research institutes attempting to found an enterprise with basic security in the case of failure (FRG).

Unfortunately, little systematic research has been conducted on the connection between the conditions under which the political measures were introduced and the measures' success. The various evaluations of these programmes that have been conducted in the FRG were mostly too narrow to give sufficient information about the programmes' applicability to other settings. Thus, it is not easy to turn knowledge about these potential solutions to governance problems into proposals for science policy.

4. Re-analysing the Case Studies

The analytical framework developed in the preceding section will now be applied to the case studies on innovative activities in Vietnamese industries. The case studies conducted by Tran Chi Duc (cf. Ch. 6) and by Bach Tan Sinh (1996) were re-analysed and information gathered regarding content, sources, organisational forms and most important hindering conditions of innovations (cf. Tab. 7.2). Information could be obtained for most cases, missing information is indicated by blank fields and ambiguous information by question marks.

Table 7.2: Overview of the Case Studies

Case	In-house R&D units	Content of innovation	Sources of innovation	Organisational forms of innovation	Conditions hindering innovation
VDPFC	no	new products	executives	intraorganisational	research instit. not adapted to user needs
BICICO	yes	new technologies new products	R&D staff	intraorganisational	
HGPC	yes	improvement of existing technologies	R&D staff	intraorganisational	research instit. lack equipment and are not capable
		new technologies new products	technology import	purchased	
HCPC	yes	new technologies	R&D staff research institutes NCNST universities technology import	intraorganisational collaborative purchased	
		new products	R&D staff / ad hoc groups		
IIC	(instit.)	new products	own staff	intraorganisational	
Bao Ngoc	no	new technologies new products	external specialists imported products documents	externally triggered, but intraorg.	
Haiha - Kotobuki	no	improvement of existing technologies improvement of existing products	?	intraorganisational	research instit. lack equipment and not capable
Hanoi Foodstuff-Export	no (?)	none (?)			outdated technologies, no resources for innovations
FIRI	(instit.)	?			outdated equipment, lack of financial resources
Nhat Linh	no	new products	external specialists	externally triggered, but intraorg.	size
Tran Phu	yes	new technology new products	external specialists technology import ad hoc groups	externally triggered, but intraorg. purchased	lack of financial resources research instit. lack equipment, not capable and not adapted to user needs
HANEL	no	new technologies	technology import	purchased	research instit. lack equipment, not capable and not adapted to user needs
VIELINA	(instit.)				
HANICHEMCO	no	new technologies	technology import research institutes	purchased collaborative	research instit. lack equipment, not capable and not adapted to user needs
LASUFECO	yes	improvement of existing technologies	own staff	intraorganisational collaborative ?	
Viet Tri	yes	improvement of existing technologies	technology import research institutes ?	purchased collaborative ?	research instit. not adapted to user needs
		new technologies	R&D staff external specialists	intraorganisational	
CECO	yes	?			

The information obtained from the case studies shows that there is not much clarity regarding the content of innovations. Innovations' results are described in four categories: Either new technologies/ products are introduced, or products/ technologies were improved. Thus, the information about innovations' content depends on how the terms 'new' and 'improved' are defined by the interviewees who described the innovation processes or by the people who provided the statistics. One general conclusion that can be drawn from the case studies is, however, that there are not many innovations whose source is R&D.

The table reveals that there are three main sources for innovations: the enterprise's own staff (mostly, but not always in in-house R&D), external specialists and technology import. Research institutes and universities play almost no role for the enterprises investigated. This may be due to the research institutes' technological (and scientific) level. However, one of the most active firms in the sample, HCPC, has contacts to research institutes, universities and NCNST. This might be an indication that these linkages depend on an active search strategy on the part of the industry as well.

Given the many descriptions of research institutes' insufficient technological basis or performance in general, it comes as no surprise that collaborative research with these institutes plays almost no role in the sample. Instead, 'external specialists' are often mentioned as sources of innovations. This leads to the conclusion that while research institutes are not seen as interesting partners for innovations, people working in these research institutes are – at least some of them. This could be the case for different reasons. The criticism of research institutes' overall performance that was communicated in some interviews could motivate enterprises to negotiate directly with partners in the institutes whose capabilities they trust. Another, more simple reason might be that the usual personal contacts every researcher and representative has are used today because they have been proven to be successful. Whatever the reasons are for this preference given to personal contacts with 'experts' of various kinds, it is obvious that it is not collaborative innovation implied here but rather a flow of ideas. That means that the systematic work on the innovations is located entirely within the enterprise. This type of innovation can therefore be described as 'externally triggered intraorganisational innovation'.

Although there are some indications of intraorganisational innovations in research institute in the case studies (e.g. information about "business activities"), we lack sufficient information about this type of innovation. Future case studies should treat research institutes the same

ways as enterprises and ask whether innovations result in new products or new technologies (and, of course, what products and what technologies). Interviews with directors of research institutes conducted by Werner Meske indicate that this type of innovation certainly exists, especially when industrial enterprises are not able to transfer successful innovations into production.

If innovations are purchased, this always happens via technology import. This enterprise behaviour can be linked to the rejection of the 'unlimited availability hypothesis': Technology import indicates that there are no domestic sources for advanced technologies. That is why in Vietnam this type of innovation is inevitably linked to foreign sources of innovation. Thus, even if the research institutes' insufficient technological basis and capabilities are today seen as the most important conditions hindering innovations, it can be doubted that we would observe more innovations if this condition is improved. It is more likely that innovations would fail because there are no suppliers of equipment for the new technologies.

If we sum up the results of this short discussion (and the conclusions from the previous chapters as well), we arrive at a picture that is methodologically good but empirically disturbing: The good news is that the case studies enable a more in-depth insight into what is actually going on in the Vietnamese innovation system. The more disturbing message concerns the empirical findings themselves: Some serious problems with innovations could be detected. Without repeating the substantial findings of the previous chapter, the organisational analysis would appear to indicate the following problems:

1) *Almost no science-based innovations*: Innovations without science are much better than no innovations at all, and such innovations occur frequently even in highly developed countries. However, if rapid progress is required, the sciences must become a stable source of innovations. From the analysis of the case studies, three possible causes could be detected: a technological level of production that is too low to enable a connection to science to be made; the poor performance of research institutes; and the insufficient size of enterprises (size is meant here in the sense of economic power rather than number of employees).

2) *Absence of collaborative innovations*: As far as research institutes are concerned, the cause underlying the lack of collaborative innovations could be the above-mentioned bad performance. A second important reason is the lack of an industry that could produce the modern equipment required for innovations. The Vietnamese engineering sector has stagnated since 1980 (cf. Ch. 5), leaving it virtually nonexistent or very weak, as, for example the low

publication activity in this field indicates (s. Ch. 4), So long as this is the case, substantial innovations are damned to rely on technology import. However, as Chapter 3 indicates, technology import does not necessarily improve domestic capabilities to innovate. It is more likely that industry moves into cycles of dependency.

3) *Generally low demand for innovations*: Although all enterprises dream of better technologies and products, the actual demand for innovations remains low. From the perspective of a transformation economy, i.e. an economy in the process of establishing market conditions, this observation is the most worrisome. Ultimately, the entire development of an innovation system hinges on demand for innovations. If there is nobody who would pay for an innovation under market conditions, the innovation system would run idle and atrophy. Main causes detected for the weak demand side include the enterprises' insufficient size and financial resources and limitations connected to the production technology currently used. There seem to be some technologies that small innovations cannot improve anymore leaving replacement the only option - which, in turn, is impossible for the small enterprises.

The scope of the findings has yet to be determined, i.e. the question what part of Vietnamese industry the observed patterns are valid for remains unanswered. This is especially important because if there were a rapidly developing high-tech industry (e.g. electronics), this industry could be expected to compensate for some weaknesses observed in the case studies. More importantly, the results regarding Vietnamese industry must be seen in relation to industry's role in Vietnam: Up to now, the Vietnamese economy is mostly agriculturally based. But however the range of validity for the case studies' findings is delineated, within this range we do know something about how innovations are initiated and are making advances.

5. Conclusions

Conclusions I: Science cannot solve Vietnam's innovation system problems

Although the case studies have clearly stated serious weaknesses in the research institutes' technological basis and adaptation to user needs, it seems highly unlikely that the problems faced by the Vietnamese innovation system can be solved by changing the science system. This pessimistic conclusion is supported by two considerations. Firstly, the case studies have also detected serious problems on the demand side, i.e. within enterprises whose products and technologies are the potential targets of innovations. These problems are partly due to the low technological level of current production. This leads to a vicious circle (or a 'catch 22

situation') because the technological level can only be raised by innovations. An even more important problem is the enterprises' ability to absorb innovations. This ability is severely limited by size, financial resources and the resulting lack of in-house R&D. Both factors – technological as well as economic – lower enterprises' demand for innovations. As long as there is no sufficient demand for innovations that must be responded to with scientific research, research institutes cannot contribute much to innovations even if they wanted to and could do so.

With regard to the supply side, the problems with research institutes are nothing compared to the missing 'hardware production'. Since Vietnam lacks the branches that could produce the equipment needed for new technologies, innovations that require new equipment (i.e. most innovations) must be realised with imported materials. Since import cannot be unlimited, the equipment could turn out to be the bottleneck of future innovations.

The case studies uncovered not only unpleasant facts but also possible sources of improvements. One of these sources is – or at least, could be – technology import by either purchased innovations or foreign direct investment. If modern technologies are imported and if the import is made dependent on the development of a domestic R&D potential regarding the imported technology, technology import could become an important and permanent source of rapid learning. Another source is intraorganisational innovation in research institutes. It is quite natural that researchers and research institutes are worried about being side-tracked by development and production. On the level of the whole economy, however, these productions are beneficial because their technological level is often above average. The scientific background these innovations are conducted against may facilitate the technological level, and the economy could benefit from expanding these activities and letting production grow out of research institutes. A third source for development is certainly the growth of enterprises. In some of the case studies, improvement of innovative behaviour seemed to be primarily a problem of reaching the critical mass. Finally, the development of equipment-producing and engineering enterprises (like CECO) and the transmutation of research institutes into firms (again, CECO may serve as an example) could close gaps in the innovation system.

Conclusions II: Further research is needed

As every good scientific study does, the case studies let us see more clearly what we do not know. For this reason I will finally propose some lines of research that could deepen our knowledge about the Vietnamese science system. Some gaps in our knowledge have already

been described in the previous sections. Thus, we must go a step further and investigate the content of innovation processes. What does it mean when an enterprise reports that it has introduced a new technology? Though we have some examples (e.g. the Viet Tri case), too much of the content of work is hidden behind labels such as "new technology", "new product", etc.

Future studies of innovation processes should include purchased innovations and foreign direct investment. If there are opportunities to enhance the benefits of imported technologies by linking them more strongly to domestic R&D, we need to know how these innovations/investments proceed and how domestic interests could be brought into in decision-making processes.

A third gap in our knowledge regards information about the actors in the innovation system. We need to know what rights the actors (mainly research institutes and enterprises) have, what their interests are and what conditions for actions they face. Of special importance is what economic and political pressure the actors feel and how their access to money, equipment and the labour force is regulated. Without this information it is difficult to understand actors' behaviour. To answer these questions might be difficult because these aspects of the economic actors' situation are changing quickly. Moreover, most of these aspects might be common knowledge among the Vietnamese investigators. Nevertheless, the empirical information must be fixed for a fixed point in time.

Thus, the case studies I tried to discuss in more depth here marked several points of departure for further research that could lead to a greater understanding of the Vietnamese innovation system. I think it important to follow this line and investigate the mechanisms that facilitate and hinder innovations.

References

- Bach Tan Sinh ,1996: Die Beziehungen zwischen FuE und chemischer Industrie in Vietnam, in: Meske, Werner and Dang Duy Thinh (eds.): Zur Situation and den Veränderungen des FuE-Systems in Vietnam, unter besonderer Berücksichtigung der Schwerindustrie. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 96-401, Berlin, p.49-66
- Basalla, G., 1988: *The Evolution of Technology*. Cambridge University Press.
- Bezanson, K./ J. Annerstedt/ K. Chung/ D. Hopper/ G. Oldham/ F. Sagasti, 1999: *Viet Nam at the Crossroads: The Role of Science and Technology*. Ottawa: International Development Research Centre.
- Etzkowitz, Henry, 1989: Entrepreneurial Science in the Academy. A Case of the Transformation of Norms. In: *Social Problems* 36, 14-29.
- Freeman, C., 1991: Networks of innovators: A synthesis of research issues. In: *Research Policy*, 20, 499-514.
- Fritsch, Michael and Rolf Lukas, 2001: Who cooperates on R&D? In: *Research Policy* 30, 297-312.
- Gläser, Jochen, 1998a: Kognitive Neuorientierung der ostdeutschen außeruniversitären Grundlagenforschung als Folge des Institutionentransfers. Discussion Paper P 98-402. Berlin: Wissenschaftszentrum Berlin für Sozialforschung.
- Gläser, Jochen /Charles Melis/ Klaus Puls, 1995: Durch ostdeutsche Wissenschaftler gegründete kleine und mittlere Unternehmen - Eine Problemskizze - Discussion Paper P 95-403. Berlin: Wissenschaftszentrum Berlin für Sozialforschung.
- Gläser, Jochen and Werner Meske, 1996: *Anwendungsorientierung von Grundlagenforschung? Erfahrungen der Akademie der Wissenschaften der DDR*. Frankfurt am Main: Campus.
- Kline, S. and N. Rosenberg, 1986: An Overview of Innovation. In: R. Landau, N. Rosenberg (eds.), *The Positive Sum Strategy*, Washington D.C.: National Academy Press, 275-305.
- Mansfield, Edwin, 1995: Academic Research Underlying Industrial Innovations: Sources, Characteristics, and Financing. In: *The Review of Economics and Statistics* 77, 55-65.
- Roberts, Edward B., 1991: The technological base of the new enterprise. In: *Research Policy* 20, 283-298.
- Rosenberg, N., 1976: *Perspectives on Technology*, Cambridge University Press.
- Rosenberg, N., 1982: *Inside the Black Box: Technology and Economics*. Cambridge University Press.
- Rosenberg, N., 1990: Why do Firms do Basic Research (With their Own Money)? In: *Research Policy* 19, 165-174.
- Rothwell, R., 1992: Successful Industrial Innovation: Critical Factors for the 1990s. In: *R&D Management* 22, 3, 221-239.
- Rothwell, R., 1994: Industrial Innovation: Success, Strategy, Trends. In: Mark Dodgson and Roy Rothwell (eds.), *The Handbook of Industrial Innovation*, Cheltenham/ Brookfield: Edward Elgar, 33-53.

International Experiences of Relevance to Vietnam

Chapter 8: Transformation of Science and Technology in European Economies in Transition - Basic Patterns, Sectoral and National Particularities¹

Werner Meske

1. Dissolution and Fragmentation of the Socialist STS

S&T in former socialist countries was (and, to a great extent, is to this day) characterised by some particularities that distinguish it from its counterparts in capitalist societies. In some cases these are specific to the system and typical of it and sometimes they are nationally specific, i.e. they are explicable only in the historical context in which a particular system was shaped. For this reason alone there are essential differences between STS in Russia and the other successor states of the former Soviet Union, the other Central and East European Countries (CEEC), and also the non-European (socialist) countries. There is a common structural heritage in the research systems of CEEC rooted in the shared past, but there are also important differences in the structures and functioning of STS in each country.

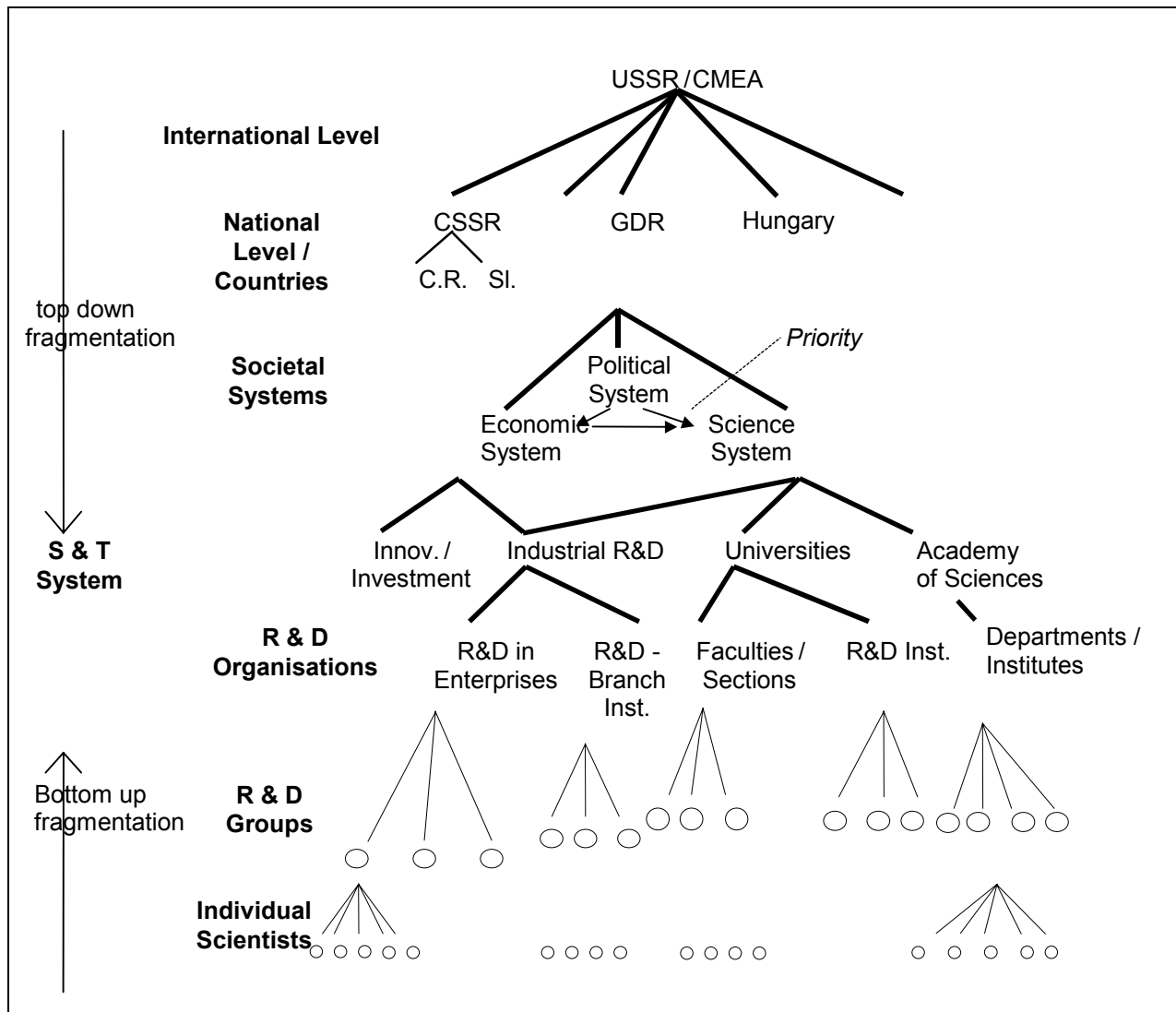
The analysis of the transformation processes in the CEEC² confirmed that each of these countries tended to be in a specific situation at the end of the socialist era. The differences between them at that time also meant a differentiation in their *starting conditions* for the transformation of the STS, which unquestionably strongly influenced the continuing processes. Decisive influence was above all exerted by the position and role of the respective country in the socialist world system of S&T, the institutional deviation from the 'Soviet

¹ This chapter discusses the findings of the EU-TSER project "Restructuring and Reintegration of Science and Technology Systems in the European Economies in Transition" (co-ordinator: Slavo Radosevic, SPRU) and in particular those of the sub-project "Institutional Transformation of S&T Systems and the S&T Policy in Economies in Transition", which was carried out from 1996 to 1998 under the direction of W. Meske (see Radosevic 1995, 1999; Meske et al. 1998; Meske 1998a).

² Beside the in-depth research on East German transformation (Meske 1993, 1998b; Spielkamp 1998), we compiled uniform analytical and statistical overviews of the individual CEEC: The six Central East European countries (Poland, the Czech Republic, Slovakia, Hungary, Romania, Bulgaria), the three Baltic states (Latvia, Estonia, Lithuania), the four European CIS countries (Russia, Ukraine, Belarus, Moldova) and the former SFR Yugoslavia, in particular Slovenia and the FR Yugoslavia. These overviews in turn provided an empirical basis for the comparative analysis of these countries. For Poland and the Czech Republic special reports on industrial R&D were also compiled. The overviews are primarily based on the country and sector reports compiled by various authors in the course of the above mentioned EU project; they also incorporate, however, other relevant publications. The account of the S&T transformation processes in the individual CEEC begins with their particularities at the outset (i), characterises the S&T relevant changes in politics (ii) and then analyses the changes in the sectors conducting S&T (iii). In conclusion a brief assessment is undertaken of the current

model' of STS and the basic societal conditions in the respective country when the socialist system collapsed. While the first steps toward state independence can be seen as the 'dissolution' of the former socialist world STS, the subsequent political and economic changes in the individual CEEC generally went beyond this and led to a *fragmentation* of their former STS (cf. Fig.8.1).

Figure 8.1: Levels of Dissolution and Fragmentation of the Former Socialist S&T System



S&T management and co-ordination structures and mechanisms that were dismantled by way of a 'top-down fragmentation' left in their wake a multitude of autonomous but completely 'isolated' universities, Academy institutes, R&D institutes, and R&D-intensive new enterprises as fragments of the former system. These were usually neither linked at all (let alone through

situation as well as future tasks and problems (iv). A statistical overview of the respective country supplements each section.

clear regulations) with one another nor with their non-scientific 'environments'. The situation of these S&T facilities was often further complicated by their simultaneous additional fragmentation through *bottom-up processes*. Many scientists (and other employees) left the S&T organisations both under pressure 'from above', exerted through political decisions and funding and salary cutbacks, and as a result of their personal decisions to take advantage of perceived new opportunities. For leading scientists and research groups in the field of armaments these opportunities arose mainly abroad; above all younger scientists saw their chances in new non-scientific fields of activity (in the business sector, often for foreign firms); there was also migration to non-socialist countries for ethnic and other reasons (e.g. Jewish migration), but also migration between the former Soviet republics (e.g. Russians).

This meant that even those scientific organisations and their sub-units that formally remained, experienced substantial changes and loss of significance; the conditions were often unclear because the non-cancellation of former employment contracts, scientists' (temporarily) going abroad with the option of return, etc., frequently led to former affiliations to organisations and actual occupations falling apart.

Following the dissolution of the socialist world system of S&T and the extensive fragmentation of the STS in the now independent CEEC, these countries generally faced the task of adapting their respective S&T institutions to the new conditions in addition to the reformation of the entire STS. Although the situation at the outset varied in the individual CEEC, the complexes of tasks facing them were very similar.

The centre of attention here are the *institutions that carry out S&T activities* and that thus perform in particular the processes of scientific and technical innovations. Their core comprises the former sectors and organisations of higher education (HE), the Academy of Sciences (AoS) and industrial R&D or their successors. In the industrial R&D sector this is closely associated with the changes occurring in the enterprises, so that both can only be understood in terms of their interaction. This also involves the general aspect of links and interactions between different S&T organisations as well as with their 'non-scientific' environments. Following the extensive fragmentation of the socialist STS, the new formation of such relationships assumes major significance. Politics plays a decisive role here as it had directly or indirectly controlled the activities of all S&T facilities under socialist conditions via the centralised management hierarchies. The rebuilding of the *political system* also brings new basic conditions for all S&T institutions. What these are and whether or how they are specified and laid down as legal regulations depends primarily upon political decisions. Such

decisions can directly affect the future of institutions, such as, for example, the AoS. Further, stipulations on the general relationship between politics and S&T, S&T legislation, the establishment of political bodies to observe or implement S&T policy and their respective responsibilities influence the very basis of the livelihood and behaviour of all institutions relevant for S&T. Because political decisions under conditions of systemic transformation not only establish new basic conditions but also often directly trigger reorganisation in S&T, they were considered first in the analysis of the S&T sectors. An important role is played here by the fact that in many countries, concurrent with the top-down fragmentation of the socialist STS, it was above all the bottom-up activities on the part of scientists and their representatives in professional associations that led to the first changes in science and compelled the politicians to act. The situation was similar with regard to the influence of the economic crisis on politics, but also on science.

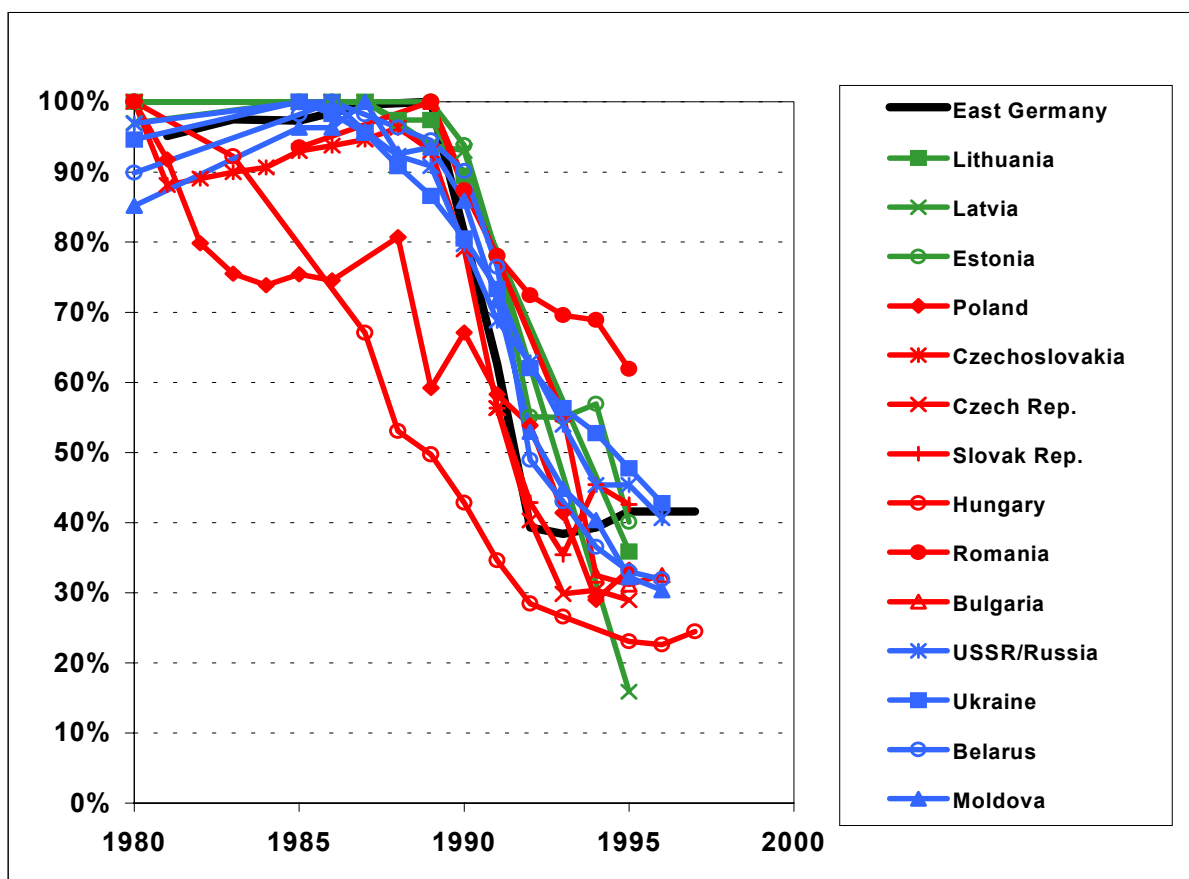
The analysis of the transformation processes in the individual CEEC clearly indicates that their initial differences in the conditions of the national STS have tended to intensify since transformation began. This applies, firstly, to the chronological sequence in which changes have occurred. In some countries new administrative jurisdictions and legal regulations were installed very quickly, i.e. as early as 1990/91 (apart from the special case of East Germany, this is above all the case in Poland, Hungary, the Czech Republic and Slovenia). In contrast, in other countries delays occurred in the transformation (in particular in those countries that had to break away from the former confederations of the USSR and the Socialist Federal Republic of Yugoslavia, SFRY). In some cases the phase of general transition (the actual system transformation) has still not been concluded; thus instability and a strong change of direction continue to dominate politics and the economy and the fall in gross domestic product (GDP) has not yet been able to be halted (in particular in the European CIS countries, but also in Bulgaria and parts of the former SFRY).

When one also considers the differences between the individual CEEC in terms of the state of their legislation (and the observance of the laws), the evaluation of facilities and scientists, the introduction of competitive forms of financing for R&D projects and their share in the total funding of R&D, etc., then one gains the impression that there is a very *wide spectrum* of variation in the *institutional transformation* of the STS in the individual countries.

In the attempt to assess and compare these different variants of institutional transformation in S&T with regard to their impact on the actual performing organisations and their activities (not least to derive implications for science policy and organisation) one comes across the

phenomenon that in all CEEC the *resources for S&T* are substantially reduced. In essentially all CEEC the main component of S&T potential, human resources (despite all methodological problems and alterations, still the best comparable indicator) has now been reduced to a level of approximately 50-20% of the former (peak) level under socialist conditions, or is tending toward such a level. That is, even if there is a time lag in some cases, the underlying trend in the CEEC in this regard corresponds to that ascertained in the development of R&D personnel in East Germany - under completely different basic societal conditions. The congruence in the basic trend is unmistakable, even if there are also certain differences between the countries regarding the course of time and the reduction in personnel levels (cf. Fig. 8.2).

Figure 8.2: R&D Personnel in CEEC



Source: Compilation by Meske, based on data from country reports (cf. Meske 1998: 35-37)

This apparent distinct contradiction between the considerable differences in the pace and degree of institutional transformation and the quantitatively essentially similar effects on R&D personnel must be explained in terms of the following.

The indicator 'R&D employees' is primarily macrostructural and thus more applicable to the national economy than specifically to the sphere of science when characterising the inner situation of the STS.

Changes in this indicator in the period under consideration can above all be put down to the influence of the economic situation of the country, i.e. to the drop in GDP, and less to the changes in the STS itself.

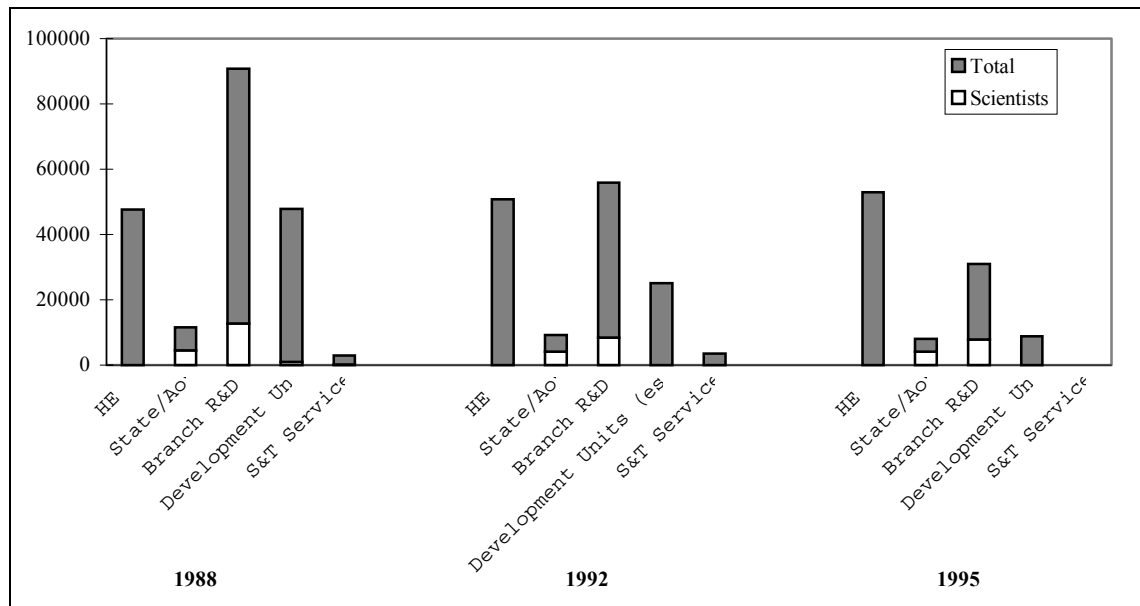
The drop in the real GDP was especially substantial between 1989 and 1992 and in the four CIS countries and Bulgaria it continued to fall until at least 1996. Even in the other countries GDP did not level out or begin to climb slightly until about 1993/1994. How dramatic these changes are can be seen in the fact that in 1996 only Poland had managed to regain its 1989 level; Slovenia, the Czech Republic, Slovakia, Romania and Hungary had barely reached 90%, the European successor states to the USSR had achieved a mere 40% to 60% of their 1989 level (cf. Stern 1997, Table 2). In all countries the economic decline in consequence of the collapse of the CMEA and the international opening of the previously relatively closed economic territory of the socialist states had, firstly, substantially restricted their real possibilities for state (public) funding of S&T (regardless of political will) and, secondly, almost completely eliminated enterprise demand for R&D output. In the political sphere the reduction of financial resources was often further accelerated by the general marginalisation of S&T within political priorities. In the economic sphere detrimental effects were felt above all from the deterioration of the R&D intensive branches, often in combination with the dissolution of the financially strong large enterprises in the course of privatisation. A lack of funds has led to investment and innovation activities being severely constrained; when they do occur, then above all via technology transfer from abroad (the West), with no necessity for domestic R&D. This is also the actual reason why in all countries that had formerly had considerable in-house capacities, in particular Czechoslovakia and Poland, contrary to expectations these enterprise capacities actually suffered the greatest staff cutbacks, while the universities and other higher education institutions which mainly concentrated on teaching were able to maintain and even raise their staff levels. Consequently, in the successor states of the SFRY growth in the HE sector in some cases even overcompensated for the reduction in the relatively small industrial R&D workforce.

The causes for the staff reductions are to be sought primarily outside science, in particular in the economy. This is substantiated firstly by the increase in the *share* of public financing of R&D in all countries and, secondly, by the above-average reduction of R&D personnel in industry (as an example see Poland and Hungary – Figs 8.3 and 8.4).

Both the common basic trend of cutbacks in the R&D workforce and the particularities in individual countries indicate that the general reduction in personnel is accordingly above all a

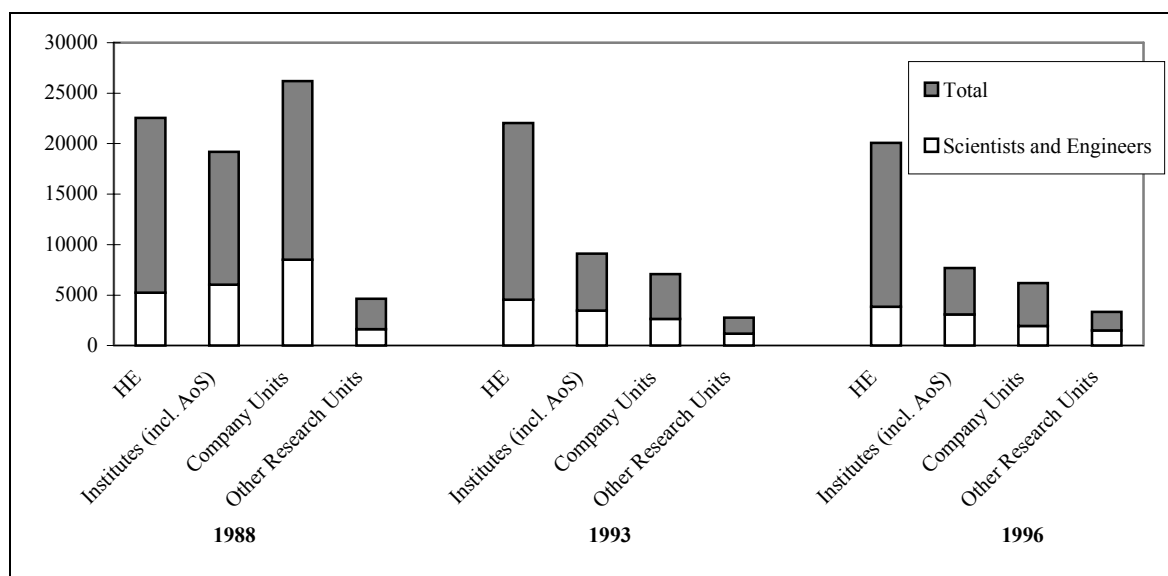
consequence and an expression of the dissolution of the 'old', socialist STS - and to this extent a prerequisite for, but not yet a feature of the formation of a new one! To assess the future-oriented institutional changes, one must thus consult other indicators that allow a differentiated assessment of the transformation of S&T in the individual CEEC to date, in particular with regard to their future sustainable development.

Figure 8.3: Poland - R&D Personnel by Sector



Source: Compilation by Meske, based on data from country reports (cf. Meske 1998)

Figure 8.4: Hungary - R&D Personnel by Sector



Source: Compilation by Meske, based on data from country reports (cf. Meske 1998)

2. Institutional Changes in S&T in the CEEC - A Systematisation of Empirical Findings

It is presumed that the institutional transformation of the STS is a long-term process with various types of changes on various levels. Experiences in East Germany indicate that three fundamental complexes of tasks must be dealt with here.

a) The reorganisation of S&T institutions by creating new (relatively autonomous) actors (in particular by fundamentally restructuring or creating new bodies and organisations in politics, industry and science) and by introducing and enforcing new rules for their behaviour.³

In the course of the GDR's accession to the FRG this was realised relatively sweepingly and quickly in East Germany by means of the "transfer of institutions" from West to East Germany. In other countries undergoing transformation, the search for their own solutions and their implementation are required, and accordingly more time is necessary.

b) The (subsequent) consolidation of the individual actors in politics, industry and science.

This pertains especially to the stabilisation of the political situation, in particular by way of a clear distribution of competencies between political and administrative bodies, as well as unambiguous legislation, the uniform application of regulations and their full enforcement. In industry this primarily concerns the establishment of independent (state or private) enterprises, operating in line with market principles, and their economic stabilisation, including the assumption of responsibility for innovation activities and (in-house) R&D. In science it primarily concerns the formation of autonomous actors with clear competence and activity profiles, in particular by reorganising universities, AoS and other public R&D institutes as well as above all by shifting the profiles of the former branch R&D institutes into the sphere of public science or (private) industry (as independent new enterprises or in-house R&D units).

In East Germany in the meantime (more than seven years after the transfer of institutions in 1991/1992) these processes have come a long way - in politics and industry they are far advanced, in science, however, they have not yet been fully completed. Our analysis of the integration of the Blaue-Liste ('Blue List') institutes, which were newly formed as successors to the former AoS institutes, revealed that in some cases the processes of internal and in most cases the external integration of these institutes persist and can certainly not yet be regarded as

³ S&T as a complex of social institutions may be considered as a system of actors and rules. This view is rooted in an understanding of an institution as a system of rules, which "sets (material) behaviour norms and (formal) procedural norms for certain situations; grant or deny specified beneficiaries disposal over financial, legal, personnel-related, technical and natural resources; determine the relations (especially those of dominance and dependence) between certain actors." (Mayntz and Scharpf 1995: 47-48).

fully comparable with West German institutes (Meske et al. 1997). Similar difficulties were experienced and continue to be experienced by the enterprises newly founded by scientists (cf. Gläser, Melis and Puls 1995) and in general by the R&D facilities and in-house R&D units in the industrial sector (cf. Spielkamp et al. 1998). In the case of HE institutions (Buck-Bechler et al. 1997), there were additional problems to be faced, firstly in finding (new, mostly West German) people to be appointed professors and, secondly, in dealing with the cuts in budgetary funding which had occurred in the meantime. Both factors delayed or hindered the establishment of new teaching and research profiles as well as the creation of an infrastructure of buildings and equipment - crucial for achieving high performance. The East German universities therefore continue to lag behind West German universities when it comes to raising additional funds from third-party sources and in terms of the scope of their research activities (DFG 1997).

c) The external networking of the new actors into a new *S&T* system, which involves the reintegration of the national science or R&D system and its linking to actors in politics, industry and other areas as well as the scientists' integration into the international scientific communities of their respective disciplines (as well as of innovative enterprises into the international markets and technology transfer).

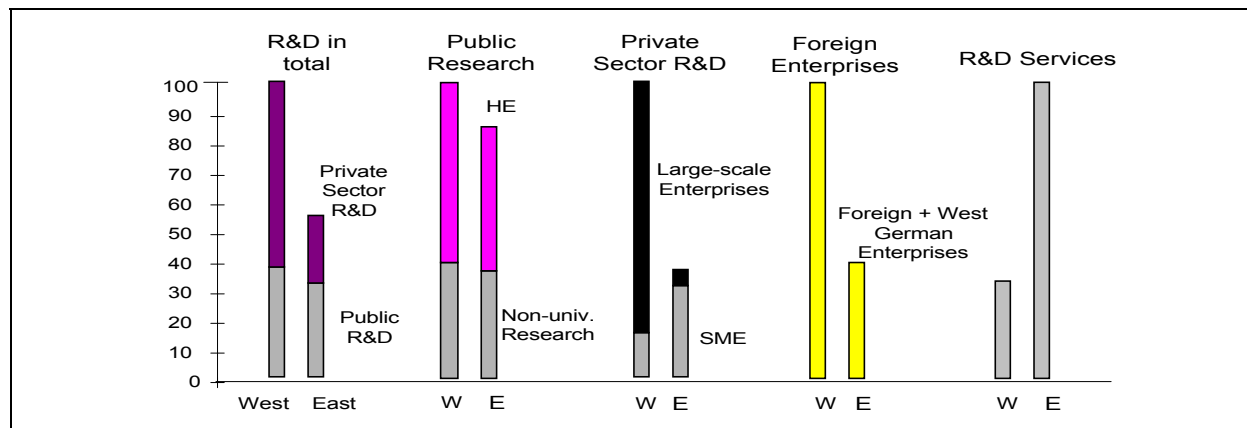
Although these processes began parallel to the formation of the individual actors, they usually require much longer because their reciprocal relations can only be stabilised and strategically developed after consolidation and once the actors have made their marks in their fields. This also means that individual actors or their failure can always disturb the system as a whole.

In East Germany there have been some excellent successes in linking universities and non-university research, above all through the consistently implemented policy of simultaneously appointing new heads of institutes to a (part-time) university professorship and through the equal participation of East German facilities in project funding (with a preference for joint projects with scientists from both areas). At the same time the connections between academic (i.e. university and non-university) research and industry in East Germany are still underdeveloped due to the weakness of the industrial sector there. There are structural differences in the R&D systems of East and West Germany (cf. Fig. 8.5), which will not be able to be fully eliminated before the year 2010, even if the developmental conditions for R&D in industry are very favourable (cf. Spielkamp et al. 1998: 155-157).

For the other countries undergoing transformation, the periods of time necessary for the required structural adaptation, for the development of optimal proportions between the various parts of the STS and for the involved alignment with other EU countries are likely to be even

longer. Thus, the first countries undergoing transformation to join the EU are not likely to become members before the start of the next century. And after this the actual processes and problems involved in integration and the intended cohesion will tend to intensify rather than already being completed by then.

Figure 8.5: Comparison of R&D Structures in West and East Germany
(Comparable Relations in Staff Levels, ca. 1995/1996)



Source: Meske (1998a:). The data for East Germany were multiplied by 4.6 for this comparison, in accordance with the employee ratio of 1:4.6 between East and West Germany. As the population ratio lies at only 1:4.1, the East German data are somewhat too high.

N.B.: R&D services are enterprises that fulfil R&D tasks for private and public contractors. In East Germany they were principally created from the former GDR branch R&D institutes.

The changes that have taken place over the almost ten years since the transformation began are thus essentially to be regarded as a transitional phase between the dissolution of the old STS and the formation of a new one. They relate not only to the fundamentally altered societal conditions of the respective country, but also to a completely restructured international environment in the economy and science. This adjustment is likely to be all the more successful, the earlier and more thoroughly a fundamental change of course for the longer-term and above all enduringly stable development of the STS in these countries is established.

In the interests of a comparative analysis of the changes involved in the individual countries undergoing transformation, we compiled a record of the most important institutional changes in the economic and political environments as well as performing sectors of S&T for all CEEC from the documents available, using the same indicators (although they were not always totally unconditionally determinable, quantifiable or comparable) (cf. Table 8.1). We then evaluated them according to a rough three-tiered scale.

A comparative analysis and condensation of the totality of the empirical findings in this (still very provisional) overview leads to the relatively distinct formation of three large groups of countries with varying advances in the institutional transformation of their STS (cf. Tab. 8.2).

Table 8.1: Institutional Changes in Sectors and Environments of S&T in (Indiv.) CEEC - Criteria

1. S&T Performing Sectors					
Higher Education		AoS / Public Sector		Industrial R&D	
Autonomy / Diversification	Role of Research	Autonomy / Evaluation	Competitive Funding	Transformation of Branch Institutes	Role of In-house R&D (personnel / funding)
2. S&T Politics					
State Authorities and Competencies		Legal System	State S&T Policy	State Funding	
				Mode	Amount (since 1995/96)
3. Economy					
GDP Changes (since 1995/96)			Enterprises		
			Restructuring	Privatisation	
				<i>Large Scale</i>	<i>Small Scale</i>

Five countries (each with a total rank estimate of 1 - Group I) clearly show the greatest advances in their transformation; another group (III), also comprising five countries (Bulgaria and the four European CIS countries), still lag considerably behind the first group with regard to the reorganisation of their STS. The other countries (Group II) tend to lie somewhere between these two groups; they have made some advances but lag behind in various other areas. Due to a lack of available data, no estimates could be made for Albania, Macedonia and Bosnia-Herzegovina.

Classification into both Group I and III is primarily determined by the stage of transformation achieved in the economy and in the S&T performing sectors. Both these groups of indicators reveal clear congruence within each group of countries, but they also reveal just as clear differences between the two country groups. In contrast, substantial advances have been made in the area of S&T politics as well as in those countries (Group II) positioned between the two 'poles'; these are often comparable to those made in the Group I countries. Without a corresponding stable economic basis, however, these political changes clearly could not (as yet) be followed through into radical changes in the S&T performing institutions. This confirms the experience formulated by Nesvetailov for the CIS countries that "a law on S&T policy is just a paper as there is no money to implement it" (Nesvetailov 1998).

Table 8.2: Classification of the Individual CEEC in Groups with Varying Advances in the Institutional Transformation of their STS

Country	Transformation of Fundamental Parts of the STS		
	S&T Sectors	S&T Politics	Economy
I. Group of Countries Furthest Advanced in the Transformation of their STS (Total Rank: 1)			
Poland	1	1	1
Czech Republic	1	1	1
Hungary	1	1	1
Estonia	1	1	1
Slovenia	1	1	1
II. Group of Countries with Medium Advances (Total Rank: 2)			
Latvia	1	1	2
Croatia	1	1	2
Slovakia	2	2	1
Lithuania	2	1	2
Romania	2	1	2
Serbia	2	1	(3)
Montenegro	2	1	(2)
III. Group of Countries Distinctly Behind in their Transformation (Total Rank: 3)			
Moldova	3	3	2
Bulgaria	2	3	3
Russia	3	3	3
Belarus	3	3	3
Ukraine	3	3	3
Countries Unable to be Evaluated due to a Lack of Documentation			
Macedonia	not available		
Bosnia-Herzegovina	at the beginning of recovery		
Albania	n. a.		
Total:	1	7	6
	2	6	7
	3	4	5

Key:

- 1 S&T Performing Sectors
- 1 = Considerable changes in all 3 sectors realised, in particular diversification (and strengthening of research) in the HE sector, democratisation, evaluation and increasing competitive funding in the AoS or public sector, changes in the former branch institutes and retention or establishment of (still small) in-house capacities
- 2 = Only partial or incomplete effecting of the changes as per 1
- 3 = Changes usually only just beginning, without fundamental transformation of the structure and mode of operation of the individual sectors
- 2 S&T Politics
- 1 = New institutional framework in S&T politics and funding installed; state S&T funding increasing
- 2 = Not fully changed or installed framework, problems in state funding
- 3 = Changes in institutional framework beginning but not yet actually realised; continuing decrease in S&T budget
- 3 Economy
- 1 = GDP growing; enterprise restructuring and privatisation largely completed
- 2 = GDP stabilising; Restructuring and privatisation of enterprises not yet completed
- 3 = GDP falling; restructuring and privatisation still in initial phase

Aside from the differences between the individual countries, there is also differentiation in the indicators within each segment of the STS crucial for the transformation.

- In the case of performing institutions the most substantial advances can be seen in the granting of autonomy to HE institutions and non-university research facilities, whereas there are still considerable difficulties involved in strengthening research in the HE sector

and in the implementation of competitive financing for public research. While advances in the institutional restructuring tend to dominate in the area of public (i.e., in the Western sense, 'academic') science, the situation in industrial R&D must, in contrast, be assessed as unsatisfactory and its restructuring as largely unresolved or as still being in its initial stages. Thus, the reorganisation of the former branch R&D institutes is far from being completed (with the exceptions of successor states of the SFRY, which never had such institutes, and the Czech Republic and the Baltic states, where they were rigorously dissolved or privatised) and often there is even a lack of conceptions as to what should be done. The aims of strengthening the in-house R&D which was already present, or building it up as a core area of the new R&D and innovation system has essentially not been achieved - with some exceptions (above all in the case of new small and medium sized enterprises (SME) and in some cases the subsidiaries of multinationals). Standards today are thus even lower than they were in the socialist era.⁴

- In the sphere of S&T politics, in general greater advances can be discerned in the creation of a new state administration and new legislation than in the formulation and implementation of new policies or of competitive forms of financing and the increase in budget funding for S&T.
- In the economic sphere, growth in GDP and the restructuring of enterprises are thus much more fundamental for the transformation of the STS than the complete achievement of privatisation, in particular as regards large-scale privatisation.

3. Discussion and Interpretation of the Empirical Findings:

The "3-Phase-Model" of S&T Transformation

The formation of at least three groups of countries as indicated by the empirical findings on differences in the advances made in the transformation of the STS is unlikely to be coincidental. Rather, the above mentioned fundamental processes in the transformation of the STS in East Germany were also found in the CEEC and can thus be considered as 'typical of transformation'. Managing these individual processes requires, on the one hand, differing periods of time; on the other hand, however, because they interrelate with one another, certain phases of transformation can only be successfully concluded after several processes have been successfully dealt with. Therefore, a distinction can be made between three phases when

⁴ For more detailed information on the situation in industrial R&D and on the changes introduced in branch R&D institutes in several countries see Schneider 1998, 1998a; Bouché 1998; Mosoni-Fried 1998; Tichonova 1998.

analysing the transformation processes of STS in the CEEC (cf. Fig.8.6); each is dominated by different changes.

Phase 1:

- dissolution and fragmentation of the old STS.

Phase 2:

- consolidation of the "surviving" portions of the old STS and their transformation; emergence of new actors and rules within S&T as well as in science, politics and the economy (privatised enterprises, new entrepreneurs, foreign direct investment);
- shifts in the activities of the various individual organisations and a macrostructural shift from research to a higher share of innovation activities within industry (technology transfer, diffusion, adaptation, import of materials and components) which are, for the most part, neither based on nor include endogenous R&D.

Phase 3:

- emergence/building of a new STS as a balanced complex of actors and activities. The challenge of this phase is to codify a set of viable rules governing actors and activities. Furthermore, an appropriate quantitative balance of activities and organisations is required. The aim of this phase is to ensure relatively stable relationships and a "dynamic balance" within the STS as well as between it and other social areas.

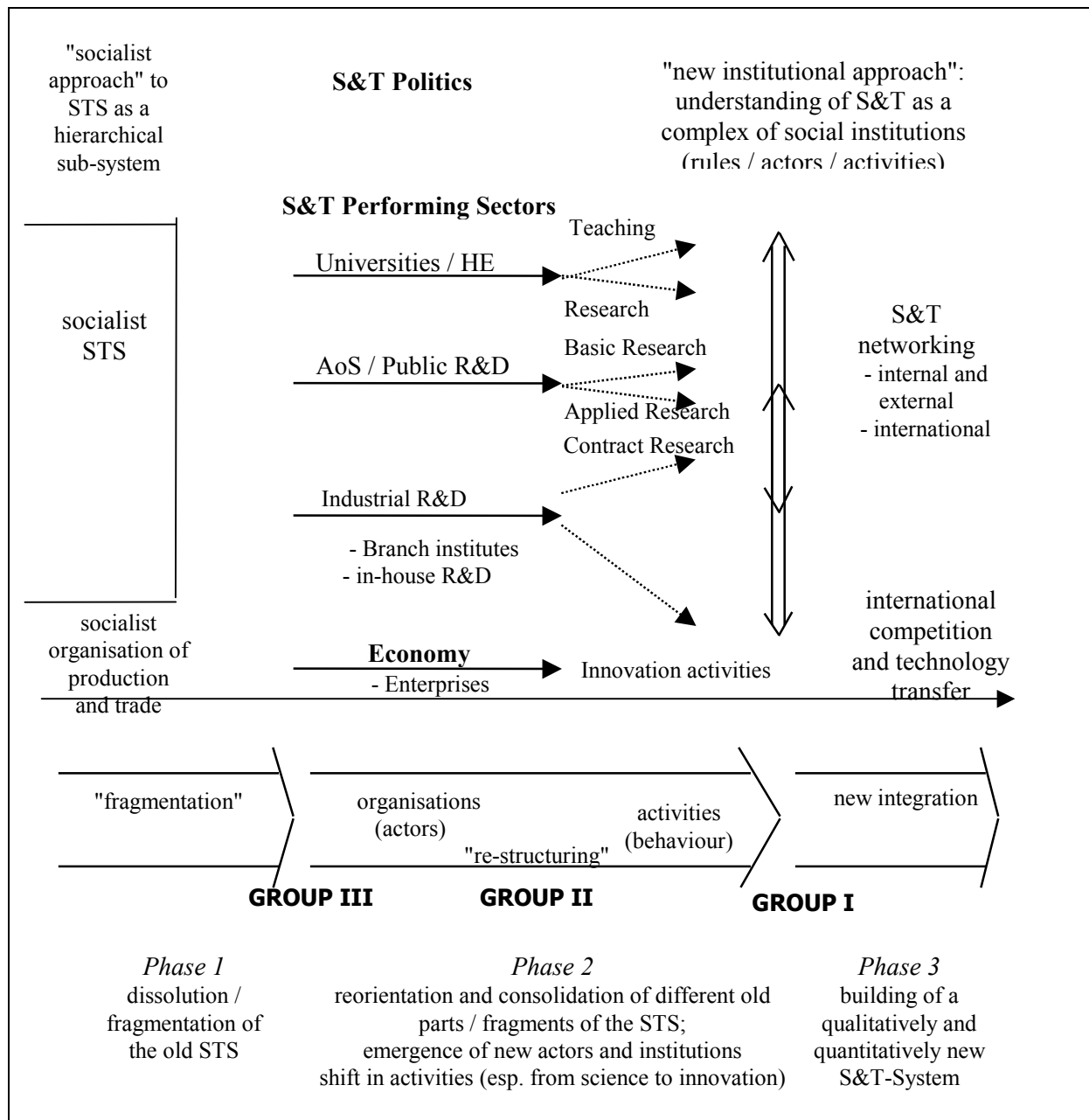
The *next phases*, 2 (the creation of new autonomous actors and rules for their behaviour in politics, science and the economy) and 3 (shaping a new S&T system by nationally and internationally connecting or interweaving the new actors and their activities) require many different restructuring processes, which must be managed simultaneously or, in some cases, one after another. The environments of politics and the economy are essential conditions for science's existence and development here. Without these environments being stabilised to a certain degree the transformation of S&T performing institutions cannot be completely realised.

The results of our analyses show that there are considerable differences regarding the *content* of the institutional restructuring of the S&T systems in different CEECs. In S&T politics, for instance, the spectrum of interim results achieved until now ranges even in the most advanced countries from the Polish case of a more centralist version of administration and the predominant retention of public funding (also in the field of applied research) to the more clearly decentralised course in the Czech Republic, where there is no specific ministry for science and research, the funding of research is left to the individual ministries and the (mainly privatised) industrial enterprises, and all former branch R&D institutes have been privatised or liquidated.

When one also considers the differences between the individual CEEC in terms of the state of their legislation (and the observance of the laws), the evaluation of facilities and scientists, the

introduction of competitive forms of financing for R&D projects and their share in the total funding of R&D, etc., then one gains the impression that there is a very *wide spectrum* of variation in the *institutional transformation* of the STS in the individual countries.

Figure 8.6: Phases in the Process of Institutional Transformation of STS in the CEEC



Classification of countries into Group I (Poland, Czech Republic, Hungary, Estonia, and Slovenia) and Group III (Moldova, Bulgaria, Russia, Belarus and Ukraine) shows that there is a clear congruence between progress in economic recovery and political transformation, and the transformation of the S&T system. In other words, there is a broad compatibility in transformation between the general system transformation and restructuring of S&T systems.

The relative autonomy of S&T can be observed in the Group II countries (Latvia, Slovakia, Lithuania, Romania, Croatia and Serbia), where there are differences in restructuring between economic transformation, S&T policy and changes in S&T institutional sectors. Without a corresponding stable economic basis, *political and policy* changes in S&T clearly could not be followed through into radical changes in the S&T performing institutions. This inconsistency in areas of change is also present within specific institutional sectors, especially when establishment of new 'superstructure' may often lead to little in terms of content; when the newly acquired autonomy of science is not always followed by competition and relevance, and when advances in academic science are accompanied by considerably fewer advances in restructuring of industrial R&D.

Despite substantial national differences, so far the transformation processes are characterised by *common phases*, each characterised by different types of changes. But there are currently still fundamental differences between the individual CEEC. While the leading group of countries has established a relatively stable new situation both in politics and the economy (which manifests itself economically in particular in the fact that GDP is again growing and the pre-transformation level is being attained or approached), the other two groups have not yet succeeded in (completely) dealing with these processes.

In most countries of Group II the necessary science policy bodies and regulations have been created. There are, however, still difficulties in carrying through and really implementing the new regulations. This means that here the issue is not so much the fundamental question of reorganisation, but rather its practical realisation. A crucial problem lies, for example, in the strengthening of competitively organised financing in publicly supported R&D. Even once it has been prepared and implemented, with there being too little competitive project funding as a whole (with a share of under five or even one percent of the total budget funding), competitive financing can essentially exert virtually no influence on the behaviour, motivation, etc. in the S&T facilities. There are also few incentives for bolstering research in higher education when the resources barely suffice to cover teaching. In addition, in these countries directly practical problems in applying the new system of regulations also play a role. The evaluation of R&D facilities and projects, for instance, requires a well functioning system of bodies, assessment and approval procedures. This creates problems precisely for smaller countries with a limited number of specialists; problems which can hardly be conclusively solved with high scientific authority without a (to date generally not attained) integration into international scientific communities. As a consequence, in this group the

focus of attention lies not only on the stabilisation of the environments, but above all on the *practical management* of the institutional changes in all parts of the STS and the development of new routines.

The *least advanced group of countries (III)* is essentially still *at the beginning of restructuring processes*. The impact of the continuing economic decline is strongest in this group and directly affects all areas of life, with a destabilising effect on the political situation. In relation to this, however, S&T institutions primarily represent a "dependent" variable, both of the economy and of politics. Thus, in Bulgaria the frequent changes of government have hindered the stabilisation of both the economy and science. In Russia the economic instability has meant that not even the planned (very low) budgetary funds for S&T are being provided, which dooms all attempts to implement competitive forms of financing to failure - with a corresponding impact on the motivation and behaviour of scientists. Without the stabilisation of these key environments, no fundamental future-oriented reorganisation of the structure and mode of operation of the individual scientific facilities nor of the STS as a whole can be achieved.

In this second phase of transformation, R&D systems in CEE have introduced competition and ensured the autonomy of science, which is now released from political control. In most of the countries competition takes the form of 'peer review' based selection, though the implementation of these systems shows weaknesses and a very low share of funds is distributed in this way. However, the introduction of these institutions has not resolved the problem of the relevance of S&T for industry and economy. On the other hand, the consolidation of scientific facilities and activities can consequently not be achieved without relatively stable political and economic conditions. In view of the national particularities we must also modify the concept of the "phase model" we developed. This model was based on the assumption that in all countries the second phase of "consolidation" would be followed by a *third phase* comprising the internal and external *integration* of S&T. According to our current information, such an option is very likely to only be realisable for the Group I countries, i. e. the next candidates for EU membership, who are just entering the third phase (which East Germany is already in). Even for some of the countries in the second group it appears questionable whether they can realise this and in the case of the third group it seems rather unlikely to occur in the near future.

This assessment follows from the fact that S&T requires a high degree of continuity and an uninterrupted "generational succession" in both the preparation and execution of research

processes and the dissemination of their results. The more profound the fragmentation of S&T potential becomes and the longer the insecurity about the future of that which remains continues, the greater the loss of ability to follow up on former scientific work - the prerequisite for continuity - will be. The distinct indicators of this tendency are the uncoupling of the scientific institutions in some CEEC from the international exchange of information, from advances made in equipment and methods, from the dynamic fields of application, and from innovative practice. These tendencies are no longer the result of political directives but rather of the lack of financial resources - which makes the effect even greater. There are also growing problems in the generational succession of scientists; they arise from the increase in the percentage of older staff members, the gap with regard to up and coming scientists, and the low interest on the part of young people to enter a scientific career due to the poor employment conditions and the lack of career opportunities. The number of publications (SCI basis) produced by scientists from the European CIS countries and Bulgaria has dropped again since 1994; this is also to be considered an effect of this tendency on scientific performance, all the more so since the countries in Groups I and II display quite the opposite trend with a continuing rise in their number of publications. In these countries the number of publications co-authored with scientists from EU countries (in the meantime about 30% of all publications) is also roughly twice as high as in the Group III countries.

One must therefore assume that the countries in this group will not be in a position to stabilise their S&T institutions and successfully begin processes of national and international integration in the near future. The long-ranging consequences of this situation for the future of S&T in these countries are to be assessed as open.

It must also be considered here that so far all countries, even those in Group I, have serious macrostructural problems in the restructuring of their STS. Of particular significance is the general weakness of enterprise sector R&D and the low demand for domestic R&D on the part of industry. The changes occurring in the sector of industrial R&D are less dependent on the sector itself than on industrial enterprises, their consolidation and innovational activities. This indicates not only the long-term character of the transformation of STS, but also the further intensification of national particularities to be expected in future, in particular between the candidates for EU membership and the other countries.

The differentiation between three large groups of CEE countries regarding the progress they have made in the institutional transformation of S&T systems in the mid 1990s has some impact on policy and co-operation with the EU. In the coming years these countries will be

faced with differing problems and tasks in the formation of their S&T systems, notwithstanding the fact that there are also many similar problems.

In those countries that are still at the beginning of reorganising their S&T systems (Group III) the main focus should be on consultation and the exchange of experiences in the area of S&T policy and organisation. This aim can be supported on a broad basis by involving these countries in international bodies and by establishing contacts by sending experts on all levels of science politics, administration and organisation to appropriate forums for the exchange of experiences or to bilateral conferences. The second group (II), in which fundamental changes in the S&T system have already been introduced or prepared, should be included in international bodies and expert exchange on all levels of S&T policy should be supported on a continuous basis. The leading transformation countries (Group I) have already consolidated their S&T systems, and co-operation with them should be intensified; this is already currently happening, with these countries being involved in the work of the EU on various levels. What primarily matters here is adapting the corresponding regulations, modes of operation, etc., to conform with EU standards and requirements. In some cases, however, interim arrangements are likely to be necessary to take into account the specific conditions in these countries even after they have become EU members, especially concerning the support of industrial R&D in the former branch institutes.

Finally, the policy of international co-operation, in particular with CIS countries, should be more diversified and should try to actively develop areas of civil science, especially those which are the basis for solving the immediate environmental, health and industrial problems.

4. Typical Problems with Strategic Importance

Regardless of the respective country-specific situation, the findings on the changes in S&T to date do draw attention to several problems that are, firstly, cross-national and thus typical, and, secondly, of a predominantly long-term character and thus of strategic importance for S&T. These are

- (a) changes in the resource structure of S&T that have not yet been dealt with, i.e. the substantial reduction of personnel in S&T needs to be at least compensated for by a considerably improved provision of funding or infrastructure for the remaining core of scientists;
- (b) macrostructural problems in the restructuring of the STS through the general weakness of the enterprise sector and the low demand for domestic R&D on the part of industry;
- (c) the reestablishment or development of new relations between the individual, now largely autonomous actors in S&T in the respective country and on an international scale.

Re (a): Staffing Level and Infrastructure in S&T

While true for some cases, in general the substantial reduction in S&T personnel is not merely a paring down of superfluous employees. Rather, it is about the implementation of a modified division of labour, in which the permanent scientific staff is concentrated in the actual core processes while the many auxiliary and secondary processes are outsourced to scientific facilities. There they are carried out by specialised service providers who do not (or no longer) belong to science. This tendency is verified in particular by the fact that the number of scientists has only dropped slightly in comparison to the total staff numbers (cf. Figs. 6.3 and 6.4). However, the core of highly qualified and capable scientists now remaining in all facilities requires a considerably higher provision of funds per employee than before in order to carry out the work. This is necessary, on the one hand, to be able to adequately pay and retain a capable workforce in science, and on the other hand, to provide this reduced number of scientists with terms and conditions of employment comparable with those offered internationally. Aside from the infrastructures of the scientific facilities (provision of equipment, technical materials and information), this also involves varied external services (e.g. equipment maintenance, conference organisation, cleaning, provision of meals, etc.), which were formerly generally carried out by a scientific facility's own staff and was one reason behind the high staffing levels in comparison with Western facilities. This also means, however, that the majority of staff previously employed in S&T has not now been lost with no replacement. Under free market conditions these employees must be 'replaced' by additional money for an improved internal and external infrastructure if one wishes to become internationally competitive.⁵ The problem of improving the infrastructure has so far only been partially solved in Hungary - through the installation of a modern information network. In all other CEEC the staff cutbacks were usually accompanied by still further cutbacks in the financial and material-technical provisions as well as the supply of information.

The improvement of the financial and infrastructural conditions is, however, imperative for the maintenance of and long-term increase in the performance of S&T.

⁵ In East Germany, in non-university research in particular, the problem of a substantially reduced workforce in the remaining (fewer) institutes has already largely been resolved by financial transfer from West Germany and the provision of modern equipment. But even here there are still deficits five to six years after the founding of the new facilities, in particular as regards the renovation of buildings. This affects the equipment of the HE sector even more since the required capacities here are much more extensive than in non-university research. In addition, their funding is primarily the responsibility of the individual federal states and the newly founded states in East Germany are often overburdened. This is, however, to a considerably larger extent, typical of all other transformation countries.

Not only the production of internationally respected research results depends on this, but also, among other things, international collaborations with equal rights (with the mutual exchange of scientists), being able to retain leading scientists in the country, recruiting young scientists, the swift practical utilisation of results, etc. To date there are considerable deficiencies in all CEEC, which can only be overcome in the long term. There are no longer political or other formal barriers to international relations, but so far they still very one sided and primarily geared towards scientists from transformation countries participation in conferences and (generally brief) working visits in Western nations (see Mirskaja 1998). As a result publication activity (as registered in the SCI) and also co-authorships with Western scientists have increased considerably (see Czerwon 1998), but this is still not an indication of durably stable and equal collaboration since many of the currently published results are based on research work carried out in the socialist era, which have frequently had to be interrupted in the meantime. Since 1994 the number of publications has dropped again in the four European CIS countries and Bulgaria - while at the same time the number of publications co-authored together with scientists from EU countries has continued to rise: This can be considered an indication of the fact that the lack of domestic resources for R&D in these countries has already begun to have an impact on their output.

In addition, low and irregular payment as well as poor prospects for the future have removed the potential up-and-coming scientists from the STS, or kept them from entering it. An increase in the percentage of older people in the current workforce is a general feature and gives rise to the danger that in approximately ten years the only just restructured STS will suffer a further setback due to personnel gaps that could once more weaken it (cf. Nesvetailov 1998a). Only some of the successor states of the SFR Yugoslavia have taken effective measures and they have achieved some notable successes. In the other countries this issue has so far not been or not been adequately reflected on; as can be seen in the example of the utterly inadequate scholarship programme established by the Russian president in 1993 - for 1100 young scientists (Izvestija 1993) - all the more as alone Serbia integrated over 1000 additional young people into its research programme between 1993 and 1996.

Re (b): Enterprise Innovation and Industrial R&D

While the development of democratic structures and processes has, especially in the area of academic science, had the strongest possible influence on the institutional framework, industrial R&D is subject mainly to influences from the market economy. The changes occurring in the sector of industrial R&D are less dependent on the sector itself than on

industry and its innovational activities. This, however, was precisely where the structural particularities and the crucial weaknesses in innovation and international competitiveness of the Soviet model of S&T lay (cf. Schneider 1994). With the introduction of the market economy in the (post-) socialist countries, it is primarily industry (specifically, the structures and behaviour of the enterprises) that is being changed. The former state enterprises had been rather tightly controlled and often restricted to a purely productive function, and are now becoming largely autonomous actors. This is occurring as a result of privatisation in particular, but it occurs even when the state remains a shareholder in the formally privatised enterprise.

Under conditions of the international opening of markets, these enterprises have, on the one hand, new opportunities and possibilities for broadening their innovative capability and also extending their markets by means of international networking. On the other hand, however, there is an increasing risk of succumbing to foreign competitors, who are superior in many ways (technologically as well as financially and in terms of marketing ability). In both cases, however, contrary to all expectations, significant problems have arisen for industrial R&D in the countries undergoing transformation. Under the conditions described, it is now hardly needed: If the enterprises are unable to hold a share of the market, they vanish, and with them their (internal and external) R&D potential vanishes. But even if the enterprises are able to maintain a hold on the market and even carry out innovation, due to expense and time pressure this occurs primarily through various forms of technology transfer and seldom through their own R&D. In addition, there are a number of new innovative enterprises that are oriented towards the swift marketing of their own R&D results and are usually characterised by the struggle to survive. Their quantitative significance in the economy and R&D is, however, very slight. This has meanwhile been confirmed by a lot of experiences in countries undergoing transformation (cf. in particular Webster 1996, Dyker 1997, Meske et al. 1998).

In the industrial sector, this development is leading to a division of labour that differs structurally from the one that has hitherto prevailed between R&D and other innovational activities in enterprises, a division of labour which tends to favour the latter: Innovations are now taking place predominantly by means of product adoption and technology transfer from Western countries, usually in conjunction with privatisation and/or capital transfer. This tendency is especially strengthened by foreign direct investments and the absence of in-house R&D capacities. It raises serious questions about the survival and future of major portions of industrial R&D, which, in most CEEC, was concentrated mainly in the branch R&D institutes,

organisationally separate from the enterprises. Only gradually is an awareness of these problems dawning, supported by analyses and hypotheses on the causes of and options deriving from the decline and fall of industrial R&D in East Germany and other countries undergoing transformation. The CMEA region was a relatively closed and, for a long time, fast-growing market, which was supplied to a great extent through its own industrial sector, which included modern branches with their own R&D hinterland. Often parallel to major Western multinationals, there had been a specialisation of particular countries and industrial combines as systems providers in information and communications technology, mechanical engineering, construction of industrial installations, the motor vehicle industry, shipbuilding, production of basic and special chemical substances. After the collapse of the CMEA, these producers lost their (protected) market; consequences are a drop in production, dissolution and realignment in the remaining and newly founded industrial enterprises. This transformation is such that R&D will not necessarily be needed in the foreseeable future, will be perceived chiefly as a cost factor and accordingly cut back wherever possible, or not even be incorporated into the transformed enterprises at all, having in the past usually been organised in specialised external institutes instead. Though we are dealing here with a clear basic tendency, the situation in each country, each branch of the economy, each enterprise and R&D institute has its specific features, and accordingly, there are considerable uncertainties, extended phases of consolidation and quite a variety of future options for R&D. A reaction to all of this on the part of policy-makers in the economy and science can, and in the face of the obvious failure of the market, *must* be forthcoming (Etzkowitz 1998 describes an equivalent trend in the USA).

But since the economic changes and the difficult acclimatisation of newcomers to the EU and the international market are inevitable, any artificial preservation of redundant and often centralised R&D capacities is condemned to fail (cf. Bitzer 1998). Instead, new tasks and opportunities must be sought out for them. For example, parts of former enterprises could reconfigure to become highly specialised producers of particular high-tech components, or to become subcontractors that produce relatively complex modules for international systems providers, combining presently existing capacities of high performance from production plants and research institutes in novel fashion. An opportunity that is opening up for other scientists is that of founding their own firms and exploiting the results of their R&D work there, or that of putting their experience to use in the economic restructuring process by becoming service providers in the form of engineering firms and consulting firms. That not

only causes the functional spectrum in enterprises to shift from R&D to innovation, but also causes parts of the human and institutional potential to abandon R&D and enter into entrepreneurial activities. Internationally too, there is a tendency toward outsourcing of R&D and other services, as well as toward growth of the share of supplies from subcontractors that are used in the manufacture of aircraft, motor vehicles, machines and similarly complex final products, and this means that individual suppliers from countries undergoing transformation who have new solutions, high quality and low costs do indeed have chances in this market.

At present there are very different reactions to all of this in the transformation countries, with the spectrum running from substantial dissolution of industrial R&D as it is abandoned to the forces of the market, all the way to its politically supported reconfiguration. Experience has so far shown, especially in East Germany, that even an actively supportive policy cannot maintain R&D personnel at its former level (Bundesministerium 1997). Cutbacks are obviously inevitable, but they should be performed in a discriminating way according to institutions, economic branches and research fields, especially in the interest of supporting structural economic changes of a kind that bring internationally competitive units into being. As these are largely bottom-up processes, their success depends primarily on the active behaviour of the actors in R&D.

If R&D capacities at present constitute a financial burden more than anything else, they may at a later date become indispensable prerequisites for the revitalisation or the international competitiveness of important branches of the economy - but only if they are given a chance to do so through transitional solutions. This is a political task; in East Germany, for example, the federal and the respective state governments dealt with it by establishing a multitude of assistance schemes and providing substantial financial resources for R&D in industry (cf. Hornschild 1998; Ruprecht and Becher 1998) - these measures are to be continued under the new Schröder administration. In Poland corresponding efforts have been made by the State Committee for Scientific Research (KBN) through the (scaled) institutional funding of the former branch institutes. In contrast, in the Czech Republic the political sphere has thus far abstained from supporting R&D in industry in overcoming the transformation problems (cf. Schneider 1998 and 1998a).

Re (c): S&T Networking

A third problem area concerns the aforementioned interconnection between the individual actors in S&T on a national and international scale. Understandably, until now the

fragmentation of the STS and the necessary formation and consolidation of new actors predominate. A fundamental feature of modern STS is, however, precisely their diverse and very flexible intertwining. In contrast to the socialist hierarchical system, this is not (and cannot) be organised top-down, but must rather be formed from the bottom up according to the principle of self-organisation (Krohn and Küppers 1989). Such networks are currently utterly underdeveloped in the CEEC; the links between facilities and scientists have often dropped to a level below that present under socialism.

To date attempts to create new links between the now autonomous actors are being made primarily in the HE sector through the (permanent or temporary) involvement of scientists from other sectors (AoS and industry) in teaching. This simultaneously creates preconditions for supporting collaboration in the course of consolidation and expansion of research activities in universities. In the sphere of Academy science the involvement of the individual scientists and research groups in the international scientific communities of the specific discipline is also of the utmost importance. We have already pointed out that the conditions in the infrastructure in the CEEC are unfavourable here. Irrespective of this, integration is a longer-term process, as our analysis of East German institutes has shown. This is above all due to the fact that these scientific communities are not only cognitively constituted but also social entities (Laudel and Gläser 1998); the individual members must "grow" and be fully "socialised" into them over a long period of time (cf. Meske et al. 1997). But considerable progress has been made here too over recent years, as the developments in the publication activity of co-authors from CEEC and EU countries recorded in the SCI indicate. The above classification of the countries into groups according to their advances in transformation is also confirmed by this data. In the mid-1990s (most) countries in Groups I and II wrote approximately 30% of all publications recorded in the SCI in collaboration with scientists from the 15 EU countries; in contrast, this figure lay at only 15-20% in the four European CIS countries and the FRY in 1996 (cf. Czerwon 1998). At the same time, however, co-operation between scientists from different CEEC has reduced significantly.

While in the AoS and HE sectors in all countries at least the beginnings of links between the various, now largely autonomous facilities can be discerned, in contrast the developing co-operation between science and industry is likely to be even more difficult and protracted. These links have largely broken down in the CEEC. In all countries the pronounced structural weakness of industrial and, in particular, enterprise R&D as well as the altered innovation behaviour of the restructured enterprises will have long-term negative effects on their need for

scientific output and services. Part of the current demand for innovative capacities has been met by, among other things, the changeover of former R&D personnel and some entire facilities to the service and production sphere. It must, however, be reckoned with that under conditions of globalisation and the move of individual countries into the EU, their role as periphery will be renewed - this time no longer as scientific-technically leading periphery, as in their relation to Russia/the USSR, but rather more predominantly as a scientific-technically backward and thus more low-tech than high-tech oriented periphery (cf. Meske 1999). It is essentially an open question what impact this new situation will have on the scale, profile and structure of the STS in the individual countries and whether it will actually come to the formation of new national STS or whether instead the smaller new member states of the EU will in fact become regional parts of a developing European STS. However, this not only concerns the East European transformation countries but rather has to do more generally with the future profile of the EU as the only partially successful attempts at cohesion between the current EU nations have shown. In connection with this, questions regarding Russia's future role as regional S&T centre as well as its relationship to the EU and the CIS countries are still to be regarded as essentially open.

This reference to future tasks and open questions should above all draw attention to the fact that the completion of the transformation in the East European countries and their integration into the EU or in general into the international market are increasingly developing into problems that affect not only the CEEC, but also essentially all European nations and their STS.

References

- Bitzer, Jürgen, 1998: Demand-Oriented S&T Policies as an Alternative Strategy for Post-Socialist Countries. Pp. 266-274 in W. Meske et al. (eds.), *Transforming Science and Technology Systems - The Endless Transition?* NATO Science Series 4/23. IOS Press: Amsterdam.
- Bouché, Petra, 1998: Alternative Approaches to Industrial R&D Institutes in Hungary and Russia. Pp. 183-197 in W. Meske et al. (eds.), *Transforming Science and Technology Systems - The Endless Transition?* NATO Science Series 4/23. IOS Press: Amsterdam.
- Buck-Bechler, Gertraude, Hans-Dieter Schaefer and Carl-Hellmut Wagemann (eds.), 1997: *Hochschulen in den neuen Ländern der Bundesrepublik Deutschland*. Deutscher Studien Verlag: Weinheim.

- Bundesministerium für Wirtschaft (ed.), 1997: Wirtschaftliche Förderung in den neuen Bundesländern. Bonn.
- Czerwon, Hans-Jürgen, 1998: International scientific cooperation of EIT countries: a bibliometric study. Unpubl. Paper. Wissenschaftszentrum Berlin für Sozialforschung: Berlin
- DFG/Deutsche Forschungsgemeinschaft (1997): Bewilligungen nach Hochschulen; Bewilligungsvolumen 1991 bis 1995. Anzahl kooperativer Projekte im Jahre 1996. DFG (Bonn).
- Dyker, David A. (ed.), 1997: The Technology of Transition. Science and Technology Policies for Transition Countries. Central European University Press: Budapest.
- Etzkowitz, Henry 1998: Science and Industrial Policy: Beyond the Endless Frontier. Pp. 57-66 in W. Meske et al. (eds.), Transforming Science and Technology Systems - The Endless Transition? NATO Science Series 4/23. IOS Press. Amsterdam.
- Gläser, Jochen, Charles Melis and Klaus Puls, 1995: Durch ostdeutsche WissenschaftlerInnen gegründete kleine und mittlere Unternehmen - Eine Problemskizze. WZB-Paper P 95-403. Wissenschaftszentrum Berlin für Sozialforschung: Berlin.
- Hornschild, Kurt, 1998: FuE-Förderung in Ostdeutschland durch das Bundesministerium für Wirtschaft - Ergebnisse aus einer Wirkungsanalyse. Pp. 327-356 in: Michael Fritsch, Frieder Meyer-Krahmer and Franz Pleschak (eds): Innovationen in Ostdeutschland - Potentiale und Probleme. Schriftenreihe Technik, Wirtschaft und Politik des Fraunhofer-Instituts für Systemtechnik und Innovationsforschung (ISI), Vol. 34. Physica-Verlag: Heidelberg.
- Izvestija, 1993: Stipendii ot Prezidenta. Moscow, 8 September, p. 1.
- Krohn, Wolfgang and Günter Küppers, 1989: Die Selbstorganisation der Wissenschaft. Suhrkamp: Frankfurt a. M.
- Laudel, Grit and Jochen Gläser, 1998: What are Institutional Boundaries and How can They be Overcome? Germany's Collaborative Research Centres as Boundary-Spanning Networks. WZB-Paper P 98-401. Wissenschaftszentrum Berlin für Sozialforschung: Berlin.
- Mayntz, Renate and Fritz W. Scharpf, 1995: Der Ansatz des akteurzentrierten Institutionalismus. Pp. 47-48 in R. Mayntz, F. W. Scharpf (eds): Gesellschaftliche Selbstregelung und politische Steuerung. Campus: Frankfurt a. M., New York.
- Meske, Werner, 1993: "The restructuring of the East German research system - a Provisional Appraisal", in: Science and Public Policy, Guildford/England, Vol. 20, No. 5, October, pp. 298-312.
- Meske, Werner, Gläser, Jochen, Gabriele Groß, Marion Höppner and Charles Melis, 1997: Die Integration von ostdeutschen Blaue-Liste-Instituten in die deutsche Wissenschaftslandschaft. Forschungsbericht. Wissenschaftszentrum Berlin für Sozialforschung: Berlin. (Unpubl. Paper).
- Meske, Werner, Judith Mosoni-Fried, Henry Etzkowitz and Gennady A. Nesvetailov (eds.), 1998: Transforming Science and Technology Systems - The Endless Transition? NATO Science Series 4/23. IOS Press: Amsterdam.
- Meske, Werner, 1998a: Institutional Transformation of S&T Systems in the European Economies in Transition. WZB-Paper P 98-403. Wissenschaftszentrum Berlin für Sozialforschung: Berlin.
- Meske, Werner, 1998b: "Öffentliche Forschung als notwendige Infrastruktur für Innovationen in Ostdeutschland", in: Fritsch, Michael, Frieder Meyer-Krahmer, Franz Pleschak (Hg.), Innovationen in Ostdeutschland - Potentiale und Probleme, Schriftenreihe Technik, Wirtschaft und Politik des Fraunhofer-Instituts für Systemtechnik und Innovationsforschung (ISI), Physica-Verlag, Heidelberg, pp. 293-312.
- Meske, Werner 1999: Transformation of R&D in Central and Eastern Europe: Asset or Liability? In S. Radošević, D. Dyker and L. Gokhberg (eds): Quantitative Studies for Science and Technology Policy in Countries of Central and Eastern Europe. IOS Press: Amsterdam.
- Mirskaja, Elena Z., 1998: The role of international interactions in contemporary science in Russia. In: Science and Public Policy, Vol. 25(1): 37-45.

- Mosoni-Fried, Judith, 1998: Structural Changes in Industrial R&D in Hungary: Losers and Winners. Pp. 171-182 in W. Meske et al. (eds.): *Transforming Science and Technology Systems - The Endless Transition?* NATO Science Series 4/23. IOS Press: Amsterdam.
- Nesvetailov, Gennady A., 1998: Changes in STS of Russia, Ukraine, Belarus, and Moldova. Comprehensive overview. Wissenschaftszentrum Berlin für Sozialforschung: Berlin (Unpubl. Paper)
- Nesvetailov, Gennady, 1998a: Compromised Futures: The Consequences of an Aging Research Staff. Pp. 93-106 in R. Mayntz et al. (eds.). *East European Academies in Transition*. Kluwer Academic Publishers: Netherlands.
- Radosevic, Slavo, 1995: Restructuring and Reintegration of Science and Technology Systems in Economies in Transition. Unpublished Project Proposal.
- Radosevic, Slavo, 1999: S&T in Growth and Restructuring of Central and Eastern Europe: The Main Patterns and Factors of Transformation. Paper presented at the TSER project final conference 'Restructuring and reintegration of S&T systems in countries of central and eastern Europe: Restructuring patterns and policy experiences', Hove, 12-13 March 1999.
- Ruprecht, Wilhelm and Gerhard Becher, 1998: Der Netzwerk-Ansatz der FuE-Förderung für die neuen Bundesländer - Das Beispiel des Programms "Auftragsforschung West - Ost". Pp. 357-378 in Michael Fritsch, Frieder Meyer-Krahmer and Franz Pleschak (eds.): *Innovationen in Ostdeutschland - Potentiale und Probleme*, Schriftenreihe Technik, Wirtschaft und Politik des Fraunhofer-Instituts für Systemtechnik und Innovationsforschung (ISI), Vol. 34. Physica-Verlag: Heidelberg.
- Schneider, Christoph M., 1994: *Research and Development Management: From the Soviet Union to Russia*. Physica-Verlag: Heidelberg.
- Schneider, Christian, 1998: Institutional Transformation in the Industrial R&D Sector - Changes in Organisational Structures, Functions, and Interrelations: Analysis by Country: Poland (Country Report). Wissenschaftszentrum Berlin für Sozialforschung: Berlin. (Part D/B1 of Final Report D of the EU project "Restructuring and Reintegration of Science and Technology Systems in the European Economies in Transition".) (Unpublished paper)
- Schneider, Christian, 1998a: Institutional Transformation in the Industrial R&D Sector - Changes in Organisational Structures, Functions, and Interrelations: Analysis by Country: Czech Republic (Country Report). Wissenschaftszentrum Berlin für Sozialforschung: Berlin. (Part D/B2 of Final Report D of the EU project "Restructuring and Reintegration of Science and Technology Systems in the European Economies in Transition") (Unpublished paper)
- Spielkamp, Alfred, et al., 1998: Industrielle Forschung und Entwicklung in Ostdeutschland, Wirtschaftsanalysen. Schriftenreihe des ZEW, Bd. 29. Nomos Verlag.: Baden-Baden.
- Stern, Nicholas, 1997: *The Transition in Eastern Europe and the Former Soviet Union: Some Strategic Lessons from the Experience of 25 Countries Over Six Years*. Working Paper No. 18, European Bank for Reconstruction and Development: London.
- Tichonova, Marina, 1998: How to Ensure a Future for industrial R&D Institutes in Russia? Pp. 198-210 in W. Meske et al. (eds.): *Transforming Science and Technology Systems - The Endless Transition?* NATO Science Series 4/23. IOS Press: Amsterdam.
- Webster, Andrew (ed.), 1996: *Building New Bases for Innovation. The Transformation of the R&D System in Post-Socialist States*. Anglia Polytechnic University: Cambridge, UK.

Chapter 9: R&D in Southeast Asian Nations. The Example of South Korea

*Barbara Susec**

1. Introduction

The economic development of the Asian-Pacific region counts as one of the most significant events in the world economy since the end of World War II. It was the first time that a group of nations that had once belonged to the category of "developing countries" managed to catch up with the industrial nations. Following Japan's lead, the so-called tiger states (South Korea, Taiwan, Hong Kong and Singapore) went through a phase of rapid growth, during which per capita incomes rose and the technological infrastructure was improved and expanded. But the other, poorer economies of the region also profited directly from development in Japan and the four newly industrialised economies (NIE). The interdependence of the whole region, both economic and technological, may therefore be presumed to constitute an important basis for understanding technological progress in the four tiger states. Each of these four states is incorporated into a dynamic regional innovation system.

The "Flying Geese Model", originally from Japan and also Japan-oriented, shall serve here as a conceptual framework (cf. Hilpert 1994; Ch. 1 in this volume), as it is the only model that accords due attention to the factors of interstate trade relations and interstate technological linkage. In other words, it attributes a major part of the economic success of the four NIE and countries such as Malaysia, Thailand and Indonesia to their relations with Japan. A fundamental drawback of this model is, however, that it ignores other important factors: it neglects, for example, the significance of national R&D systems. An R&D system consists on the one hand of institutions that carry out, fund and direct R&D, and is determined on the other hand to a great degree by functional conditions in the form of specification of content made by R&D programmes and projects. Thus, R&D depends upon three planes of activity, which influence each another: the political, economic and scientific. From this departure point we will go on to furnish a brief overview of the development of the R&D system in South Korea, one of the most successful nations of the region.

* The first draft of this chapter was written by B. Susec in 1997. This version was edited by W. Meske in 1999. Our thanks go to Seong-soo Kim (STePI/Seoul) for carefully reviewing the manuscript and making valuable corrections. We decided against updating the chapter to incorporate Korea's most recent changes because we felt that it is the initial stage of system development in particular that can provide less developed Vietnam with policy implications for building-up an effective R&D system.

South Korea, today a member of the OECD, belonged just a few decades ago to the group of developing countries. In the shortest possible time it went through a phase of rapid economic growth, one of "catching up" in industrial terms, or *late industrialisation*. What is characteristic of this phenomenon is that "all late industrializers have in common industrialization on the basis of learning" (Amsden 1989: V). Korea's industrialisation too was based essentially on the import of technology from foreign countries and its gradual adaptation, and not – as in traditional industrial nations – on progressive development of new products and production processes.

South Korea's economic development stands as an example of late industrialisation and exhibits all of its typical traits: a high degree of state intervention, the central role of large, heavily diversified and state-protected conglomerates of enterprises, concentration on technology imports, availability of a qualified and cheap workforce. A change of this strategy, for example a turn toward development of a country's own technologies and with it the establishment of an efficient R&D system, occurs only at a very late date, induced by changing external and internal factors. But first, the economic development of South Korea will be outlined in brief.

2. Economic Development

Between 1910 and 1945 the Korean peninsula was a Japanese colony with an economy geared to the needs of the Japanese empire: Korea had a mainly agrarian economy that supplied Japan with rice and a variety of raw materials, while serving in turn as a market for Japanese goods. The first industries were built up in the 30s, the major part of heavy industry and the chemicals industry being concentrated in the northern regions of the country, whereas light industries were predominantly located in the South. Enterprises were under 94% Japanese ownership, and 63.4% of land used agriculturally in the South belonged to the Japanese colonial masters (cp. Chung H. Lee 1995: 13). What that meant was that when colonial rule over Korea ended in 1945, no full-fledged entrepreneurial culture existed, and technical expertise along with people that had managerial skills were lacking. On top of that, there was the division of the country at the 38th parallel, which tore an interdependent economy asunder. The South received a little less than 50% of the territory, approximately three fifths of the population and a large share of agriculture, but had hardly any raw materials deposits and only a few industrial capacities. The end of the Korean War in 1953 saw a country, in which all remnants of an economic infrastructure had been completely destroyed, in which the gross

national product (GNP) of South Korea summed up to just USD 4,547 million and mean annual per capita income was only USD 224. The economic structure was predominantly agrarian, with agriculture, fishery and forestry having a share of 47% of GNP, while industry accounted for only 9% of total GNP.

The South Korean economy, despite the poor conditions it faced at the outset, soon gained ground through support from abroad, which in the period between 1953 and 1960 constituted approximately 90% of capital formation. In this period South Korea received around 120 million USD from the *United Nations Korea Reconstruction Agency* and further 2,000 million USD from other financial sources (cf. Chung H. Lee 1995: 19). The whole economic structure was inwardly directed, with high tariffs as well as quantitative limits being imposed on imports. Monetary policy was characterised by a complex system of multiple exchange rates and overvaluation of the domestic currency. Protected by these measures, mining and production industries noted annual growth of 15% between 1953 and 1957. In the sectors of the construction and textiles industries and production of consumer goods, growth rates were even higher. But this dynamic phase soon ended, once the domestic market had become exhausted at the end of the 1950s. As a consequence, the government saw itself compelled to carry out stabilisation programmes, which, though they were able to cut the inflation rate from 40% to zero, also led to a drop in private investment and the growth rate.

This stagnation was only of short duration. As Kuznets notes, even at this early stage three important cornerstones were laid for the rapid economic development that was to follow: first, many enterprises were established in this period – including the foundation or renewal of *chaebols*, which will be dealt with later – second, the government began to concentrate more and more on a comprehensive education policy, and third, the South Korean army developed into a training centre for disciplined and qualified workers (cf. Kuznets 1977: 43-45). Moreover, there were the land reforms of 1945 and 1952, with the changes they brought about, notably with respect to ownership of property: Land reform in Korea helped bring about equality of opportunities and the possibility of economic and social upward mobility for the masses of Koreans, thus contributing to the *shared growth* in the subsequent period. [...] A perhaps unexpected effect of land reform in Korea was the promotion of the growth of import-substitution industries during the 1950s. If it had remained a powerful interest group, the landlord class could have opposed the shift from primary commodity exports to import substitution in consumer goods industries (cf. Chung H. Lee 1995: 21).

The industrialisation of South Korea from that time on may be roughly divided into three periods. The *first phase*, from 1961 to 1972, was characterised by fundamental political reforms and institutional development processes intended to initiate export-oriented industrialisation, while an import substitution strategy was pursued simultaneously. In the *second phase*, which began in 1973 and continued until 1980, the strategy of the *Heavy and Chemical Industry Drive* (HCI) (cf. Somi Seong 1997: 52) was pursued, with the following instruments: subsidised credits, preferential treatment of certain industrial branches by way of a low-taxation-policy, selective protection, curbs of power in connection with direct control over industrial decision-making processes on the part of government. In the *third phase*, starting in 1980, the South Korean government continued the policy of export-orientation while setting further priorities in the areas of price stability, market liberalisation and processes of industrial restructuring.

Phase I, 1961-1972

An important institutional cornerstone for the desired economic development of the country was laid at the beginning of this phase, when the *Economic Planning Board* (EPB) was founded in July 1961. The EPB served as a central agency for planning and control both in matters of economic policy and its implementation. In order to overcome the stagnation of the South Korean economy at the beginning of the 1960s – a time at which the growth rate had fallen below the rate of population growth and at which development aid provided by the USA was being reduced in stages – it was intended that a sturdy economic infrastructure be built and the export industry promoted. At the same time, the government maintained strong protection of domestic industry.

In 1962 the first *Five Year Economic Development Plan* (FYP) was passed, focused mainly on fast industrialisation, development of technology and the training of a qualified workforce, along with the expansion of the export industry. The first two FYPs (1962-66 and 1967-71) encompassed the development of the industrial sectors of cement, petroleum refinement and fertilisers for the sake of import substitution; the expansion of export-oriented industries such as the textiles and wood industries; and the improvement of the industrial and R&D infrastructure. For lack of technological capacities, the South Korean economy had been required to import technologies in the form of turn-key firms and industrial installations, along with technical know-how and experts from abroad. Technology policy in this phase was thus limited mainly to implementation and adaptation of technologies from foreign countries.

That called for very little more than basic technical qualification, and the development of indigenous technological research was not required.

The growth rates of the South Korean economy (in terms of GDP) increased in this phase from 2.2% in 1962 to 8.8% in 1971.

Phase II, 1973-1980

Supported by six laws, which were passed in the course of the second FYP and were aimed at promoting specific industrial branches (e.g. mechanical engineering in 1967, shipbuilding in 1967, electronics in 1969, steel in 1970 and the petrochemical industry in 1970), the third FYP contained precise production quotas for goods that were scheduled to be produced by 1980. The *HCI Promotion Council*, expressly created to implement HCI policy, determined the stages that so-called priority industrial branches were to pass through in the course of ten years (cf. Kihwan Kim and Leipziger 1993: 20):

minimum scale - active support and planning, as well as protection, on the part of government

optimum scale - consolidation, while state support continues

international scale - industries shall have become self-reliant and independent of state support

international first-class scale - achievement of international competitiveness

South Korean planners were for the most part correct in their calculations – an amazing thing, considering that at the beginning of the 1970s hardly any firms had the technological and financial resources they would have needed to enter heavy industry or the chemicals industry. Yet HCI exports reached the international level in the mid-1980s, and by the late 1980s these industrial branches reached the point of being competitive internationally. In order to create a market for the new industries, the South Korean government reintroduced import limitations on certain products and guaranteed tax advantages to enterprises that purchased machinery produced in Korea. Furthermore, in 1975 the *Tax Exemption and Reduction Law* was passed, which provided incentives to investors in the sectors of heavy industry and the chemicals industry.

Thus, fiscal policies were among the most important instruments applied by the South Korean government to implement the HCI Plan. The government was directly involved in the mobilisation and distribution of financial resources for the industries in question. It did that both through the control it exercised over a major part of the financial sector and by giving preferential treatment to particular companies when granting credit (cf. section dealing with the *chaebols*).

The government began with large-scale investments in the construction of an adequate infrastructure for these particular branches of industry: Large industrial parks were created, the existing education system was adapted to the changing needs of industry for qualified specialists and engineers, and the first research institutions were founded for the purpose of developing necessary technologies (cf. section on the R&D system).

Along with rising growth rates, one effect of this policy was excess capacities in both heavy industry and the chemicals industry at the end of the 1970s. In April 1979 the government passed the *Comprehensive Stabilization Programme*, which contained a comprehensive package of fiscal and monetary measures. This programme, however, was not fated to succeed, as it was undermined by a series of unexpected domestic and foreign developments. Just as happened to other NIE, the second oil shock shook the Korean economy, which was dependent upon foreign energy resources. It was further affected by the subsequent world-wide recession and the rising interest rates that were associated with it (cf. Somi Seong 1997: 54). Even so, it is to be noted that "it was this excess capacity in human as well as nonhuman capital that laid a foundation for the export boom in the heavy and chemical industries that began in 1983" (cf. Chung H. Lee 1995: 32).

Phase III, 1980 to date

The negative developments of the late 1970s made new restructuring processes urgently necessary. After the second oil shock, many industrial branches, among them shipbuilding, suffered under a drop in orders, existing overcapacities and financial bottlenecks. The South Korean government attacked these problems by initiating comprehensive programmes of rationalisation and finally by passing the *Industrial Development Law* in 1986. This law superseded the seven individual industrial promotion laws and defined the role of government chiefly as that of a trouble-shooter:

In accordance with this role, the government is to intervene for industrial rationalisation in areas where market failure occurs. In industrial sectors whose international competitiveness is vital to the economy, but which are not expected to be competitive if left to market forces, the government is to encourage specialisation through indirect incentives designed to promote technological advancement (cf. Somi Seong 1997: 56).

Starting that year (1986), the South Korean economy experienced a new upturn, with the growth rate of the GDP climbing up to 12.5%, due to an increase in exports.

A fundamental turnabout was effected in the area of technology policy, which was now declared an "urgent national development goal"; the development of high-tech industry was to be propelled by means of a comprehensive technology policy for the 1980s (cf. Arnold, W. 1988: 442-443). The government had recognised that to maintain the international competitiveness of South Korean industry, indigenous technological capacities would have to be fortified, and that it would not be possible to do so without a well-developed R&D system.

At the beginning of the 1990s a further restructuring of the South Korean economy is discernible, accompanied by a tendency to make investment in new technologies a priority. In the productive sector the HCI, once significant investments had been made in R&D, entered a new phase of expansion, as opposed to the branches of so-called light industries, which were declining.

3. The Construction of a Network of State Research Institutes

In highly developed Western nations (having a long tradition of science and technology), industry itself was given part of the direct responsibility for developing technologies right from the outset. The government, on the other hand, was responsible for promoting basic research or large-scale projects, which industry could not undertake of its own accord – as, for example, in the areas of nuclear energy, environment, public health, etc.

In Korea, a country that stood just at the beginning of its economic development, in which no R&D structures existed and in which industry still lacked the capacities to develop technologies of its own, the government assumed a central role in all areas. In doing so, the Korean government was acting on a strategy that had three components: (a) the creation of organisational prerequisites (institutions), (b) government laws aimed at promoting R&D, and (c) the expansion of the education and vocational training system.

In 1961 the Korean government began to reorganise its structures through the creation of the *Economic Planning Boards* (EPB). The goal was effective economic planning and its practical execution. Pursuant to this policy, the passage of the Technology Promotion Law and the foundation of the Ministry of Science and Technology (MOST) followed in 1967. The latter was assigned responsibility for the co-ordination of science and technology policy, for which several ministries had been responsible until that time.

The newly created MOST – the first thing of its kind in a "developing country" – now held responsibility for all matters of science policy. A qualification must be made, insofar as its policy stood in the 1960s under the aegis of the influential EPB, with the Ministry of Trade and Industry also playing a decisive role. Central components of MOST policy were R&D policy, creation of organisations and institutes for R&D, promotion of the education of scientists and engineers, and international co-operation. Another area, in which MOST became involved, was the creation of a climate favourable to the development of science and technology.

The co-ordination of policies concerning science and research by a single ministry, to which accordingly a kind of "across-the-board impact on the entire cabinet" (cf. Choung-Ouk Lee 1988: 42) is inherent, proved difficult in practice, especially inasmuch as the development of R&D was to become an integral part of economic development policy. For this reason, important plans and decisions were brought before an intergovernmental commission, the *National Council for Science and Technology* (NCST), which was established in 1973 and was chaired by the prime minister. The NCST was superseded in 1982 by the *National Promotion Conference* and the *Technology Promotion Council*, which meet semi-annually, with the participation of 200 delegates. Among the delegates are all cabinet members, representatives of industry, scientists and engineers from universities and research institutes, etc. The MOST operates more or less as the executive secretariat of the two institutions.

In order to expedite the building of an R&D infrastructure, the Korean government pursued several strategies, which followed one another in sequence. As mentioned, the establishment of state R&D institutes was undertaken at the start. These were meant to carry on applications research, but also to train highly qualified specialists. This development was inaugurated by the foundation of the *Korea Institute of Science and Technology* (KIST), which in a certain way came to be the centre of a whole network of research institutes. Following that came the establishment of a *National R&D Programme*, which was intended to improve co-operation between industry and SRI, and to embed the previously created network of R&D institutes into the economic structures of the country. Finally there was a third component, the promotion of *R&D activities in the private sector* (cf. Overview. 9.1).

Overview 9.1: R&D Activity in Korea, 1980-93

	1980	1985	1990	1993
1. R&D expenditure (thousands of millions of won)	282.5	1237.1	3349.9	7894.7
. Government	180.0	306.8	651.0	1260.2
. Private sector	102.5	930.3	2698.9	6634.5
. Government vs. private sector	64:36	25:75	19:81	16:84
2. GERD/GDP (%)	0.77	1.58	1.95	2.61
3. Productive industry				
. R&D expenditure (in thousands of millions of won)	75.97	688.59	2134.70	4854.1
. in % of turnover	0.5	1.51	1.96	2.55
4. Number of scientists (total) of whom, within:	18,434	41,473	70,530	117,446
. State research institutes (SRI)	4598	7542	10,434	15,465
. Universities	8695	14,935	21,332	42,700
. Private sector	5141	18,996	39,737	59,281
5. Number of company-owned R&D centres	54	183	996	1980

Source: Ministry of Science and Technology, Annual Survey Report on R&D Activities, reports of several years

Korea Institute of Science and Technology (KIST)

The rapid economic development of industry increased the demand for R&D. In order to meet that demand, the Korean government decided to set up a network of state-supported research institutes (SRI). The *Korea Institute of Science and Technology (KIST)* lay at its core, having been founded in 1966 in co-operation with the US National Academy of Sciences as the first multidisciplinary state R&D institute. It was meant to pursue the following ends: the adoption of foreign technologies; giving support to the marketing of foreign technologies; promotion of R&D in the industrial sector; adaptation and modification of advanced technologies for Korean use. Substantial initial funding was granted by USAID and the World Bank. Through this connection, the KIST was the first state research institute (SRI) to successfully "win back" scientists trained in the US, and this success soon developed into a fundamental strategy of the Institute. Although the KIST and other SRI received the lion's share of government R&D funding in the 1960s and 70s, the hoped-for success was elusive for a time, because almost no links to industry existed. There was almost no demand from industry for the services provided by the SRI. The discrepancy resulted mainly from the fact that a major proportion of scientists employed at the SRI had come from the academic sector or from other R&D institutes, which meant that they lacked appropriate practical experience and the know-how that is important for production. Therefore they could not satisfy the demand for the development of samples and prototypes that were needed during this phase. Korean research institutes were neither

able to compete with foreign suppliers of technology, nor were they in a position to assist industrial enterprises in the solution of problems they initially faced (cf. World Bank 1982).

In 1980 the KIST was amalgamated with the *Korea Advanced Institute of Science* (KAIS), a college of engineering sciences. The institute thus created was called KAIST. Nine years later the KAIST was once again split up into the KIST and the KAIST (graduate school). From that time on the KIST was again responsible exclusively for R&D, and it has the following tasks: development of innovative new core technologies; conduction of large-scale projects; carrying out basic and applied research; providing R&D services for industry and other research institutions.

The fundamental aim of the KIST is to promote the competitiveness of the Korean export industry. To this end, Korean scientists and engineers who work in Europe, Japan or the US are still being wooed back to Korea. Nevertheless, the mission of the KIST is still defined in very broad terms – a matter that may cause the KIST to face problems in the future, as it is positioned in an wide range of activity between basic research and specialised services for industry. Added to that is the competition it meets from the private R&D centres of the *chaebols*. These seek to recruit highly qualified scientists away from their present activities by making them lucrative proposals, and they are more dynamic generally. The SRI are subject to bureaucratic control by the government, something that often stifles the vibrant life of creative individuals by imposing rigid regulations that create serious motivational problems. In contrast, private R&D is under market control, dynamically responding to market and technological changes for survival (cf. Kim Linsu 1997). The continuous expansion of the Korean economy and the increasing sophistication and diversification of industry that accompanied it led to a growing demand for new and higher level technologies in many areas. KIST was unable to meet this demand alone. Therefore, a great number of specialised research institutes were created in the most important fields: shipbuilding, marine technologies, electronics, telecommunications, mechanical engineering, metals, chemicals, standardisation and energy.

Although a multitude of new specialised research institutes originated within the KIST, and in addition a number of independent research institutions were founded there, the KIST continues to be an integral component of Korea's research and technology policy. It is the leading SRI of Korea and is likely to expand at the same rate that the Korean government hikes R&D funding. The Korean government regards the KIST as one of the most important policy instruments for achieving the goal of catching up with the leading industrial nations by

the year 2000. As the technological base in Korean industry becomes increasingly consolidated, the KIST is applying itself more and more to experimental basic research, even though applied R&D continues to be the major emphasis.

Organisationally, the KIST is divided into ten departments; four affiliated institutes belong to it and have been placed under the direct supervision of the KIST's president. The latter are the *Korea Research Institute of Bio-Science and Bio-Technology* (KRIBB), the *Systems Engineering Research Institute* (SERI), the *Research and Development Information Centre* (KORDIC) and the *Science and Technology Policy Institute* (STEPI). The ten departments of the KIST are supervised by the vice-president and are subdivided as follows: research planning and co-ordination; metals; ceramics; polymer research and technology; applied science; electronics and information technology; mechanical engineering and control systems; chemical technology; the biomedical research centre; administration.

Superimposed upon this structure is a special matrix: Researchers from the various departments form work groups with specific goals, in order to pool their expertise and to conduct in this way large-scale national R&D projects.

In 1993 KIST and the institutes affiliated with it had 1,497 employees, 793 of them at the KIST alone. It therefore certainly counts as one of the large research institutes in the East and Southeast Asia region, though it is relatively small in comparison to its Taiwanese counterpart ITRI (which has over 5,000 employees). More than 50% of its employees are scientists, but only 4% are engineers. The KIST, an institute that performs research commissioned from outside, is oriented largely toward satisfying "customer" demand and hardly sets priorities of its own. It does research jobs for companies and for the government. In these cases the patent rights, research results and other outputs accrue to the customer, in other words, to the party financing the particular research project. Moreover, advisory services in technical matters and technical problems are offered, just as studies, laboratory investigations and chemical analyses are performed. Among these services are international S&T monitoring and S&T analyses in co-operation with STEPI.

Besides doing R&D, the KIST conducts training programmes for engineers.

Until the mid-1970s, over 80% of funding stemmed from research orders placed by industry. Since 1982, in other words, ever since the *National R&D Programme* came into being, national R&D projects have brought in around 65% of income.

Before the background of Korean universities' considerable weakness in the field of R&D, SRI such as KIST and KAIST will continue to be of prime importance for Korea's R&D policy.

R&D at Universities

Korea has over a hundred (state and private) universities offering graduate studies. In Korea, universities are an abundant brain pool, in that an overwhelming share of high-calibre scientists are in universities. Yet R&D activities are sluggish in Korean universities, which do not have sufficient fund or research facilities. Professors also have an excessive teaching burden, another source of low R&D (cf. OECD 1996: 57).

That is also reflected in R&D expenditures: In 1993 only 7.2% of research funding went to university research programmes, compared to 21.3% for SRI and 71.5% that go to research institutions in industry. Even the universities' share of state R&D expenditure was low, only 8.2%. This distribution comes as a surprise, considering that in that same year 73.6% of all scientists that had completed their doctorates were working at universities, as opposed to only 17.7% at SRI and 8.7% in industry (cf. Tab. 9.1).

Table 9.1: Scientists and R&D Expenditure by Sector, 1993

	Total	of which		
		Universities	SRI	Industry
Scientists	98,764	28,618 (29%)	16,068 (16.3%)	54,078 (54.7%)
of whom, with a doctorate	26,813	19,750 (73.6%)	4737 (17.7%)	2326 (8.7%)
R&D expenditure (millions of USD) (100 millions of won)	7615 (ca 61,115)	7.2%	21.3%	71.5%
State-funded R&D expenditure (100 millions of won)	10,266	824 (8.2%)	8495 (82.6%)	947 (9.2%)
R&D expenditure per scientist (won)	62,300	15,539	81,564	81,322

Source: MOST, 1994, Report on the Survey of R&D in Science and Technology

At the beginning of the 1970s Korea had a massive shortage of researchers with doctorates and university degrees, as students of natural and engineering sciences had no choice but to go to Western foreign countries in order to engage in graduate studies. To prevent this emigration, the government in 1971 founded the *Korea Advanced Institute of Science* (KAIS), a university of advanced science and studies on engineering. (As has been mentioned, it was later amalgamated with the KIST and renamed *Korea Advanced Institute of Science and Technology* (KAIST), although the two were later separated once again.) This institution of higher education differs from other universities in that the departments and students are

financed solely through government funds and in that it is directly subordinate to the MOST (other universities and colleges being subordinate to the Ministry of Education). Besides training highly qualified scientists and engineers, KAIST also carries out research projects of relevance to industry, in order to provide students with training of a practical orientation. KAIST "produced" several hundred graduates and scientists with doctorates annually. In 1993 it employed 691 scientists.

4. The National R&D Programmes

This section will summarise the evolution of the *National Korean R&D Programme* in the course of the past decade. (The following list of programmes is in no way complete, though the programmes do represent a preponderance of Korean national R&D.)

The *National R&D Programme* was initiated by the MOST in 1982. It was precipitated by the following three developments: First, during the industrialisation of the 1960s and 70s, R&D activities were keyed primarily to provide support in the adaptation and imitation of foreign technologies. They include, among other things, substantial investments in the heavy and chemical industries, something that led to a gradual shift away from primary and toward secondary industry. This shift called for new structures, which were needed to be able to meet the demand for technological innovation that it had created in the branches of industry cited previously. Second, the Korean government as well as enterprises were having to face growing problems relating to the import of new technologies, since owing to sharper competition on international markets, leading industrial nations were less and less prepared to deliver technical know-how to potential competitors. Third, the private sector in Korea was still equipped with low in-house R&D capacities and was therefore unable to develop technological innovations. The government recognised the necessity of initiating collaborative R&D between SRI and industry, thereby inducing industry to invest in R&D. One reason is that there was little indication that during the 1970s Korea's "discovery push" strategy, supported by the state's organisational measures and institution building, was translated effectively into viable applied technological advances for Korean industry. Until recently most in-house domestic industry R&D was rather inconsequential, as firms tended to rely on licensing or purchasing foreign technology. Moreover, Korea's state-affiliated S&T institutions were not yet effective providers of the manufacturing know-how frequently needed by industries with start-up problems during initial stages of production (cf. Arnold 1988: 442). A characteristic feature of the *National R&D Programme* is the emphasis it places

on large-scale complex projects dealing with trend-setting technologies of the future. The intention was to create a comprehensive network as a basis for technological innovation – by setting up projects in such a way that industry too was a participant, alongside SRI and universities. Project content coincided with what were referred to as strategic branches of industry and encompassed information technologies, biotechnology, new materials, energy, and also medical and environmental technologies.

Hobday (1996: 110) distinguishes five project types within the National Research Programme:

- *National projects*: These are initiated by the government and financed 100% by the state.
- *State-and-industry projects*: The government bears 70% of expenses of SMEs, 50% of the KIST's expenses and 30% of the expenses of large companies.
- *International projects*: These are carried out in co-operation with R&D institutes in foreign countries; funding varies.
- *Subject-oriented basic research projects*: These serve in particular to promote basic research at universities, with the government bearing 100% of expenses.
- *Evaluation projects*: These include feasibility studies, evaluation of individual projects and the assessment of results produced by the projects mentioned previously.

In 1987 the Ministry of Trade and Industry (MTI) passed the *Industrial Generic Technology Development Law*, in this way rounding out the National R&D Programme of MOST. While the MOST programme focused on long-term basic research and research into new technologies, the MTI programme concentrated primarily on applied research and on technologies aimed at improving competitiveness and productivity in manufacturing. But as the term "generic" would tend to imply, general and basic technological research were other points that the programme emphasised.

In 1988 the Ministry of Energy and Resources (MOER) started up the *Alternative Energy Development Programme*. The MOER implemented R&D projects in the field of alternative energy sources development, new energy technologies and improved energy utilisation. These projects were aimed at reducing Korea's dependence on energy from abroad, while at the same time developing clean forms of energy.

In the 1990s a partial reorientation of national R&D programmes took place when the *Highly Advanced Nation (HAN) Project* was implemented.

The HAN Project was prepared systematically, with government commissions being set up to manage it, and was finally put into effect in 1992. The aim of this project is to fortify industrial and technological capacities in the so-called strategic sectors, in order to catch up

with the highly industrialised states by the beginning of the new millennium. Designed as a comprehensive programme involving several ministries, it includes a total of 11 technology departments, which work under the supervision of the appropriate ministries. The HAN Project may be subdivided into two major sectors (cf. Overview 9.2): The first of these is concerned with the development of specific products and product technologies, especially in the area of high-tech, in which Korea has the potential to compete internationally with leading industrial nations. The second sector is involved with the development of fundamentally new technologies, especially of key technologies that are meant to improve the standard of living and to further the development of the economy and society. Four of the eleven projects are overseen by MOST directly, while the others are subordinate to other ministries.

Overview 9.2: HAN Project (South Korea)

1. Development of Product Technologies

Project	Aim
Development of new pharmaceuticals and chemicals for agriculture	Development of new pharmaceuticals on the basis of traditional East Asian medicine by 1996 Discovery and development of two or three new pharmaceuticals and chemicals for agriculture
Development of B-ISDN	Development of ATM (asynchronous transfer mode) by 1996 Development of B-ISDN by 2001
Development of HDTV	Setting up of HDTV monitor technology by 1993 Development of transmission and transmitter technologies by 1994 Development of flat picture screens by 1997
Development of "next-generation" motor vehicle technology	Development of technologies relevant to next-generation motor vehicles and components (e.g. environment-friendly vehicles)

2. Development of Basic Technologies

Projects	Aims
Development of ultra-large-scale integrated circuits	Development and production of a 256 MB DRAM by 1996 Development of a 1 GB DRAM by 2000
Development of sophisticated new materials for the information, electronics and energy industries	Development of sophisticated new materials and the synthesis of raw materials of the greatest purity for the information industry
Development of future-oriented production systems	Development of computer-integrated manufacturing (CIM) by 1996 Research on and development of an intelligent manufacturing system (IMS) by 2000
Development of new functional biomaterials	Development of sophisticated and long-lasting biological raw materials that will be important in the 21st century
Development of new environmental technologies	Optimised technology for the solution of national and global environmental problems
Development of new energy technologies	Development of high-efficiency and clean energy sources
Research on and development of a "next-generation" nuclear reactor	Design and preliminary study for a new reactor concept; securing access to non-fossil energy sources

Source: MOST, quoted in OECD 1996

In 1992 the former Ministry of Communications, now renamed Ministry of Information and Communication, also initiated an R&D programme. This *Telecommunication Technology Development Programme* was aimed at improving the competitiveness of the information and telecommunications industries and to build an infrastructure suited to an information society. This programme is not funded out of government sources earmarked for science and research, but out of an *Information and Communication Fund* created for that purpose.

5. Promotion of Private Sector R&D

Although the Korean economy was to a great extent dependent on the import of technologies from abroad, the attempts made at adaptation, assimilation and innovation through learning processes were extraordinarily successful. Korean firms have acquired technological capacities by developing and applying the more sophisticated technologies. The rapid acquisition of technological capacities may be attributed to these factors: well-educated specialists, the spirit of enterprise and incentives provided by government. Autonomous and creative in-house R&D was especially indispensable in the process of establishing technological capacities in the private sector, and industrialisation brought about a systematic interactive relationship between imported technology and national R&D efforts.

Until the beginning of the 1980s, however, the R&D activities of the private sector were on a low scale. The major part of R&D expenditure derived from the government, and R&D expenditure rose at an average real annual rate of 15%. After 1982, R&D expenditure on the part of private industry also increased, and the annual R&D growth rate climbed to around 25%, and a change in the proportions of technology imports and in-house R&D took place. It is reasonable to attribute this change primarily to the increase in private industry investments in R&D. Although technology imports continued to rise steadily throughout the 80s, from the beginning of the 80s on, they were increasingly supplemented by indigenous R&D work. The latter may be attributed to three factors: (1) When the Korean economy began to have more technology-intensive structures, it was no longer able to meet its needs to a sufficient degree from foreign sources. At the same time, foreign companies became more and more reticent to supply technology of crucial importance. The import of conventional technologies lost some of its significance. (2) In the mid-80s Korea lost its relative advantage of having low wages paired with high qualification of the work force. Korean firms recognised that this could be offset only by developing technological capacities of their own. (3) Government policy staked more and more on supporting company-based R&D in the private sector.

The Policy of Incentives

When the structure of industry became more capital-intensive and technology-intensive, and competition in export markets became stiffer, Korean firms recognised the significance that technological capabilities had for the competitiveness of their products. The rise in private R&D activities also rested on a change in the position that technology had within the management strategies of these enterprises. Enterprises hiked R&D investments dramatically, set up company R&D departments and founded private research institutes.

The private sector accounted for 32% of the nation's total R&D expenditure in 1971 but its share increased to 75% in 1985 and to 83% by 1993 (cf. Table 5.2.1). This is one of the highest proportions of private R&D spending among advanced and newly industrialising countries (cf. Somi Seong 1997: 57).

The increase in absolute R&D expenditure on the part of the industrial sector was paralleled by the increase of its intensity, though the latter varies from one industrial branch to another: in 1992 expenditure for R&D was highest in the sector of the electronics industry and lowest in the metal industry and garments industry. Moreover, a gap is visible within the private sector between major firms and SME. The performance of large firms that invested heavily in R&D has improved substantially in recent years while, even in the same line of business, small and medium-sized enterprises have managed only moderate improvement. This dichotomy remains one of the major concerns with the Korean economy today. Approximately 83% of total R&D expenditure in 1993 derived from big companies. The five largest companies alone accounted for 31% of total expenditure, and the Top-20 firms together for more than half of it.

The Role of the Chaebols

In contrast to Taiwan, which limited the construction of major enterprises, the Korean government founded large companies – *chaebols* – as an instrument for developing so-called *economies of scale* in conventional technologies, and in order to promote strategic industrial branches and with them the export economy. The government played a key role both in mustering the capital resources and later in the diversification of these *chaebols*. Unlike Japan, which did not privatise Japanese companies confiscated after World War II, the government in Seoul sold both former Japanese colonial assets and (Japanese) state enterprises to specially selected local entrepreneurs, who received favourable long-term opportunities to finance them in the period of inflation. Since all banks were at that time in the hands of the state, the

government gave essential support to the formation of *chaebols* by allocating scarce foreign currency and offering preferential financing schemes at extremely favourable interest rates. Furthermore, large-scale import substitution projects were awarded to the *chaebols*, while the necessary technology import in the form of turn-key factories and other plants was for its part funded through cheap government credits. Finally, foreign debts incurred as a consequence of currency fluctuation were counterbalanced by the extremely low interest rates on credits.

However, the Korean government later continued to intervene heavily in the affairs of the *chaebols*, punishing bad performance or rewarding good performance. For example, new licenses were granted to successful *chaebols*, making their further diversification possible. The *chaebols* that invested in high-risk sectors were rewarded with licenses in lucrative sectors. In these ways a protective buffer was created in support of so-called *infant industries*. In contrast, the government refused any and all support to badly managed or corrupt big enterprises in otherwise "healthy" branches of industry, and even offered them to be taken over by other *chaebols* (cf. Amsden 1989: 129-131; 150-151). In its function as the supervisory authority over all banks, the government was in a powerful position, as it was also able to block credit to less successful *chaebols*. This policy had the result that "only three of the largest 10 *chaebols* of 1965 – Samsung, Lucky-Goldstar, and Ssangyong – remained on the same list 10 years later. Similarly, seven of the largest 10 in 1975 remained on the same list in 1985." (Cf. Kim Linsu 1993: 363).

In the area of R&D too, the *chaebols* play an important role today. Encouraged by government incentives, there has been a grand proliferation of industrial R&D institutes in the last ten years. The Samsung group, which counts as a leading enterprise world-wide, presently maintains 26 research centres, which are active in a great variety of sectors, from genetic technology to foodstuffs and pharmaceuticals, all the way to high-tech audio and video components, semiconductors and computers. Some of these are the *ULSI* (Ultra-large-scale-integration) *R&D Center* belonging to *Samsung Electronics Co. Ltd.* and the *Samsung Advanced Institute of Technology*. The *chaebol* Lucky Goldstar also maintains 18 research institutes in the sectors of electronics, new materials, telecommunications systems, computers, high-precision chemistry, semiconductors and superconductors. Industrial research institutes were also established by the following *chaebols*: Daewoo with 17 research centres specialising in automation technologies, new materials and aircraft components; Hyundai with 14 research institutes, which are working to develop new vehicles and new automobile engines; Sunkyung with five research institutes; Kolon with three research centres; Ssangyong

with four research centres; Korea Explosives with four research centres; and Hanjin with one research centre (cf. Crow and Nath 1992: 122). In 1989 the *chaebols* Samsung, Daewoo and Lucky Goldstar established a research consortium for the purpose of developing and marketing High Definition Television (HDTV). This consortium is funded in part by the Korean government (cf. The Wall Street Journal 1989). Here too, one sees the unabated prominent role that the Korean government has in promoting R&D, including private-sector R&D.

Private Research Institutes

In 1981 the government introduced a registration system for private research institutes (PRI). 53 PRI registered with the MOST that same year. Simultaneously, the government drew up a catalogue of incentives for the foundation of PRI, such as tax breaks for PRI buildings and grounds, exemption from military service for scientists, tax exemption for equipment, etc. Moreover, PRI were encouraged to participate actively in the national R&D programme. In 1985 the government cut the minimum staff size for PRI from ten to five, so as to encourage SME to establish PRI as well.

While in the beginning most PRI were founded by large companies, the SME have gone a long way toward catching up in recent years and now possess two thirds of all PRI. Most SME-PRI were founded in the mid-1980s, which may be apprehended as a direct result of the turnabout in government policy, as opposed to the foundation of research institutes by large companies, which is more evenly distributed over time. At the end of 1994 there were around 2000 PRI.

With respect to the industrial sector as a whole, the distribution of PRI is similar to that of R&D expenditures – here too, the areas of electronics, mechanical engineering, steel and chemicals make up the major part. As to the number of employees and the size of investments, the structures of the PRI vary greatly. Over 50% of PRI have between five and nine employees, and more than one third of them invest less than a half million won in R&D activities, and more than half employ fewer than ten scientists in their R&D departments. These facts lend credence to the view that although the number of PRI is constantly rising, only very few PRI are adequately equipped to carry out "full-scale" R&D. Besides that, it must be taken into consideration that over one third of PRI belong to mother firms, whose turnover is below 10 thousand million won. Here too, large firms prove to be the ones that bear the largest share of R&D expenditure.

References

- Amsden, A. H., 1989: *Asia's Next Giant. South Korea and Late Industrialization*. New York & Oxford, Oxford University Press.
- Arnold, Walter, 1988: "Science and Technology Development in Taiwan and South Korea", *Asian Survey* 28 (4): 437-450.
- Choung-Ouk Lee, 1988: "The Role of Government and R&D Infrastructure for Technology Development", *Technological Forecasting and Social Change* 33: 33-54.
- Chung H. Lee, 1995: *The Economic Transformation of South Korea – Lessons for the Transition Economies*, Paris: OECD.
- Crow, Michael M., and Shrilata A. Nath, 1992: "Technology strategy development in Korean industry: an assessment of market and government influences", *Technovation*, Vol. 12, Nr. 2, p. 122.
- Hilpert, Hans Günther, 1994: "Yen-Block in Asien? Die wirtschaftliche Verflechtung Japans mit der asiatisch-pazifischen Region", *Geographische Rundschau* 46 (11): 616-621.
- Hobday, Michael, 1996: "South-Korea – facing the challenge of restructuring", in: Howard Rush et. al., *Technology Institutes: Strategies for Best Practice*, London and Boston: International Thomson Business Press, p. 110.
- Kim, K. and D. M. Leipziger, 1993: *Korea - A Case of Government-Led Development*, Washington, D.C., The World Bank.
- Kim, Linsu, 1993: *National System of Industrial Innovation: Dynamics of Capability Building in Korea*. R. R. Nelson (ed.). *National Innovation Systems*. New York, Oxford University Press: 357-383.
- Kim, Linsu, 1997: "Korea's National Innovation System in Transition", lecture presented at the International Symposium on Innovation and Competitiveness in Newly Industrializing Economies in Seoul, Korea, May 26-27, 1997.
- Kuznets, Paul W., 1977: *Economic Growth and Structure in the Republic of Korea*, New Haven, Yale University Press, p. 43-45.
- MOST, 1994: *Report on the Survey of R&D in Science and Technology*, Seoul.
- OECD, 1996: *Reviews of National Science and Technology Policy - Republic of Korea*. Paris, OECD.
- Seong, Somi, 1997: "Industrial Policy in Korea", in: Seiichi Masuyama et. al. (eds.), *Industrial Policies in East Asia*, Singapore and Tokyo: ISEAS & NRI 1997, p. 53-66.
- The Wall Street Journal, 1989: "South Korea details plans for high-definition TV". June 27.
- World Bank, 1982: "Korea Technology Development Project: Staff Appraisal Report" Washington, D.C.: Industrial Projects Department, the World Bank 3707-KO, February 25, 1982.

Chapter 10: Summary and Conclusions

Werner Meske / Dang Duy Thinh / Jochen Gläser

1. The Restructuring of Vietnamese S&T as a Contribution to Doi Moi Policy

Science and technology have played an important role in Vietnam ever since the country gained independence. Vietnam was strongly influenced by socialist ideas and common practice in the former socialist states. Consequently, science was primarily perceived as a 'productive force' and promoted accordingly, and the 'linear model of innovation', which had generally predominated internationally since the middle of the 20th century, thus also constituted the basis of Vietnamese S&T policy. R&D was perceived as the point of departure for innovation and the Soviet-style or Chinese-style industrialisation that was striven for was seen as the basis of societal development. During the 1960s and 1970s the establishment and consolidation of R&D facilities was prioritised as a strategic investment in the future, i.e. they were built up more rapidly than was the economy as a whole (cf. Ch. 2).

However, well into the 1980s, normal development, industrialisation in particular, was hindered by wars and their aftermath. Economic policy subsequent to the unification of Vietnam in 1975 did not lead to the successes that were called for. Consequently, as early as the late 1980s a transition to a "socialist market economy" took place in line with the developments occurring in China - prior to the upheavals in Eastern Europe. In Vietnam – similarly to China - this transition is characterised on the one hand by the increasing liberalisation of agriculture, while on the other hand it has not been characterised by the rapid privatisation of state-owned enterprises. At the same time there is no clarity as to the long-term character of this type of free market, nor is there, accordingly, a strategy as to how it can be achieved. Wolff (1997) therefore describes the situation in Vietnam as an "uncompleted transformation". But the specific situation of Vietnam should be better characterised by its double context of being both a *developing country* (with high growth rates in GDP, industrial output and employment) and a *country in systemic transformation*. Thereby, the transformation context is special too. In contrast to the European countries (cf. Ch. 8), Vietnamese transformation did not start with a fundamental system change in either politics or the economy. As a consequence, most actors remained in their roles. That is why the dissolution and fragmentation of the former system in general and also in S&T could be

avoided in the first phase of transformation. However, retaining the system also hindered radical change and thus eliminated chances for a completely fresh start in many areas.

One of these lost chances concerns the necessary differentiation between economic policy and science policy. Here, a path was followed that characterised all former socialist countries: Research was linked more and more closely to the economy and in particular to industry by state regulation. In Vietnam the following main phases can be distinguished (cf. Bach Tan Sinh, 1996):

- In a *first phase (1958 to 1975)*, a so-called "planning of the application of technical results" was implemented, creating an administrative link between R&D and industrial production. This link, however, always functioned via the superordinate state authorities. Direct, or even informal relationships between research institutes and enterprises were not only not promoted, but were even looked upon as illegal.
- In a *second phase (1976 to 1980)*, many R&D facilities and industrial enterprises established direct relations with one another, parallel to the state-organised system, which the government all the while insisted on retaining.
- In a *third phase (1981 to 1987)*, the government accepted the informal relationships and even promoted them, leading to the establishment of contractual relations between R&D facilities and enterprises.

Doi moi policy did not change the overall political direction of subsuming science under the economy's needs but supplemented political pressure on science with economic pressure (cf. Ch. 2 and 5). Both the organisational restructuring of S&T and the introduction of economic relations led to significant changes in the Vietnamese research and innovation landscape. Again, three phases can be distinguished (cf. Bach Tan Sinh, 1996; Wolff, 1997: 4-30; Ch. 2 in this volume).

- In a *first transformation phase (1988 to 1991)*, the government reduced its direct influence on relations between research and industry and increasingly left it up to the "market" to regulate them. This caused state-owned R&D to decline due to reduced financial means and limited demand. At the same time so many new research facilities were being founded that the government lost track of what was going on and sought to regain control of the system's development.
- In a *second phase (1992 to 1995)*, this led to concepts being devised for the restructuring of the whole R&D system. Two fundamental directions of action were taken in pursuit of this aim. Firstly, basic research was to be shifted from the national research centres to the

universities. Secondly, enterprises, or the newly founded enterprise corporations, were given responsibility for some branch institutes that had previously been subordinate to various ministries, in particular those within industry. In general, this entailed a greater differentiation in the facilities' organisational and functional spectrum and in the funding of R&D to promote greater effectiveness in practical applications. At the same time, the government attempted to halt a further decrease in R&D personnel by providing a minimum of institutional funding. Since it proved difficult to even draw up principles for the reorganisation of the R&D system, these principles could only be implemented to a very limited extent in this phase (cf. Ch. 2, 4 and 5).

- Thus, the *period from 1996* onward can be called *a third phase* in Vietnam's new S&T policy, one involving the establishment and initial consolidation of a new R&D system that should be better adapted to market conditions in Vietnam. But, as our analysis has shown, this process has so far only really started – also due to the weak demand for R&D results in industry (cf. Ch. 4, 6 and 7).

During the *doi moi* period S&T policy thus continued its change primarily in the direction of becoming a 'technology policy'. In other words, the major emphasis was placed on improved *utilisation* of the available scientific potential, which had been developed at an earlier date as an investment in the future under the conditions of the planned economy. This is evidenced in the orientation of all research institutes toward the needs of enterprises, in the stepped-up establishment of contractual relationships, in the (at least intended) increasing funding of scientific institutes through orders for services, and in the administrative allocation of institutes to SOE and to newly established corporations.

This fundamental policy orientation in favour of putting S&T to use for 'industrialisation and modernisation' purposes is also preserved in the 'Law on Science and Technology' passed by the parliament in June of 2000. At the same time, however, changes in emphasis are visible, as enterprises are to be encouraged to carry out more research and innovation on their own and are to be supported in these efforts, while at the same time government funding of S&T is to be increased to 2% of the state budget. These measures are to be supplemented both by special programmes for the training and retraining of S&T human resources inside and outside the country and by building up a network of more than 30 national key laboratories, which are supposed to set qualitative standards for the whole country, while intensifying the international ties of Vietnamese science (cf. Ch. 2).

In contrast, during the 1990s there is a dearth of political orientations and measures aimed at maintaining and developing science as such, i.e. towards improving working and living conditions of scientists and relating to the content and quality of the research work done at scientific institutes.

2. Impact of Doi Moi Policy: Achievements and Unsolved Problems

Structural versus functional change

The political process of restructuring the Vietnamese S&T system has led to important changes that provide a new basis for further policy. With regard to financing S&T, the main aim was to diminish the share of the state and to increase the funding provided by industry. Both aims have been achieved to a significant extent. However, since the industrial financing could not compensate for the decrease in state funding, two obviously unintended processes have been initiated. Firstly, a decrease in S&T personnel occurred that is similar to the transformation scenarios in Eastern European countries (cf. Ch. 4 and 8). Secondly, the share of R&D activities in the institutes has decreased because institutes compensated for decreasing state financing with various other activities. In order to provide job security for their employees, institutes felt forced to engage in non-R&D and non-innovative business activities rather than selling R&D results or innovative products.

A second aim of science policy was to adapt institutes' organisational structures to the demands of industrial innovation. Many new, smaller and more specialised units have been created. These new units can be assumed to adapt more easily to the demand for innovations. However, the general description of research institutes as conducting 'applied research', 'development' or 'experimental activities' by no means implies that what is done in the institutes is actually useful for industry. Thus, although an organisational change has doubtless been achieved, it is by no means certain that it actually resulted in the aimed for changes in the behaviour of institutes.

The changes in research institutes' organisational and budget structure were not only to reduce the state's share but also to simultaneously increase industry's influence on the content of the institutes' R&D activities. While an increased dependency of research institutes on industry's money has certainly been achieved, it is doubtful whether these institutes now produce the innovations needed by their partners in industry. The comments made by managers from industry in the course of our investigation suggest that a basic obstacle to improved innovation activity (seemingly) remains unchanged: Institutes were described as not being adapted to user

needs (cf. Ch. 6). From this follows that there may be obstacles to such an adaptation that cannot be overcome by increasing the pressure on research organisations. Some of these obstacles could be identified in our investigation (see below).

For these reasons, the results of *doi moi* policy in the area of S&T must be described as ambiguous: Although much has been achieved regarding the transformation of S&T institutes, the hoped-for consequences in the form of increased innovation activities have not occurred so far. Our study shows that the political measures that have been implemented have been proven suitable since they produced some *necessary* conditions for more and stronger innovations. However, these conditions are not *sufficient* to facilitate innovations. There is an incongruity between successful structural change and functional change that has not or only partially occurred so far. However, our results would make it appear doubtful that this is simply a matter of time. Our macrostructural analyses and case studies revealed some serious problems that diminish Vietnam's current and future opportunities to utilise S&T for economic growth and social welfare. These problems are located within three main components of the Vietnamese innovation system: in the science system, in industrial enterprises as targets of innovations and in infrastructural conditions for innovation.

Developmental problems in science and technology

Macrostructural analyses indicate a *distorted age structure of scientific personnel* in Vietnam. A mixed age structure in the S&T workforce is of vital importance for several reasons. The most important is that it takes a long time to train scientists. In most cases it is therefore impossible to replace a large proportion of scientific personnel in a short period. The system of scientific education must be prepared to meet such a demand, and preparing takes time. A second reason is that the different generations in S&T have different strengths and weaknesses. To benefit from all strengths and to compensate for all weaknesses requires a mix of generations. Thirdly, S&T are social systems that depend on personal contacts to a great extent. Scientific and technological knowledge inevitably remain partly implicit, i.e. bound to the holder of the knowledge. This 'tacit knowledge' (Polanyi 1966) is transmitted by personal contacts. If one generation dominates the personnel structure of S&T, a great deal of tacit knowledge is in danger of being lost when this generation leaves the system.

From this perspective, the age structure of Vietnam's scientific personnel appears to be a serious threat to future development. If nearly half of the scientists and engineers will be leaving the Vietnamese science system in the near future (cf. Ch. 2 and 4), then several links

might be broken that are important for the system's reproduction. A loss of scientific knowledge, of international collaborations, of experience in dealing with organisational problems, with enterprises, etc. seems unavoidable. Of equal importance is the question how the S&T system is prepared to replace the scientists who will leave. This is not only or not primarily a question of training enough graduates. The crucial question is whether these graduates are interested in a career in S&T. The current age structure might be the usual indication of a shrinking science system, such as we can observe in many countries (e.g. in Germany). But the worst case (i.e. the case science policy must respond to) occurs when not enough young scientists enter the system even when this would be possible. Several comments made in interviews seem to indicate that public S&T in Vietnam do not offer careers that are attractive to (and attracting) young graduates. We regard the science system's age structure (and possible barriers to its improving) as the most serious problem faced here.

As we have tried to demonstrate, research institutes have been successfully restructured by several policy measures set up since the introduction of *doi moi* policy. However, our case studies indicated that the institutes suffer from weaknesses that cannot be overcome by organisational changes. In order to function as a stable source for innovations, S&T must have an advanced technological basis. Even if innovations are to be generated that will improve existing production technologies, the creation of such improvements can only take place if the source's technological basis is significantly ahead of the 'target' production technology. This holds all the more true if research is to function as a source for innovations. Solla Price has hinted at the fact that at least a significant share of science-based innovations is grounded on research technologies being turned into production technologies (Solla Price 1984). It is obvious that in this case the quality of innovations directly depends on the quality of research technology.

Interviews both in enterprises that are partners of research institutes and in institutes themselves indicated that the *institutes' technological basis is far beyond these requirements* (cf. Ch. 5 and 6). Thus, there is a problem related to the content of work that cannot be solved by changing the work's organisational forms. The institutes must improve their equipment, and they must do so by buying new equipment. In the context of restructuring, this of course cannot mean a simple replacement of old devices by new ones since an institute's equipment determines the range of research that can be done. The first question must be whether the institutes have a *strategic orientation and research programmes* (by types of subject, methods and aims/results) suitable for their new role in the innovation system. Only on the basis of

such a programme can the improvement of the institutes' technological basis contribute to an improvement of innovation capacity. This seems to be the root of another unsolved problem.

Our case studies indicate that while restructuring was successful and institutes' dependency on industry has increased, these changes have not yet led to new types of research programmes. As a result, paradoxically, while numerous contracts exist between enterprises and research institutes, and while enterprises actually pay for contract research's results, enterprises also unanimously criticise the *institutes' bad adaptation to industry's innovation needs*.

On the other hand, however, this situation can also not be explained by the institutes retreating or drifting into basic research far removed from any applications and following international trends. In fact, the actual research does appear to be concentrated on topics that concern fundamental national problems (cf. Nguyen Van Hieu 1998), but it neither leads to interesting international results (i.e. publications) nor directly to innovations in enterprises. Indications of this phenomenon can be seen in the fact that the number of publications in SCI journals has remained fairly stagnant in most scientific fields (cf. Ch. 4) and in the (officially identified) low share of basic research in the activities of all R&D facilities (cf. Ch. 2). A comprehensive evaluation of the entire system of R&D facilities is required: Not only their politically determined function within the R&D system must be assessed but also their actual activities and the given financial, staffing and technological conditions in the institutes to fulfil this function. Without such an evaluation no reliable conclusions can be drawn.

Enterprise developmental problems hindering innovation

Causes for low innovation activity do not necessarily lie on the supply side outside of industry, i.e. within S&T. Enterprises are the innovation system's decisive component because they are the targets of and main actors in innovation processes. This also means that they generate the demand for innovations. Moreover, they contribute to innovations by producing innovative equipment and by adapting skills, organisational forms, marketing, etc. to the conditions ensuing from new technologies and products. Because of this central position, weaknesses in enterprises affect the whole innovation system more deeply than any other weakness could do (cf. Ch. 7).

Enterprises may be too weak either to generate intraorganisational innovations or to absorb exogenous innovations. Our study strongly suggests that this is actually the case in Vietnam. This 'weakness' of enterprises has two dimensions; one that is related to economic power and another that is related to enterprises' capabilities.

a) Enterprises' economic power depends primarily on *size* in terms of turnover, capital, financial resources, etc. Only an enterprise that is 'big' enough in this sense can internally create the conditions necessary for the implementation of innovations. Of these conditions, it is primarily free resources that are required, i.e. 'spare money' to invest in innovations. This money must be accumulated within the enterprise or acquired through loans and state support schemes. In both cases, however, the money spent on innovations must somehow relate to the enterprise's overall economic power as expressed by capital and sales. Most Vietnamese enterprises seem to be too small and earn too little profit to afford innovation (cf. Ch. 4 and 6).

b) Insufficient economic power can also hinder enterprises in establishing R&D units, thus resulting in their being unable to conduct the specialised work that is needed for innovation. Whenever innovation is to become an enterprise's continuous activity, and whenever collaborative innovations are to be conducted, a specialised unit within the enterprise is necessary. Such units can only be created if the enterprise is 'big' enough in economic terms. Since this prerequisite is not given in many cases, enterprises cannot afford to create and maintain R&D units. Thus, by not being able to establish specialised work on innovations, enterprises have only limited *capabilities* to generate or to absorb innovations. Another restriction for capabilities is set by an enterprise's production technology. Both demands and opportunities for innovations in Vietnamese industry are severely limited by the mostly *outdated production technology*. A technology can simply be too old to be seriously improved (or to be worth the investment). These technologies require either small improvements that keep them running or a complete replacement (cf. Ch. 7).

Both factors - economic power and limited capabilities - lead to a very specific demand for innovations: Vietnamese enterprises seem to need either small improvements to existing technology or a complete replacement of this technology. Though both types are completely 'normal' variants of innovations, they also have in common that they produce only little demand for external R&D: The best source of small improvements is the enterprise's own staff, who have the best knowledge of the production technology, and, for reasons we will describe in the following section, the replacement of production technology is mostly carried out via technology import.

For these reasons, there is a serious problem on the demand side of innovation: The demand for the type of innovation that requires contributions from research institutes is limited by the enterprises' ability to absorb these innovations. That is why enterprises' criticism of institutes

not being adapted to user needs is only part of the truth. From our investigation follows that no measure whatsoever that is directed only to the supply side of innovation can improve innovation activities because a significant part of the problem lies within the Vietnamese economy. The measures that have been set up so far have produced important necessary conditions in the R&D institutes for more and better innovations. From now on, increasing pressure on research institutes and the organisational restructuring of the S&T system are of limited impact because other problems, in particular within enterprises, are more urgent. The formation of national corporations would appear to be an important step in the direction of strengthening the enterprises (cf. the *Chaebols* in South Korea, Ch. 9). For the time being, however, the corporations in Vietnam seem to be more administrative, formal aggregations of various firms and research facilities, than new, effective and innovative enterprises. Nevertheless, in future they may offer better conditions for the associated firms to not just undertake the continual incremental improvement of existing technologies, but to also modernise selected production processes with completely new (initially imported) ones.

Innovation infrastructure

Vietnam appears to be facing serious problems with regard to innovation infrastructure. Beside all the well known aspects of innovation in developed countries (cf. Porter/Stern 1999) Vietnam shares a typical feature of less developed countries: Most equipment that is necessary to implement innovations, i.e. also the "normal", unspecified 'hardware' of new technologies, cannot be produced by Vietnamese industry itself. Thus, even if research institutes and enterprises design new technologies, these technologies cannot be built. Whole technologies or most elements of them must be imported anyway. This lack of production capacity for innovations contributes to the above-mentioned restriction of innovation to either small improvements or the replacement of whole technologies. Moreover, it makes it necessary to import the new technologies that are to replace the old ones. This is why foreign direct investment has become the most important source of significant technological improvements. This results in a further problem. Vietnam lacks suitable capabilities to assess the advantages and disadvantages of foreign technologies when local raw materials, labour force, etc. are taken into account (cf. Ch. 3). It may be expedient to set up capable consulting and engineering firms to mediate between (local) innovation interests and foreign offers of relevant equipment, products and technologies. Such firms could simultaneously consult with local experts from R&D institutes for individual projects or purchase or commission specific items of capital expenditure from Vietnamese enterprises. In this way elements of an

infrastructure conducive to innovation could be created or strengthened in Vietnam, which could simultaneously serve as a bridge between R&D institutes and enterprises.

3. Weighing Achievements and Problems

A general conclusion from our investigation is that it is not yet clear whether the 'tiger scenario' or the 'transformation scenario' will be followed. The 'tiger scenario' is supported by the restructuring of S&T and by the introduction of market conditions for industrial research. It is hindered by problems with the material side of S&T and by the economy's limited ability to generate and absorb innovations. Which scenario will become reality depends mainly on what can be achieved in the time remaining before the opening of markets. Time pressure is now paramount.

The weaknesses detected on the part of industrial enterprises led to some conclusions concerning research institutes' adaptation to industry's needs. While such an adaptation is certainly necessary and must be continuously supported and forced, it remains an open question to what extent institutes should *depend* on industry. Such a dependency could prove fatal if industry neither needs these sources of innovation nor can afford them (in financial terms). In this case, industrial research could suffer from the weaknesses of the partner it depends on. Vietnam seems to be in a similar situation to that faced by South Korea in the 1960s and 1970s (cf. Ch. 9). In this phase, South Korea's industrial research was mostly state financed precisely because industry was too weak to maintain it. As industry gained strength, financial contributions to R&D increased, and the state withdrew its support. Even if Vietnam has significantly less time for such an development, another basic scenario is difficult to imagine.

Finally, it is important to place our results on Vietnamese industrial R&D and innovation in context. Industry is still a small sector of the Vietnamese economy, with limited impact on economic growth and societal welfare. Therefore, improvements in the industrial innovation system will have only a limited impact on overall economic development. At the same time, however, industry is also the sector with the highest growth rates and a strong influence on increases in GDP (cf. Ch. 2, 4 and 5). Further industrialisation is thus absolutely indispensable; it requires, however, a careful assessment of the available (domestic and foreign) resources and the greatest sustainable effects to be gained using them.

4. Science Policy Implications

In the previous section we summed up main problems faced by the Vietnamese innovation system, as indicated by our research project. This perspective is, of course, limited due to problems associated with macrostructural data (cf. Ch. 2, 3 and 4) and because the case studies (cf. Ch. 6) cannot be regarded as representative for Vietnamese industry without further investigations. Furthermore, it should be taken into account that in some respects agriculture is a far more important sector of Vietnam's economy. Agriculture has not been the object of investigation in this project. However, since agriculture is of great economic weight and might even be economically strong during the next decade, it seems promising to focus innovation policy on the economy's strengths rather than trying to eliminate all the enormous weaknesses within a short time. Vietnam's S&T strategy should therefore assign high priority and major resources to modernising agriculture, forestry and fisheries and to strengthening the associated industrial branches. The aim would be to create a truly 'advanced agrobusiness infrastructure' (cf. Bezanson et al. 1999: 126) and to increase the production of high-quality output for domestic and international markets by combining domestic efforts and foreign investment.

Despite all the limitations of our study, the problems' seriousness requires political action regardless of whether further studies reveal other problems in other areas of the innovation system. The summary of problems indicates that the restructuring of research institutes has been successful and has created important prerequisites for improving the innovation system. However, the policy measures that have been implemented so far were too narrowly focused on organisational and financial changes in a limited part of Vietnam's science system. We can observe a similar paradox here to that which led to serious damage in the GDR's innovation system: Although it is quite natural to try to improve innovation activities by narrowing down science policy to technology and innovation policy, a policy that is narrowed this way cannot improve innovation over a longer period because it inevitably neglects the requirements of science system's reproduction (cf. Gläser/Meske 1996: 350-374).

Thus, we are of the opinion that current problems in R&D and innovation in Vietnam cannot be solved by the organisational restructuring of research facilities alone. It seems more important to improve the *personnel and the material* basis of the supply side of innovation (i.e. R&D) and to simultaneously strengthen the demand side significantly. The empirical investigations have led us to draw the following conclusions:

1) It is of the utmost importance to *enhance the innovation capacity of industrial (and, perhaps, agricultural) enterprises*. Our investigation indicates that although many enterprises do urgently require innovations (and know this), they are not able to realise them for various reasons. Enterprises are too small in terms of economic power, they lack the necessary R&D capacities, and they have technologies that are too old to be subject to innovations. To improve the enterprises' overall innovation capacities, a bundle of policy measures¹ could be imagined that includes the following:

- Measures that enhance in-house R&D in enterprises, e.g. by introducing special subsidies for R&D staff wages.
- Measures that facilitate spillovers from FDI, i.e. by requiring or promoting the creation of domestic intra-firm R&D around imported technologies.
- Measures that promote technology-based growth of enterprises, e.g. by making low-interest loans available for establishing new production lines.
- Measures that promote research contracts, e.g. by subsidising enterprises that engage in collaborative innovations.

2) On the supply side of innovation, the long-term safeguarding and qualitative improvement of the workforce in R&D institutes by attracting young scientists will become a main task. Additionally, the *improvement of research institutes' technological basis* is a prime task for strengthening the functional impact of organisational (structural) changes. Currently the insufficient technological basis is one of the Vietnamese innovation system's bottlenecks. Since it is certainly not possible to improve the technological basis of all research institutes at once via public subsidies, regulations should be drafted that enable (and force) the industrial institutes to improve their technological basis with the money they earn themselves. Contract research should include money for research equipment. Furthermore, research institutes that create innovations should be allowed to enhance production and to use the profits for improving their technological basis. Since a research institute's equipment determines the directions of its research to a great extent, it is important that industry-oriented research institutes have a clear research programme that is oriented towards the needs of industrial innovation. These programmes should be developed jointly with industry representatives, and advisory boards should be set up that observe the institutes' research. The existence of

¹ Examples of political measures implemented can be found, for example, in the EU and especially in East Germany during the 1990s. They include in particular short term assistance schemes specifically for small and medium-sized enterprises. The suitability of such measures for Vietnamese conditions should be investigated.

research profiles and programmes approved by industry should be the focus of an initial evaluation of these institutes. Later, institutes should be subject to an evaluation 'by the market' (i.e. dependent on contract research) rather than being regularly evaluated by state authorities. A systematic evaluation of various (publicly financed) research organisations in Vietnam could augment this by clarifying the institutes' actual situation with regard to their designated function and the conditions or measures required to fulfil it. Such an evaluation could simultaneously be the basis for a strategy to develop scientific facilities in Vietnam, including the envisaged building-up of 30 national key laboratories.

3) Both limitations of enterprises' innovation capacity and tendencies towards business activities in research institutes suggest the *promotion of innovations by building new firms* around them. Research institutes should be permitted to implement their innovations if they cannot be transferred to industry. Furthermore, the founding of enterprises on the basis of new technologies developed in research institutes should be promoted via financial measures.

4) The political measures that promote innovation must be accompanied by measures that *ensure the reproduction of the science system*. The new 'Law on Science and Technology' already included some measures in this direction. Absolute priority should be given to measures that make scientific research and engineering challenging careers that are satisfying with respect to the content of work, anticipated promotions and salaries and that enjoy material working conditions in line with international standards. It is very important to make careers in S&T attractive and promising. At the same time, the institutes' strategic specialisation in application-related research must be made possible and then supported by the substantial improvement of their technological equipment.

5) Our study indicates that some *lines of future research* are particularly important for a better understanding of Vietnam's S&T system. The aim of this research is to enhance the knowledge that is necessary to govern science, technology and innovation. Governance necessitates knowledge about the structure and the mechanisms of the system; our study revealed some 'blind spots'.

- High priority must be given to the investigation of the reproduction of S&T personnel structure. Since an important short term task is to ensure that the best graduates enter the science system, career structures and working conditions, including scientific instrumentation, must be evaluated.

- A second task to be completed by future research is the investigation of the conditions for and barriers to innovation in industrial and agricultural enterprises. The case studies included in this report are an important step in this direction. However, additional in-depth studies of innovation processes are necessary in order to get a better picture of conditions promoting and hindering innovation, also in corporations with incorporated R&D institutes.
- The appraisal of FDI (cf. Ch. 3) has indicated that it could be a catalyst for the advancement of domestic R&D. To investigate this assumption it would be necessary to conduct case studies on FDI and its influence on technological change in Vietnam.

Case studies should also be conducted regarding the content of research contracts between institutes and enterprises. In the previous section we mentioned the paradox situation that despite there being many such contracts, industry criticises the institutes' poor adaptation to innovation needs. This indicates that there might be a substantial difference between the formal level of contracts and financial relations, on the one hand, and the content of work that is done to fulfil the contracts, on the other hand. Since science policy primarily responds to the formal indicators, in-depth studies are necessary to investigate the content of contract relations.

References

- Bach Tan Sinh, 1996: Die Beziehungen zwischen FuE und chemischer Industrie in Vietnam, in: Meske, Werner and Dang Duy Thinh (eds.): Zur Situation und den Veränderungen des FuE-Systems in Vietnam, unter besonderer Berücksichtigung der Schwerindustrie. Veröffentlichungsreihe der Forschungsgruppe Wissenschaftsstatistik des Wissenschaftszentrum Berlin für Sozialforschung (WZB), P 96-401, Berlin, p.49-66
- Bezanson, K./ J. Annerstedt/ K. Chung/ D. Hopper/ G. Oldham/ F. Sagasti, 1999: Viet Nam at the Crossroads: The Role of Science and Technology. Ottawa: Intl. Development Research Centre.
- Gläser, Jochen/ Werner Meske, 1996: Anwendungsorientierung von Grundlagenforschung? Erfahrungen der Akademie der Wissenschaften der DDR. Frankfurt am Main: Campus.
- Nguyen Van Hieu, 1998: Development-oriented research in the basic sciences: the case of Vietnam, in: Garrett, Martha J., Claes G. Granqvist (eds.): Basic Sciences and Development, Ashgate, Aldershot, p.123-127
- Polanyi, Michael, 1966: The Tacit Dimension, Doubleday & Company, Garden City, New York
- Porter, Michael E., Scott Stern, 1999: The New Challenge to America's Prosperity: Findings from the Innovation Index; Council on Competitiveness Publications Office, Washington
- Solla Price, Derek de, 1984: The Science/Technology Relationship, the Craft of Experimental Science, and Policy for the Improvement of High Technology Innovation. In: Research Policy 13, 3-20
- Wolff, Peter, 1997: Vietnam – Die unvollendete Transformation. Schriftenreihe des deutschen Instituts für Entwicklungspolitik. Band 113. Weltforum-Verlag: Cologne.

List of Authors

Dang Duy Thinh, Dr., Vice Director, National Institute of Science and Technology Policy and Strategy Studies (NISTPASS), Hanoi

Dao Duy Tinh, , M.Sc., General Director of Vietnam's Electronics Engineering Company, Hanoi

Gläser, Jochen, Dr., Wissenschaftszentrum Berlin für Sozialforschung (Social Science Research Center Berlin), Berlin

Meske, Werner, Prof. Dr., Head of Working Group 'Transformation of Science Systems', Wissenschaftszentrum Berlin für Sozialforschung (Social Science Research Center Berlin), Berlin

Nguyen Thanh Thinh, Dr., Senior Research Fellow, Department for Science and Technology Policy, National Institute of Science and Technology Policy and Strategy Studies (NISTPASS) and Director of the Project for Planning of National S&T System, Ministry of Science, Technology and Environment (MOSTE), Hanoi

Pham Huyen, Dr., Deputy Director General, International Relations Department, Ministry of Science, Technology and Environment (MOSTE), Hanoi

Susec, Barbara, Dipl. pol., Wissenschaftszentrum Berlin für Sozialforschung (Social Science Research Center Berlin), Berlin

Tran Chi Duc, Dipl. Mat., National Institute of Science and Technology Policy and Strategy Studies (NISTPASS), Hanoi

List of Figures

Figure	Page
2.1 Economic Development in Vietnam, 1980–1987	24
2.2 Range of S&T Activities by Sectors	46
2.3 The Innovation Chain: Participants and Public Funding	47
2.4 Vietnam's R&D System in 1986	48
2.5 Affiliation of R&D Institutes in 1996	50
2.6 Vietnam's R&D System in 1996	51
2.7 Vietnam's National Centre for Natural Sciences and Technology (NCNST) (1997)	52
3.1 Foreign Investment in Vietnam (1988-2000)	69
3.2 Average Size of Registered FDI Projects	71
3.3 Streams of Technology Transfer	75
4.1 Gross Domestic Product by Ownership	90
4.2 Gross Domestic Product by Economic Sector	90
4.3 Development of GDP and S&T Expenditure	97
4.4 S&T Personnel in Vietnam	101
4.5 Development of Universities	107
4.6 Vietnam's Publication Activity (basis: SCI)	110
4.7 Vietnam's Publication Activity by Fields	112
4.8 Publication Activities of Vietnam and ASEAN-4	113
7.1 Sources of Innovations	187
7.2 Innovations' Locations within and between Organisations	192
8.1 Levels of Dissolution and Fragmentation of the Former Socialist S&T System	206
8.2 R&D Personnel in CEEC	209
8.3 Poland - R&D Personnel by Sector	211
8.4 Hungary - R&D Personnel by Sector	211
8.5 Comparison of R&D Structures in West and East Germany	214
8.6 Phases in the Process of Institutional Transformation of STS in the CEEC	219

List of Overviews

Overview	Page
2.1 Reform Measures in Vietnam (Chronological Overview)	30
5.1 R&D Facilities Administered by the MOI, 2000	130
5.2 Changes in the Functions and Activities of Industrial R&D Institutes	134
9.1 R&D Activity in Korea, 1980-93	241
9.2 HAN Project (South Korea)	247

List of Tables

Table		Page
2.1	Investment and Accumulation Rates in Selected Asian Countries (1993)	28
2.2	Economic Development in Vietnam	31
2.3	Employees (thousand persons)	32
2.4	Growth in GDP per Annum by Sectors (%)	32
2.5	Contribution of the Sectors to GDP (%)	32
2.6	Development of Foodstuffs and Industrial Production	33
2.7	State-Owned Enterprises in Industry and Agriculture (1992)	34
2.8	Foreign Investment	36
2.9	Gross Domestic Product (GDP) and Inflation	37
2.10	Structure/Distribution of the S&T Cadre (University and Polytechnic Graduates) according to Fields of Training and Employment (1982)	42
2.11	Number of Doctorates (PhD by Disciplines)	42
2.12	Expenditure on S&T	43
2.13	Number of Tertiary Institutions by Subject Areas (1995)	49
2.14	R&D Organisations of Central Institutions (1998)	54
2.15	Distribution of R&D Organisations and Personnel According to Ownership (1998)	54
2.16	Distribution of R&D Organisations and Personnel According to S&T Fields (1998)	54
2.17	Number of State R&D Programmes and Projects	60
2.18	R&D Expenditure	63
2.19	Graduates in Different Scientific Fields (1994)	65
3.1	Top Foreign Investors (2000)	70
4.1	Industrial Gross Output: Volume and Structure	92
4.2	State-Owned Enterprises by Branch (1992)	94
4.3	S&T Expenditures and GDP	96
4.4	Number of R&D Facilities	97
4.5	Changes in the Organisational Structure of R&D	98
4.6	Personnel in the R&D Facilities (1998)	98
4.7	Personnel in S&T	102
4.8	Structure of personnel with higher academic degrees by age (July 1, 1997)	103
4.9	S&T Personnel by Qualification (July 1, 1997)	104
4.10	(State) Universities	106
4.11	Vietnamese (SCI) Publications: Number and Structure by Authorship	109
4.12	Vietnamese Publication Activity by Fields	109
4.13	Publication Activity by Affiliation of Authors	112
4.14	Publication Activities in Vietnam and Other Southeast Asian Countries (ASEAN-4)	114
4.15	Vietnam's Main Foreign Partners in Publications	115
4.16	German Facilities Involved in Co-Authorships in Vietnamese Publications	117
4.17	Joint Publications of German and Vietnamese Scientists	119
5.1	Annual Growth Rate of Industrial Output	124
5.2	Average Annual Growth Rate by Branches	124
5.3	R&D Facilities in Heavy Industry, 1992	129
5.4	Funding of R&D Facilities According to Sources	133
5.5	Organisational Structure of R&D Institutions: Number of Divisions	136
5.6	Workforce of the R&D Institutions	137
5.7	Capital Value/Fixed Assets of R&D Institutions	138
5.8	Projects Carried out by Institutes (number)	140
5.9	Domestic and International Contracts by Institute	141

Table	Page
6.1 Fertiliser Corporation (VDPFC): R&D Expenditure	148
6.2 Fertiliser Corporation (VDPFC): Staff Members Directly Participating in R&D	148
6.3 Fertiliser Corporation (VDPFC): R&D Output	149
6.4 Biotech. Corporation (BICICO): R&D Staff Structure	151
6.5 Biotech. Corporation (BICICO): R&D Expenditure	151
6.6 Biotech. Corporation (BICICO): Results of Scientific Research	151
6.7 Paint Corporation (HGPC): Staff Structure(%)	152
6.8 Paint Corporation (HGPC): Staff Participating in R&D	153
6.9 Paint Corporation (HGPC): Expenditure on R&D	153
6.10 Paint Corporation (HGPC): R&D Results	153
6.11 Chemical Corporation (HCPC): Staff Structure(%)	154
6.12 Chemical Corporation (HCPC): Staff involved in S&T activities	155
6.13 Chemical Corporation (HCPC): Results of S&T Activities	155
6.14 Chemical Corp. (HCPC): Number of New Technologies by Sources	155
6.15 Institute of Ind. Chem. (IIC): Staff Structure (persons)	156
6.16 Institute of Ind. Chem. (IIC): Departments and Personnel	156
6.17 Institute of Ind. Chem. (IIC): Financial Resources	157
6.18 Confectionary Company (Haiha): Staff Structure (%)	162
6.19 Confectionary Company (Haiha): Innovations	162
6.20 Food Ind. Research Institute (FIR): Staff Structure (persons)	165
6.21 Food Ind. Research Institute (FIR): Staff Activities (persons)	165
6.22 Food Ind. Research Institute (FIR): Financial Resources	166
6.23 Food Ind. Research Institute (FIR): Expenditure	166
6.24 Electro-Mechanical Company: Staff Structure	171
6.25 Electro-Mechanical Company: Expenditure on Solving Technical Problems	172
6.26 Electronics Corporation (HANEL): S&T Expenditure According to Sources	176
6.27 Institute of Electronics (VIELINA): Staff Structure (%)	177
6.28 Institute of Electronics (VIELINA): Staff Specialisation	178
6.29 Institute of Electronics (VIELINA): Income Structure	178
6.30 Institute of Electronics (VIELINA): Expenditure Structure	179
7.1 Types of R&D Organisation	189
7.2 Case Studies	196
8.1 Institutional Changes in Sectors and Environments of S&T in (Indiv.) CEEC - Criteria	215
8.2 Classification of the Individual CEEC in Groups with Varying Advances in the Institutional Transformation of their STS	216
9.1 Scientists and R&D Expenditure by Sector, 1993	244

