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TECHNOLOGY INVENTORY - SINGAPORE

This report provides an overview of the R&D environment in Singapore. Included is a survey of companies that undertake R&D locally and a summary of their operations and interest in engaging in technology transfer or other business ventures. Various government bodies that oversee the R&D efforts of the nation are also indicated.

CANADIAN HIGH COMMISSION

TECHNOLOGY INVENTORY - SINGAPORE

6 MARCH 1991

SRI International
South East Asia & South Pacific
Regional Headquarters

Dept. of External Affairs
Int. Cons. Affairs
200-2-100

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Project #2045



TECHNOLOGY INVENTORY - SINGAPORE

SCOPE

This report provides an overview of the R&D environment in Singapore. Included is a survey of companies that undertake R&D locally and a summary of their operations and interest in engaging in technology transfer or other business ventures. Various government bodies that oversee the R&D efforts of the nation are also indicated.

For our purposes, we have concentrated on R&D that will result in commercially viable products (manufactured and/or sold in Singapore) or technology that the organizations plan to sell in the form of technology transfer, licensing agreements or as joint venture projects. We have thus not listed any companies where R&D is done for internal use, (ie., product packaging), which exists particularly among the MNCs in Singapore. Other MNCs were also omitted since they were unwilling to divulge information or indicated a total lack of interest in engaging in technology transfer from the local plant.

Dept. of External Affairs
Min. des Affaires extérieures

JAN 5 1995

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The Canadian High Commission in Singapore commissioned SRI International to prepare this survey and analysis. This report is designed to help Canadian organizations meet their initial information needs regarding technology transfer in Singapore. The information presented is believed to be accurate and from sources SRI believes to be reliable. Readers are urged to verify pertinent information before committing resources.

SRI International acknowledges the fine work Pacific Rim Consulting Group did in support of the preparation of this report.

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TECHNOLOGY INVENTORY - SINGAPORE

CONTENTS

THIS REPORT COVERS THE FOLLOWING TOPICS :

- **SECTION I - OVERVIEW OF R&D CLIMATE IN SINGAPORE**
 - Background
 - International Comparison
 - Problems and Projections
 - Priority Areas in R&D
 - R&D Promotion Schemes
 - R&D Infrastructure

- **SECTION II - COMPANIES AND ORGANIZATIONS**
 - Overview of Survey
 - Biotechnology/Biomedical Sciences
 - Electronics/Microelectronics/ Computer Systems
 - Robotics and Artificial Intelligence
 - Information Technology
 - Communications Technology
 - Petrochemicals and Chemicals

- **SECTION III - GOVERNMENTAL BODIES INVOLVED IN R&D PROMOTION ACTIVITIES**

- **SECTION IV - NATIONAL UNIVERSITY OF SINGAPORE CONTACTS AND CURRENT RDAS WORKS IN PROGRESS AT NUS**

- **ANNEXES**
 - I Summary Profile of Companies
 - II Graphical Representation of Survey
 - III Index of Companies
 - IV Map of Technology Corridor
 - V References

OVERVIEW OF R&D CLIMATE IN SINGAPORE

BACKGROUND

1979 marked the beginning of a new era in Singapore's economic development. Prior to this date, labor intensive activities were encouraged to ensure high employment. However, as labor shortages began to develop in the late 1970s, emphasis shifted to the higher value added, skill and technology-intensive industries and services. The promotion of science-based and research-oriented industries was actively pursued.

With the move towards industrial upgrading in 1979, the government formulated a long-term Research and Development (R&D) plan to serve as a guide to government action in this area. A step-by-step approach was adopted whereby progress in R&D and measures to enhance that progress were continuously reviewed as a guide to further policy initiatives and action. Such measures enabled past and current R&D policies to be formulated in tandem with Singapore's overall industrial or economic development policy. The importance placed on services and technology in Singapore's economic restructuring is reflected in the initiatives taken by the Singapore Government over the last few years to encourage the growth of industrial R&D activities in areas such as micro-electronics, automation and robotics, information technology, computer hardware and software and biotechnology (Y. L. Guo & M. Narendran, Window on the Future, Science Council of Singapore, 1987).

Research and development is expected to be one of the fastest growing activities in Singapore over the next few years. In 1981/82, S\$81m or 0.3% of the nation's GNP was devoted to R&D. By 1984/85, S\$214.3m was spent, doubling the R&D expenditure to 0.6% of GNP. These figures were further increased to S\$374.7m or 0.9% of GNP by 1987/88 (R&D Survey, 1987/88).

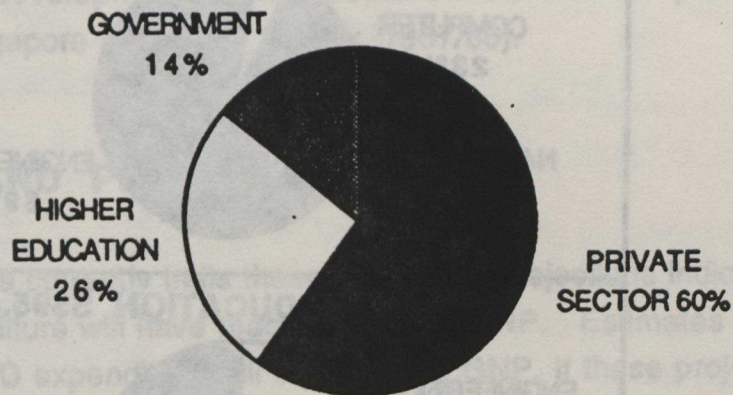
The results of the Science Council's national survey published in 1988 revealed that

- R&D expenditure and manpower has continued to increase significantly.
- More companies are committed to R&D and the number of local companies performing R&D has increased significantly (although still small in number).
- The private sector is the primary investor in R&D, accounting for 60% of national R&D expenditure.

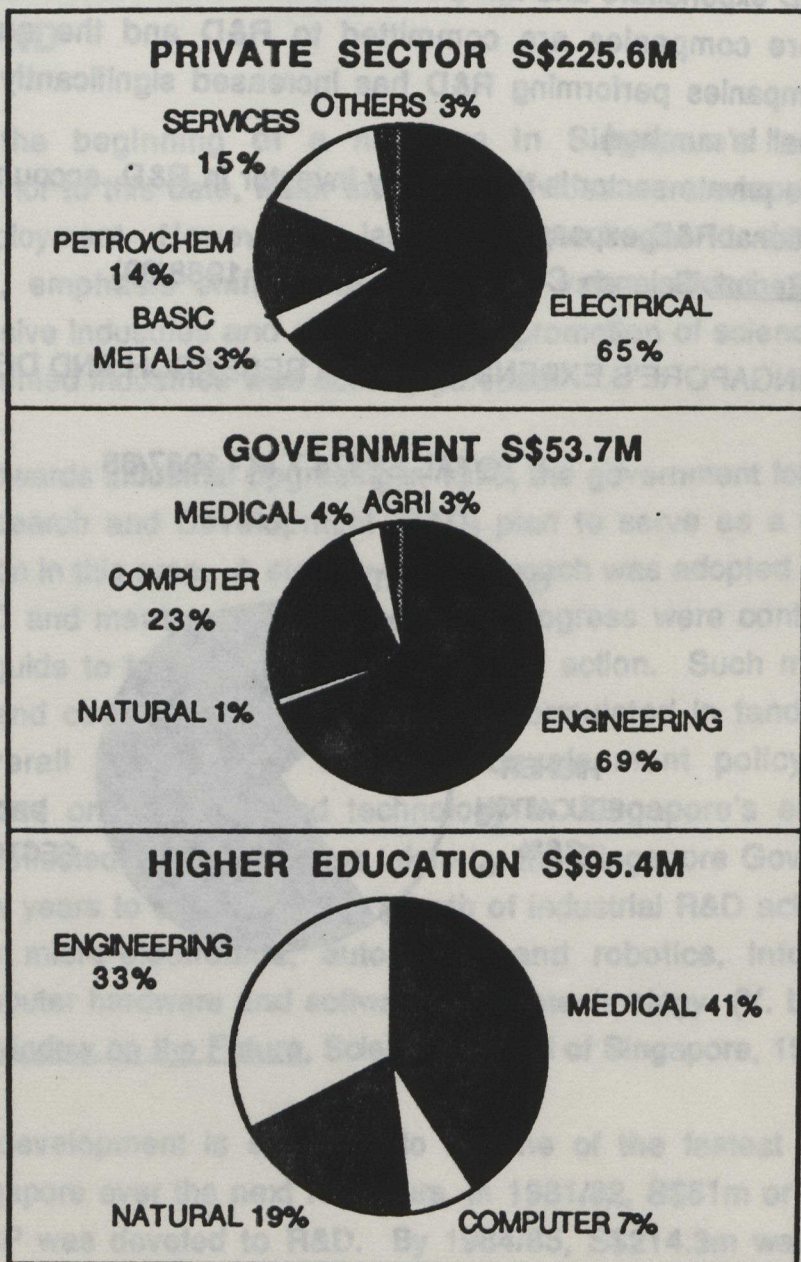
(Annual Report, Science Council of Singapore, 1988/89)

SINGAPORE'S EXPENDITURE ON RESEARCH AND DEVELOPMENT

TOTAL S\$374.7 M - 1987/88



SINGAPORE'S EXPENDITURE ON RESEARCH AND DEVELOPMENT BY FIELDS WITHIN SECTORS



Source: R&D Survey, Sep/Oct 1988; NSTB

INTERNATIONAL COMPARISON

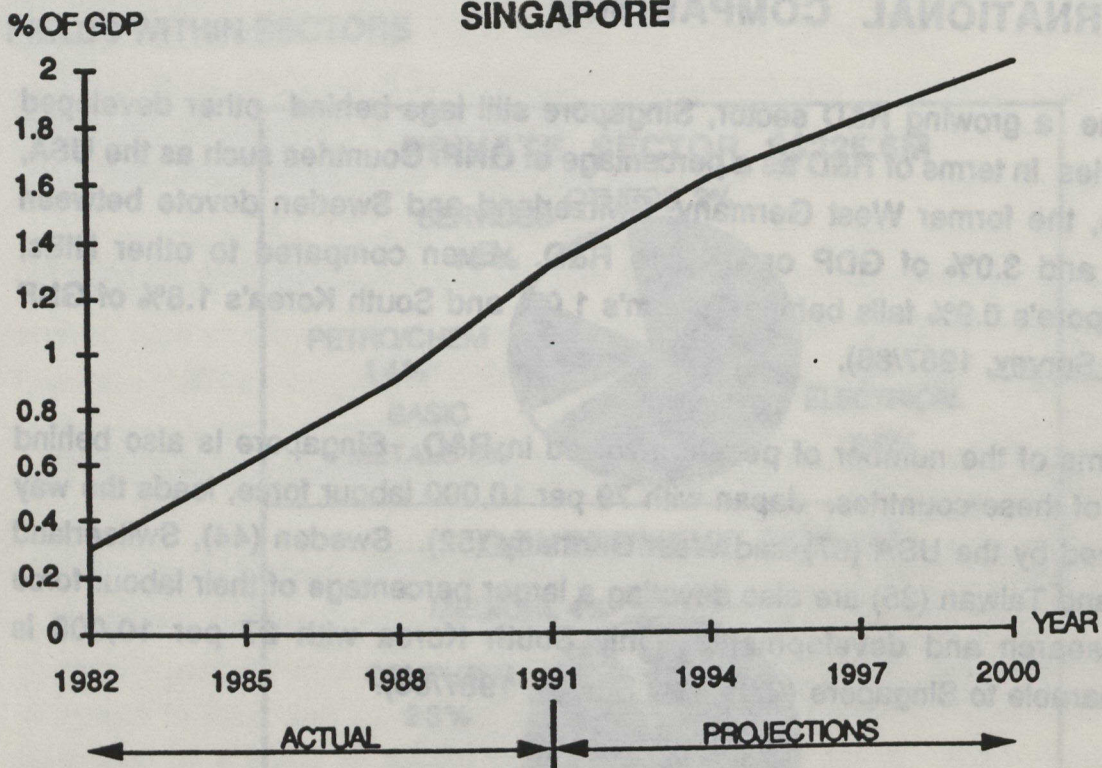
Despite a growing R&D sector, Singapore still lags behind other developed countries in terms of R&D as a percentage of GNP. Countries such as the USA, Japan, the former West Germany, Switzerland and Sweden devote between 2.5% and 3.0% of GDP or GNP to R&D. Even compared to other NIEs, Singapore's 0.9% falls behind Taiwan's 1.0% and South Korea's 1.8% of GNP (R&D Survey, 1987/88).

In terms of the number of people involved in R&D, Singapore is also behind most of these countries. Japan with 79 per 10,000 labour force, leads the way followed by the USA (67) and West Germany (52). Sweden (44), Switzerland (36) and Taiwan (35) are also devoting a larger percentage of their labour force to research and development. Only South Korea with 27 per 10,000 is comparable to Singapore (27) (R&D Survey, 1987/88).

PROBLEMS AND PROJECTIONS

Although Singapore currently trails these countries, projections indicate that by 1991, R&D expenditure will have reached 1.3% of GNP. Estimates are that by the year 2000, R&D expenditure will equal 2% of GNP. If these projections are attained, Singapore should achieve the level of R&D expenditure of the developed countries by the turn of the century (Source: NSTB).

EXPENDITURE ON R&D AS % OF GDP SINGAPORE



Sources: R&D Survey, Sep/Oct 1988; NSTB.

The government is also increasing its emphasis on the development of manpower. Various institutes like the Singapore and Ngee Ann Polytechnics, Nanyang Technological Institute, and the National University of Singapore are increasing their intake of engineering and science students in an attempt to increase the pool of R&D scientists and engineers.

Technology transfer fits with the Singapore government plans. As such, organizations are open to licensing agreements and joint ventures. Organizations also express a need for increasing the manpower pool and skills (i.e., more PhDs), a problem that various government sponsored institutions like the Japan-Singapore Artificial Intelligence Center and French-Singapore Institute have begun to address with their emphasis on training.

Other areas of improvement cited were the need for new ideas for product development and collaboration between the public and private sector, and between academia and industry. The NSTB, through its Research Development Assistance Scheme (RDAS), is setting an example with its funding of such collaborative R&D projects.

PRIORITY AREAS IN R&D

The Singapore government has identified fields that will be given priority in R&D endeavors. These areas include:

- **biotechnology/biomedical sciences**
 - pharmaceuticals
 - genetic engineering
- **micro-electronics**
 - consumer electronics
 - computer hardware
 - Application Specific Integrated Circuits (ASIC)
- **robotics & artificial intelligence**
 - automation
- **information technology**
 - computer software
- **laser technology and electro-optics**
 - medical use
 - communications - fibre-optics
 - lenses
- **communications technology**
 - satellites
 - PABX systems
 - microwave communications

(Singapore Science & Technology, Science Council of Singapore).

While some of these fields have developed viable R&D activities, others have been slow to follow. Among the priority areas identified, the following have developed a relatively high level of R&D.

* **Biotechnology and Medical Technology**

The Department of Surgery at the National University of Singapore and the Department of Hematology at the National University Hospital are undertaking the development of an *ex vivo* liver support system for the treatment of fulminant hepatic failure (RDAS Update, May/June 90).

Rhone Merieux has been granted an RDAS award of S\$438,900 for its project on "Towards an Effective Solution to Newcastle Disease in Poultry: Part One - Production of Monoclonal Antibodies against Newcastle Disease Virus" (Synergy, Sep/Oct 1990).

* **Electronics and Micro-electronics**

Lectret Precision Pte Ltd has been awarded a 3 year, S\$275,100 RDAS grant to develop an integrated silicon hearing aid microphone (RDAS Update, May/June 90).

AT&T has a center at the Science Park that provides product design for Application Specific Integrated Circuits (ASICs) (Synergy, Sep/Oct 1990).

* **Robotics and Artificial Intelligence**

The new Artificial Intelligence (AI) Center jointly set up by the Japanese and Singapore governments will focus on the development and practical application of AI technology (Synergy, Sep/Oct 1990).

Electronic Data Systems has been successfully developing and installing comprehensive sophisticated software for financial accounting, distribution and manufacturing for various local companies.

* **Information Technology**

Maxtor Singapore Ltd, together with the Department of Electrical Engineering, National University of Singapore, is undertaking the development of a low profile micro-drive motor and actuators for hard disks (RDAS Update, May/June 90).

The chemical and petrochemical industries do perform R&D activities in Singapore, however, these industries have not been regarded as "priority" areas to receive R&D funds. Nevertheless, two recent projects, involving two Exxon-related companies, Energy Chemicals and Fuels Technology Center, are concentrating on the development of specialty chemicals for the oil industry and fuel additives & lubricants respectively.

R&D PROMOTION SCHEMES

The main tool used by the government to promote R&D is the Research and Development Assistance Scheme (RDAS), administered by the National Science and Technology Board (NSTB), formerly the Science Council of Singapore. Beginning in 1988, the second phase of RDAS was given S\$50 million for 5 years to assist companies carrying out R&D activities which have met with government approval. The ultimate objective of the scheme is to enhance the global competitiveness of Singapore-made products and services. Under this phase, the following 4 types of ventures will be eligible to receive RDAS assistance:

- Local companies and joint-ventures between local & foreign firms
 - University/industry collaboration
 - Public sector/industry collaboration
 - Foreign companies and multinationals operating in Singapore
- (Annual Report, Science Council of Singapore, 1988/89).

The difference between the first and second phases of this scheme is that while the first phase primarily targeted private companies, the second phase includes the public sector.

In order to transform Singapore into a "technopolis" that serves ASEAN and the surrounding region, the government has developed a range of incentives and grants in addition to the RDAS. These include:

- * Coverage of 70% of total costs for computerization of local companies.
- * Coverage of 50% of consultancy costs incurred by local companies.
- * Provision of loans for computerization at special interest rates.
- * Coverage of linkage costs between government departments and private sector companies.
- * Incentives and grants to train technicians and automate facilities.
- * Investment allowance of up to 50% for R&D and equipment and tax exemptions of up to 5 years.
- * Tax deferral for R&D reserves: 20% of the profits from approved companies can be set aside as R&D reserves. These reserves will enjoy tax exemption if spent within three years.
- * Companies that include substantial R&D as part of their operations may be granted a longer tax-free holiday.
- * Financial assistance covering up to 75% of the cost of product development and design carried out by local firms under the Product Development Assistance Scheme (PDAS).
- * Grants to SMEs interested in improving technological and managerial productivity.

Sources: Economic Development Board
National Productivity Board
National Computer Board
Trade Development Board
National Science and Technology Board

The National Computer Board also administers the Software Development Assistance Scheme (SDAS), a plan that encourages and assists local IT companies develop innovative and high quality computer software. This scheme covers up to 50% of direct costs.

One of the more lucrative financial incentives for companies to launch R&D projects is the Double Tax Deduction scheme administered by The Trade Development Board. This scheme allows companies to deduct against taxable income 200% of R&D costs incurred in eligible activities. This scheme is awarded to companies engaged in marketing activities to promote export of Singapore-based products, or in R&D activities.

R&D INFRASTRUCTURE

As a result of the promotion schemes and infrastructure facilities, a number of foreign multinationals and local companies have set up R&D centers in Singapore. Table 1 by the National Science and Technology Board shows the various categories of industrial R&D together with examples of the organizations that fall under each category.

Most of the R&D activities, whether private or government, are located in the Science Park. This forms the hub of the "Technology Corridor" which includes the Science Park, National University of Singapore (NUS), National University Hospital (NUH), the Singapore and Ngee Ann Polytechnics, the Jurong Town Corporation, the French-Singapore and German-Singapore Institutes, the Science Center and the Nanyang Technological University (Window on the Future: The Singapore Science Park, Science Council of Singapore. Please see Map - Annex IV).

The Science Park has become the island's center of industrial research and innovation. Several dozen private enterprises, together with a number of public bodies, are engaged in research work in areas such as biotechnology and biomedical sciences, computer and information technology, micro-electronics, and chemical and petrochemical engineering. With two phases completed and two more planned, the land area of the Park will encompass a total of 115 ha.

Two government agencies have been set up within the Science Park to assist private companies carrying out R&D activities. The National Computer Board (NCB) promotes and coordinates the implementation of the National Information Technology Plan. Through its research arm, the Information Technology Institute, training and consultancy services in the IT field are available. The Knowledge Engineering Resource Center serves as the library of the National Computer Board where IT information is available to organizations performing research in this field.

The National IT R&D Committee, set up in November 1990, is in the process of identifying the areas in which Singapore should concentrate its R&D efforts, the ways to build the R&D infrastructure, and how to apply the new technologies to the end-users. The Committee aims to make IT products and services that are for use in the home such as electronic transactions and home automation.

The NSTB, in the second half of 1991, will announce a masterplan to lead Singapore's R&D endeavors for the 1990s. Human resources and infrastructure development are the main essentials for increasing Singapore's technological capabilities. Key areas for growth include "niche areas" such as information technology, biotechnology, micro-electronics, materials technology, electronic systems, medical science, manufacturing technology, food and agro-technology, and water, energy and environmental technology. This plan includes the establishing of a Technology Promotion Division which will develop and oversee schemes to attract more R&D investment in Singapore.

The chart below describes NSTB's main tasks:

THE WORK OF THE NATIONAL SCIENCE AND TECHNOLOGY BOARD

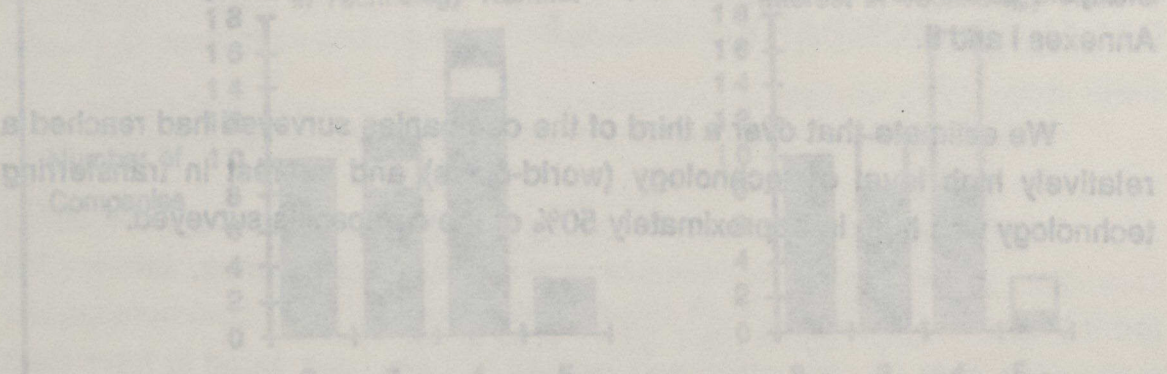
- o Promote research and development activities
- o Coordinate the formation and activities of existing and new research institutes
- o Be the central authority in issuing research funds
- o Assess and address Singapore's science and technology manpower needs
- o Undertake exchange and joint programmes with its overseas counterparts
- o Increase public awareness of science and technology
- o Form companies and joint ventures with private firms

("Science and Technology Masterplan on the Cards", Business Times, January 16, 1991).

Testing and calibration services as well as R&D consultancy and services in areas such as materials technology, food technology and product development and design are provided through the Singapore Institute of Standards and Industrial Research (SISIR).

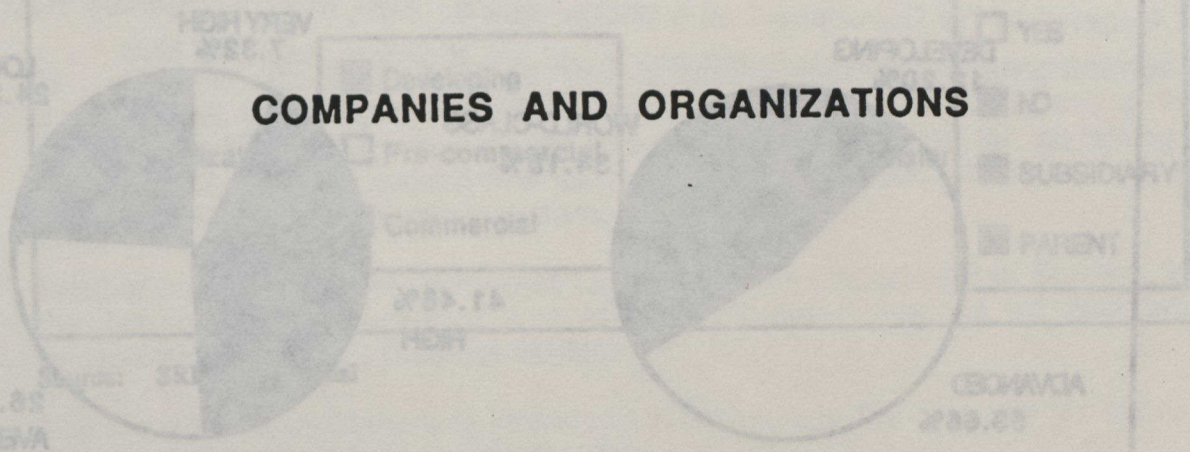
Two special research centers have been set up at the National University of Singapore. The Institute of Systems Science (ISS) carries out work on information technology and the Institute of Molecular and Cell Biology (IMCB) undertakes research in biotechnology.

Commercialization of technology transfer are both more common than are currently...
 To prepare this report, a survey of companies that engaged in high...
 technology research and development was carried out in January and February...
 1991. The results of this survey follow in this report section. An overview of the...
 survey's background is given below, with the full analysis being contained in...



SECTION II

COMPANIES AND ORGANIZATIONS

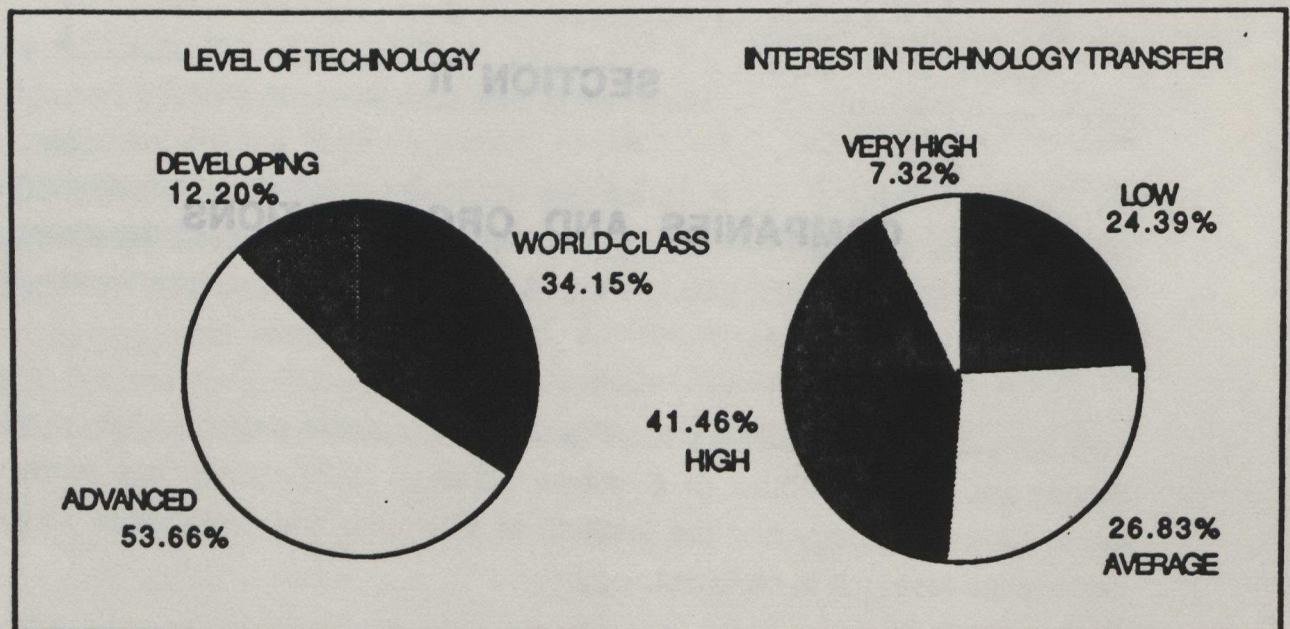


Source: SRI International

COMPANIES AND ORGANIZATIONS

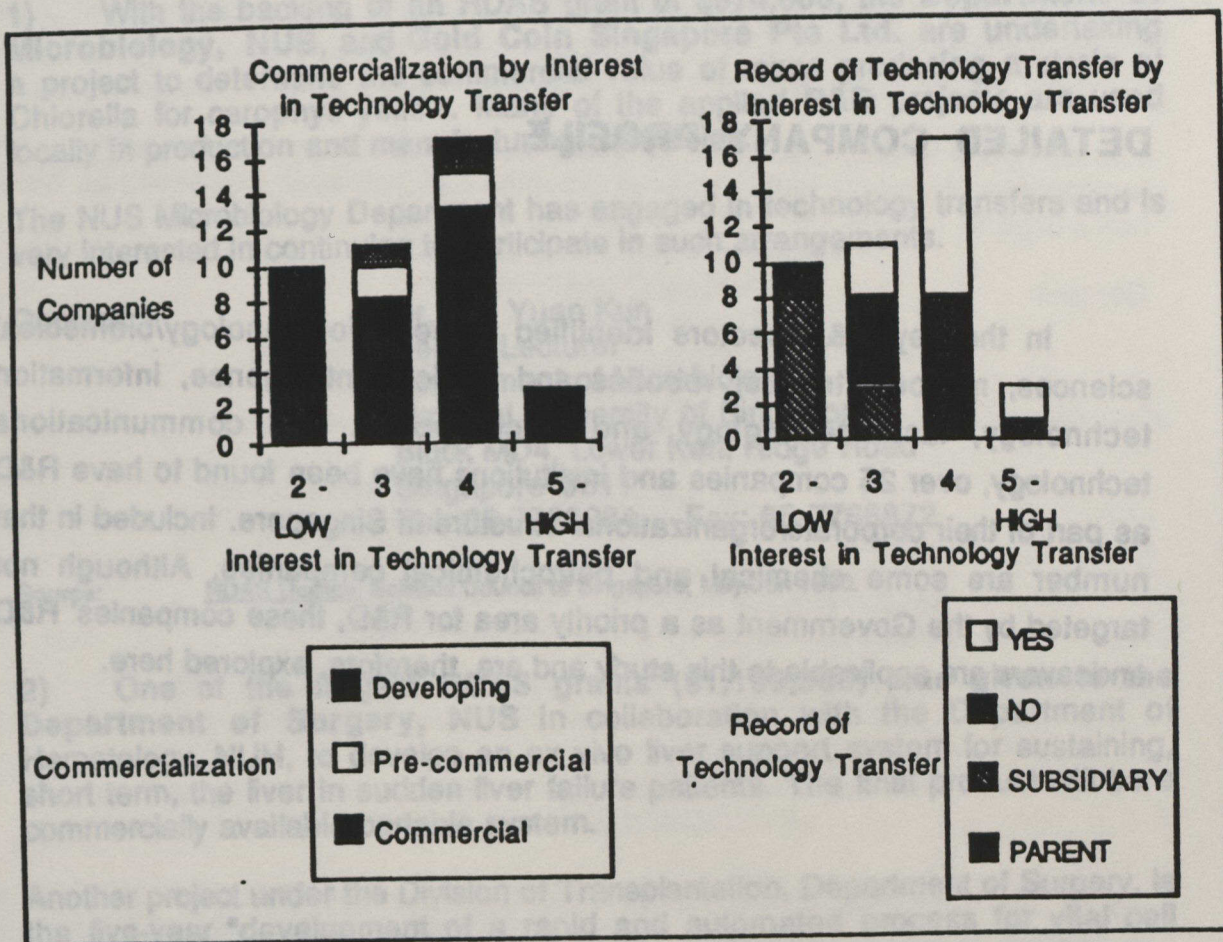
To prepare this report, a survey of 41 companies that engaged in high technology research and development was carried out in January and February 1991. The results of this survey follow in this report section. An overview of the analysis performed is shown below, with the full analysis being contained in Annexes I and II.

We estimate that over a third of the companies surveyed had reached a relatively high level of technology (world-class) and interest in transferring technology was high in approximately 50% of the companies surveyed.



Source: SRI International

Commercialization of technology developments and previous experience with technology transfer are both more common among firms that are currently keen on engaging in technology transfer agreements.



Source: SRI International

The Department of Surgery is interested in technology transfer and feels that their level of technology is sufficiently high.

Contact:

Dr. Susan Lim
 Department of Surgery
 National University of Singapore
 Lower Kent Ridge Road
 Singapore 0511
 Tel: 65-7724220 Fax: 65-7778427

Source: SRI Update, Science Council of Singapore, May/June 1990.

DETAILED COMPANY PROFILE

In the key R&D sectors identified earlier, biotechnology/biomedical sciences, microelectronics, robotics and artificial intelligence, information technology, laser technology and electro-optics, and communications technology, over 25 companies and institutions have been found to have R&D as part of their corporate/organizational structure in Singapore. Included in that number are some chemical and petrochemical companies. Although not targeted by the Government as a priority area for R&D, these companies' R&D endeavors are applicable to this study and are, therefore, explored here.

Source: S&I International

BIOTECHNOLOGY/BIOMEDICAL SCIENCES

1) With the backing of an RDAS grant of \$374,000, the Department of Microbiology, NUS, and Gold Coin Singapore Pte Ltd. are undertaking a project to determine the commercial value of mass producing a strain of *Chlorella* for carophyll yellow. Many of the applied R&D projects are used locally in production and manufacturing companies.

The NUS Microbiology Department has engaged in technology transfers and is very interested in continuing to participate in such arrangements.

Contact: Dr. Lee Yuan Kun
Senior Lecturer
Department of Microbiology
National University of Singapore
Block MD4, Lower Kent Ridge Road
Singapore 0511
Tel: 65-7723284 Fax: 65-7766872

Source: RDAS Update, Science Council of Singapore, May/June 1990.

2) One of the largest RDAS grants (\$1,199,300) was given to the Department of Surgery, NUS in collaboration with the Department of Hematology, NUH, to develop an ex vivo liver support system for sustaining, short term, the liver in sudden liver failure patients. The final product will be a commercially available portable system.

Another project under the Division of Transplantation, Department of Surgery, is the five-year "development of a rapid and automated process for vital cell transplantation in type I Diabetes Mellitus".

The Department of Surgery is interested in technology transfer and feels that their level of technology is sufficiently high.

Contact: Dr. Lim Susan
Department of Surgery
National University of Singapore
Lower Kent Ridge Road
Singapore 0511
Tel: 65-7724220 Fax: 65-7778427

Source: RDAS Update, Science Council of Singapore, May/June 1990.

3) **Diagnostic Biotechnology** is involved in the development and production of monoclonal based immunodiagnostics. Current products include various diagnostics kits for AIDS, Leukemia and Dengue Virus. Other products being developed in cooperation with research institutions in the USA, Europe, China and ASEAN countries, are a range of Hepatitis B and Epstein Barr Virus enzyme immunoassay kits. Equipment has been installed to facilitate programs involving recombinant DNA or genetic engineering technology.

The company is very interested in transfers of technology if the conditions are appropriate. Need for highly trained scientist was however expressed as being more urgent.

Contact:

Dr. Lily Chan
Director of R&D
Diagnostic Biotechnology (Pte) Ltd
65A Science Park Drive
The Fleming
Singapore 0511
Tel: 65-7782855 Fax: 65-777741

Sources:

Company Profile, Diagnostic Biotechnology.
1989 Annual Report, Diagnostic Biotechnology, May 1990.
Science Park Tenants, The Science Council of Singapore, 1990.

4) **The Institute of Molecular and Cell Biology (IMCB)** is involved in a number of research projects, ranging from toxins to kill mosquito larvae to treatments for diabetes and various cancers. The Institute contracted with Boehringer Mannheim (Germany) and Genzyme (USA) to supply technology to the international community in the form of a recombinant tumor necrosis factor-B as a research reagent.

Boasting 160 scientists and over 150 published articles over the first three years since establishing in 1987, IMCB is performing world-class research, with development and production following closely. The goal of the Institute is to become a "...center of excellence for biological science, resulting in the creation of a critical mass of brains who can understand new technology at all levels, and are able to recognize opportunities to participate in the several waves that this technology will bring."

The human brain, plant genetic engineering, and cell regulation are the three main areas under which most of the Institute's projects fall. The beneficiaries of this work will be people with brain disorders, and those who suffer from many other diseases related to cell growth, division or communication; plant and flower growers will also benefit from the work.

The newly established **Singapore Bio-Innovations (SBI)** is the dynamo for promoting international licensing agreements, joint ventures, and technology transfer agreements into and out of Singapore.

Contact: **Dr. Chris Y. H. Tan**
Director
Institute of Molecular and Cell Biology
National University of Singapore
10, Kent Ridge Crescent
Singapore 0511
Tel: 65-7723789 Fax: 65-7770402

Sources: "Basic Research at the Institute of Molecular and Cell Biology", The Singapore Biochemist, Vol 7(1), 1990.
IMCB's Research Report, NUS, January 1991.
"Operation Research", Lifel, The Straits Times, January 28, 1991.

5) **Pacific Biomedical Enterprises** seeks to develop and manufacture mechanical and biological prosthetic heart valves for the Asian market.

The company is open to technology transfer although they feel that the opportunities are for them to obtain foreign technology.

Contact: **Mr. Richard Martin**
Executive Director
Pacific Biomedical Enterprises P/L
51A Science Park Drive
The Faraday
Singapore 0511
Tel: 65-7781955 Fax: 65-7774162

6) **Plantek International** is a multinational plant biotechnology research company. The company's main activity is the genetic improvement of tropical crops like tea, coffee, cocoa, and palm oil through the research and the application of plant tissue culture technology.

While the company is interested in technology transfers, the research undertaken may not be appropriate for Canadian firms.

Contact: **Mr. Yang Show Fooi**
Managing Director
Plantek International (Pte) Ltd
59A Science Park Drive
The Fleming
Singapore 0511
Tel: 65-7792042 Fax: 7780375

7) **Rhone Merieux Asia Pacific Pte Ltd**, the veterinary division of Institute Merieux of France, is engaged in immunology and biology. The R&D projects center on the study of animal diseases in Asia Pacific.

The company is open to transfers of technology although they are a subsidiary of Institute Merieux and most of their needs are sourced from France.

Contact: **Dr. Monty T. Lee**
General Manager
Rhone Merieux Asia Pacific Pte Ltd
12 Science Park Drive
#04-02, The Mendel
Singapore 0511
Tel: 65-7785977 Fax: 65-7766903

8) **Scitech Genetics Pte Ltd** is a new organisation that undertakes R&D in monoclonal antibodies. They specialise in blood group characterisation and most of their research is in the area of blood cell grouping and antibodies.

While just newly established, the company is open to technology transfer opportunities.

Contact: **Dr. Sandrine Dousson**
Scientific Researcher
Scitech Genetics Pte Ltd
12 Science Park Drive
#04-04, The Mendel
Singapore 0511
Tel: 65-7796638 Fax: 65-7793784

9) **Shimadzu (Asia Pacific) Pte Ltd** is a leading Japanese scientific and medical equipment manufacturer undertaking R&D and marketing in Singapore. R&D efforts in Singapore focus on new analytical methods and application software for various analytical instruments. Shimadzu supplies medical systems and equipment such as X-ray apparatus, gamma cameras, X-ray CT scanners and therapeutic equipment and Magnetic Resonance Imaging systems to hospitals for use in most fields of science.

Limited interest in technology transfer since the company is a subsidiary of Shimadzu Corporation. Other ventures will however be viewed favorably.

Contact:

Mr. Kenichi Maeda
Managing Director
Shimadzu (Asia Pacific) Pte Ltd
16 Science Park Drive
#01-01, The Pasteur
Singapore 0511
Tel: 65-7786280

Source: Synergy, Science Council of Singapore, May/June 1990.

10) **Singapore Biotech Pte Ltd** devotes one-third of its operations to promote R&D activities. The company is actively researching the production and isolation of highly specific monoclonal antibodies for use in the treatment of infectious diseases, cancer-screening and genetic blood disorder test kits. Specifically, the company is developing or has launched diagnostic kits for nasopharyngeal cancer, thalassaemia and toxoplasma.

The company feels that in the Biotechnology field, there is good potential for Canadian firms to invest money and especially manpower and contribute ideas. Technology transfer is encouraged.

Contact:

Dr. Khong Peck Wah
General Manager
Singapore Biotech Pte Ltd
12 Science Park Drive
#02-01/03/04, The Mendel
Singapore 0511
Tel: 65-7791919 Fax: 65-7788703

Source:

Company Profile of Singapore Biotech, Singapore Biotech Pte Ltd.

11) The **Singapore National Eye Center (SNEC)**, was established in 1989 with the objective of "...ensuring quality eye care and to achieve international excellence..." in ophthalmic services. R&D activities focus on clinical research in the areas of radial keratotomy, laser treatment in diabetic retinopathy, complications and results of extracapsular extraction and implant surgery. The applications and effects of lasers on eye diseases such as diabetic retinopathy and glaucoma are also being studied. Priority areas of R&D include laser technology, lens implantation, and cornea transplants.

SNEC is interested in technology transfer and/or other licensing agreements. In fact, Dr. Arthur Lim, the Medical Director has been approached by pharmaceutical and ophthalmic equipment companies to be an advisor to their product development (for operating microscope and intraocular lens designs).

Contact: **Dr. Arthur Lim**
Medical Director
Singapore National Eye Center
11 Third Hospital Avenue
Singapore 0316
Tel: 65-2277255 Fax: 65-2277290

Sources: **Singapore National Eye Center, SNEC.**
Ms. Charity Wai, Administration Manager, SNEC.

ELECTRONICS/MICROELECTRONICS/COMPUTER SYSTEMS

1) **AT & T Microelectronics Design Center**, an AT & T Bell Laboratories facility, provides product design for Application Specific Integrated Circuits (ASICs) for AT & T and other OEM customers within the Asia Pacific Region. In addition to ASICs, other product lines are communication chips, graphics and speech processors, analog integrated components and linear arrays, interconnect and lightwave products and power supplies. With the hiring of world-class engineers, AT & T has the technical support to enhance product development and customer relationships.

The organization is a subsidiary of AT&T and most of their requirements are met by the parent company. They are however open to other ventures.

Contact: **Mr. C.M. Tang**
Director, IC Design Center
AT & T Microelectronics (Asia/Pacific)
14 Science Park Drive
#03-02A/04, The Maxwell
Singapore 0511
Tel: 65-7788833 Fax: 65-7777495

Source: Synergy, Science Council of Singapore, Sep/Oct 1990.

2) **Flotronic Technology** undertakes research into the control gear for florescent lighting. Their electronic ballast is the basis of their control gears and is different from normal inductive ballast.

The company is very open to technology transfer and licensing opportunities if they arise.

Contact: **Mr. Peter Skalak**
General Manager
Flotronic Technology Pte Ltd
291 Serangoon Road
Serangoon Building #03-00
Singapore 0821
Tel: 65-2970037 Fax: 65-2922348

3) **IPACS Computer Services** provides software and hardware services in data processing, on-line network systems and industrial automation. IPACS received a Product Development Assistance Scheme (PDAS) grant from the EDB for the Air Cargo System, a part of the "FreightNet" System of computer networks for freight forwarding coordination. Development work is also carried out on man-machine communication applications which will utilize voice recognition and interactive voice dialog features.

The organization is open to technology transfer arrangements. However, they feel that opportunities are limited.

Contact: **Mr. Wong Sing Lam**
Managing Director
IPACS Computer Services (S) Pte Ltd
73 Science Park Drive
#B1-15, Cintech Building
Singapore 0511
Tel: 65-7752388 Fax: 65-7780080

4) **Lectret Precision Pte Ltd** is the recipient of a \$275,100 RDAS grant to develop, using silicon processing technology, a subminiature hearing aid microphone. Lectret would like to engage in technology transfer agreements.

Contact: **Mr. Lim Kok Chuan**
General Manager
Lectret Precision Pte Ltd
26 Ayer Rajah Crescent, #04-01
Singapore 0513
Tel: 65-7761021 Fax: 65-7791021

Source: RDAS Update, Science Council of Singapore, May/June 1990.

5) **Logicraft Products Manufacturing Pte Ltd** does R&D on electronics and computers, specializing in Laptop and Note-book computers. Design and manufacturing is also carried out on silicon products for other electronic components.

The company expressed an interest in technology transfer although they express reservations about Canadian interest in their current technology.

Contact:

Mr. Steven **Chai**
Managing Director
Logicraft Products Manufacturing Pte Ltd
21 Kallang Ave
#05-169
Singapore 1233
Tel: 65-2939088 Fax: 65-2937300

6) **Maxtor Singapore**, in conjunction with the Department of Electrical Engineering, NUS, received an RDAS grant of \$380,000, to study the role of magnetics in the fabrication of disk drives. A leading-edge producer of high capacity disk drives, Maxtor mostly engages in R&D for use by the headquarters, however, they are open to licensing agreements.

Contact:

Dr. M. A. **Jabbar**
Manager, R&D Center
Maxtor Singapore Ltd
Ang Mo Kio Industrial Park 2
Block 5006 #03-13
Ang Mo Kio Avenue 5
Singapore 2056
Tel: 65-4801603 Fax: 65-4823208

Source: RDAS Update, Science Council of Singapore, May/June 1990.

7) **Snowflake Technology Pte Ltd** is an automation system house undertaking design and development in applying electronic and computer control technology to various plants. They specialize in Systems Control and Data Acquisition and have experience in designing complete plant control systems. They have acted as a technology access point for the South Australian Government in defence and aerospace related areas as well as having back-to-back servicing agreements with various high technology companies in Singapore.

The company voiced a very strong interest in engaging in technology transfer and other business ventures.

Contact: **Mr Ted Packer**
Chief Executive Officer
Snowflake Technology Pte Ltd
1 Science Park Drive
#B2-58 SISIR Building
Singapore 0511
Tel: 65-7794001 Fax: 65-7794241

8) **Tata-Elxsi** performs research, development, manufacturing and marketing of the Elxsi System 6400, an expandable multipurpose, 64-bit parallel processor computer system. The system's range, from minisupercomputer to supercomputer capabilities, makes it an efficient instrument for use in national research labs, universities, and industrial, engineering, and research companies. Primary applications include real-time data acquisition, analysis, simulation, seismic data processing, large multi-user/database, and software development.

Little interest in technology transfer was expressed.

Contact: **Mr. Patrick McGoldrick**
Managing Director
Tata-Elxsi Pte Ltd
55 Science Park Drive
The Faraday
Singapore 0511
Tel: 65-7794733 Fax: 65-7787494

9) **Teradyne Singapore Ltd** is one of the world's largest Automated Test Equipment (ATE) companies. Teradyne's ATE systems are used to test integrated circuits, circuit boards, connection systems (military uses), and telecommunications equipment. The Assembly Test Development Center was created as the R&D arm for the company.

While the company is open to technology transfer, they feel that Canadian firms would have limited interest in their technology since there are few companies in Canada that are in the same field.

Contact:

Mr. Melvin Low
South-Asia Regional Manager
Assembly Group
Teradyne Singapore Ltd
16 Science Park Drive
#03-01, The Pasteur
Singapore 0511
Tel: 65-7730766 Fax: 65-7730961

Sources: Synergy, Science Council of Singapore, Sep/Oct 1990.
1989 Annual Report, Teradyne, Inc., March 1990.

Little interest in technology transfer was expressed.

Mr. Patrick McQuinn
Managing Director
Teradyne Singapore Ltd
16 Science Park Drive
The Pasteur
Singapore 0511
Tel: 65-7730766 Fax: 65-7730961

Contact:

ROBOTICS AND ARTIFICIAL INTELLIGENCE (AI)

1) The Artificial Intelligence Center is a joint endeavor of both the Japanese (Japan International Cooperation Agency - JICA) and Singapore (National Computer Board - NCB) Governments. The Center will focus on the development, practical applications, and training in expert systems-based AI technology. Primarily a training institute at present, the center intends to produce a pool of 500-600 AI specialists over the next five years. Training courses to be offered starting in the third quarter of 1991 will train managers, software engineers, and business professionals in AI and expert systems, helping the managers decide which systems are suitable for their business.

At this time, the technology transfer has been from JICA in the form of Artificial Intelligence and expert systems technology to Singapore.

Contact:

Mr. Teo Thiam Chye
Head of Administration
Japan Singapore AI Center
c/o NCB
71 Science Park Drive
NCB Building
Singapore 0511
Tel: 65-7720967 Fax: 65-7773043

Sources: Synergy, Science Council of Singapore, Sep/Oct 1990.
JSAIC, Japan Singapore AI Center.
IT Focus, NCB IT Industry Newsletter, NCB, June 1990.

2) The Automation Applications Center (AAC) was set up to develop expertise in factory automation technologies, including low-cost automation, flexible automation, computer integrated manufacturing, manufacturing resource planning, and advanced industrial engineering techniques. AAC hopes to extend the use of these techniques to local companies through, for example, training and consultancy. Projects include an industry-wide study of automation in Singapore for utilization in the National Automation Master Plan (1987/88) and Consultancy to 100 selected companies to identify possible areas of automation feasibility, commissioned by the EDB (1989/90).

The organization shows a willingness to engage in technology transfer arrangements.

Contact: Mr. James Ling
Center Director
Automation Applications Center
61A Science Park Drive
The Fleming
Singapore 0511
Tel: 65-7797311 Fax: 65-7795129

Sources: Science Park Tenants, The Science Council of Singapore, 1990.
Company Profile, Automations Application Center, 1990.

3) **GINTIC**, a Computer Integrated Manufacturing Institute, is a division within the Nanyang Technological Institute, funded by the Ministry of Finance with a grant of S\$50 Million over 5 years. Their aim is to undertake R&D in Industrial Artificial Intelligence applications. Gintic's focus is on flexible manufacturing systems where machine tools are programmed to handle precision machining of parts and printed circuit board assembly. The organization also uses Stereolithographic apparatus for desk-top manufacturing of prototypes and models. Gintic is also a CAD/CAM centre using an IBM mainframe and undertakes design and analysis work for electrical, electronic and mechanical engineering applications.

The Business Group is responsible for the commercialization of the results of GINTIC's R&D efforts. GINTIC expressed an interest in technology transfer.

Contact: Dr. Lim Beng Siong
Engineering Manager
GINTIC
Nanyang Technological Institute
Nanyang Ave
Singapore 2263
Tel: 65-6605547

Source: GINTIC: Institute of CIM, GINTIC.

4) **Life Technologies Pte Ltd** carries out automation research and development in areas like medical, clinical, biotechnological, food and drink, pharmaceuticals and Agro-veterinary fields. They emphasize developing and the packaging of technology into a commercially viable product.

While not keen to engage in technology transfer arrangements, they are open to other joint venture agreements.

Contact: **Mr Kenneth Chong**
Director
Life Technologies Pte Ltd
16 Science Park Drive
#03-04A The Pasteur
Singapore 0511
Tel: 65-7793228 Fax: 65-7766070

5) **SW International Systems Pte Ltd** is involved in the development and use of Expert Systems in the areas of Health Care, Manufacturing and Distribution. The company signed an agreement in mid-1990 with SGH and ICL Singapore to develop software to computerize all obstetric patient records. Two products are SAGA, a productivity tool for the generation of applications programs, and ParaMedic, a system for managing a medical office or for providing hospitals with the facility to submit claims and information through the Central Claims Processing System.

The firm is open to technology transfer opportunities.

Contact: **Mr. Brian Cohen**
Technical Director
SW International Systems Pte Ltd
14 Science Park Drive
#04-01, The Maxwell
Singapore 0511
Tel: 65-7780066 Fax: 65-7779401

Sources: **Synergy**, Science Council of Singapore, May/June 1990.
Science Park Tenants, Science Council of Singapore, 1990.
SAGA, SW International Systems.
ParaMedic, SW International Systems.

INFORMATION TECHNOLOGY

1) **Bizpoint System Pte Ltd** develops a range of user friendly, comprehensive standard accounting packages. Turnkey projects are also undertaken which entail system study, system design and development, training and implementation as well as hardware selection and evaluation.

While the company is open to opportunities for any transfer of technology, they feel that flow of technology from Canada to Singapore is more appropriate.

Contact:

Mr. Teo Yee Cheong
Director
Bizpoint System Pte Ltd
73 Science Park Drive
#B1-07/08, Cintech Building
Singapore 0511
Tel: 65-7755588 Fax: 65-7796300

2) **EDS Electronic Document Systems** plans to market whole system document imaging packages where available computer related hardware is available together with software produced by their research and development team. They are conducting R&D in software that stores documents in optical discs through optical character recognition. They aim to provide effective and efficient indexing and storage of documents so that retrieval may be facilitated.

The company voiced a strong interest in technology transfer and indicated a need for venture-capital funding.

Contact:

Mr Christopher Loke
Manager
EDS Electronic Document Systems
1 Science Park Drive
#B1-06 SISIR Building
Singapore 0511
Tel: 65-7777911 Fax: 65-7757353

3) **Information Engineering Services** is a software house specialising in application software like financial, transport, maintenance and management software and experts systems. They possess one of the largest pools of software engineers in Southeast Asia and have developed an Artificial Intelligence based tool of auditing named AuditPro to enable junior auditors to undertake the function of a senior auditor.

The company has expressed an interest in engaging in technology transfer.

Contact:

Mr Lim Koon Sang
General Manager
Information Engineering Services Pte Ltd
#02-180/181
Tyrwhitt Road
Singapore 0820
Tel: 65-2926888 Fax: 65-2929677

5) The **Information Technology Institute**, the R&D arm of the National Computer Board. Manpower needs are currently their priority area with plans to increase the number of IT professionals to 30,000 by the year 2000. Increased enrollment in IT educational institutes, recruitment of overseas talent, and on-the-job Systems Programming courses are all designed to realize the manpower goal.

Contact:

Mrs. Chin-Tan Tahn Joo
Director
Information Technology Institute
Information Technology Industry Division
National Computer Board
71 Science Park Drive
NCB Building
Singapore 0511
Tel: 65-7720389 Fax: 65-7789641

Source:

"IT Industry Aims for 30,000 Professionals by Year 2000", Business Times, January 24, 1991.

6) The Institute of Systems Science, NUS, is setting up an R&D Center for the development of image archival systems. For use in companies or organizations with large databases, these systems are made to store and quickly retrieve documents that incorporate images, text, and photos. The ISS hopes to involve five or six companies in the funding of the R&D Center.

ISS engages in two main types of R&D: 1) Tool development for use in-house and for sale to computer vendors and 2) State-of-the-art technologies that will help Singapore companies become more productive and will aid in their ability to use new computer technologies. The three main product divisions, in which there are currently 16 projects in progress, include Multimedia, Natural Language (Computer Aided Translation), and Advanced AI products. Actual projects from these divisions include: an artificial intelligence diagnostic system for avionics equipment for Singapore Airlines; a computer-aided translation system for IBM Asia-Pacific; and an inventory of videotapes for the Curriculum Development Institute of Singapore.

Long-term plans for R&D have been identified as Knowledge Acquisition, Processing, and Interconnected Distribution. The first involves a computer that can obtain and describe information in the form of images, graphics, voice and sound. The second concerns the deciphering patterns, such as language. The third will focus on computers transferring information (video) across telecommunications networks.

Contact:

Dr. Desai Narasimhalu
Program Manager
Institute of Systems Science
National University of Singapore
Heng Mui Keng Terrace
Singapore 0511
Tel: 65-7722002 Fax: 65-7782571

Sources:

"Institute of Systems Science Hopes to Set up R&D Center", The Straits Times, January 17, 1991.

Dr. Desai Narasimhalu, Program Manager, ISS.

"Operation Research", Lifel, The Straits Times, January, 28, 1991.

7) **Mentor Graphics (Singapore)** is involved in systems integration, software development, marketing and servicing Electronic Design Automation Systems. The company offers Integrated Design Automation Solutions, ASIC/VLSI design, mechanical design and thermal analysis, Computer-Aided Software Engineering (CASE) and Technical Publishing Software.

The firm did not express an interest in technology transfer although they are open to other types of ventures.

Contact: **Mr. Steve Ting**
General Manager, Pacific Rim
Mentor Graphics (Singapore) Pte Ltd
53 Science Park Drive
The Faraday
Singapore 0511
Tel: 65-7791111 Fax: 65-7794455

8) **Ontrax Systems** is a software house specializing in developing object-oriented software packages. These packages are used as tools to enable programmers and advanced users to develop application software in the customer's environment.

They have expressed an interest in technology transfer but feel that they are unlikely to be able to offer much at the present since their products are still in the developing stages.

Contact: **Mr Ho Ming Heng**
Director
Ontrax Systems
1 Science Park Drive
#B1-42A SISIR Building
Singapore 0511
Tel: 65-7732726 Fax: 65-7732725

9) **Singapore Computer Systems (Pte) Ltd (SCS)** is a systems house offering a comprehensive range of products and value added services that cater to a wide range of information needs using Object-oriented Technology. Areas of focus include: Management Information Systems (MIS), especially accounting-based application and productivity tools; CAD/CAM; Library Automation; Application Systems for Banking and Finance, Manufacturing and Distribution; Systems Software such as Performance Tools and Capacity Planning Management; and Educational Training Products.

The company expressed an interest in technology transfer opportunities.

Contact:

Mr. Denis Yong
General Manager, Research Unit
Singapore Computer Systems P/L
750D Chai Chee Road,
Chai Chee Industrial Park,
Singapore 1646
Tel: 65-4412600 Fax: 65-4412811

10) **Singapore Network Services Pte Ltd (SNS)** provides cost effective and efficient business communication solutions to the Singapore business community. The TradeNet System, an Electronic Data Interchange (EDI) network system, is one such solution allowing various parties from the private and public sector to exchange structured trade documents and information electronically. Future stages of TradeNet will enable information exchange between trading partners and an eventual link up with similar EDI networks overseas.

An interest in technology transfer and other types of ventures especially in data exchange networking was expressed.

Contact:

Mr. Chan Kah Kuen
Assistant General Manager,
Director of Corporate Services
Singapore Network Services P/L
73 Science Park Drive
#02-06/08, Cintech Building
Singapore 0511
Tel: 65-7785611 Fax: 65-7785277

COMMUNICATIONS TECHNOLOGY

1) **Chartered Microwave** is a unique organization in this region undertaking research & development and the production of microwave components and subsystems. Their design, etching and production facilities are equipped with the latest Computer Aided Design tools, Microwave Integrated Circuit (MIC) fabrication and clean-room technology. Low-noise blocks used in satellite communications are also designed and manufactured in Singapore. Other products that have been developed include UHF components like Oscillators, Amplifiers, Frequency Multipliers, Filters, Mixers, Phase Detectors; and Sub-assemblies like Synthesizers, Frequency Converters, and Phase Locked Oscillators. Such State-of-the-Art products find application in a wide variety of microwave and telecommunication systems, both in the commercial and military markets.

A very strong interest in technology transfer and licensing agreements was expressed. The company also feels that Canadian companies would be very interested and showed an openness to participate in ventures in the microwave communication field.

Contact:

Mr. Leon Koh
Assistant General Manager
Chartered Microwave Pte Ltd
57 Science Park Drive
The Faraday
Singapore 0511
Tel: 65-7762388 Fax: 65-7774603

Source:

Chartered Microwave

2) **Dorart Industries** carries out design, research and development and manufacturing of telephone systems.

Contact:

Mr. Neo Kim Tuay
General Manager
Dorart Industries Pte Ltd
21 Kallang Ave
#04-165/167
Singapore 1233
Tel: 65-2930393 Fax: 65-2920758

PETROCHEMICALS AND CHEMICALS

1) **Energy Chemicals Asia Pacific (EnCAP)**, a division of **Exxon Chemical SIMCO Pte Ltd**, is involved in petroleum exploration, and the production, transportation and refining of chemicals and petrochemical production aids. Its Regional Technology Center conducts product R&D.

An interest in technology transfer was not expressed since the organization is a division of Exxon Chemicals.

Contact:

Dr. Philip Dunn
Business Manager, Asia Pacific
Exxon Chemical SIMCO Pte Ltd
14 Science Park Drive
#02-04, The Maxwell
Singapore 0511
Tel: 65-7792697 Fax: 65-7781325

2) **Intermediates Technology Center (INTEC)**, a petrochemical product laboratory also operating under **EXXON Chemical SIMCO Pte Ltd**, is equipped with up-to-date instruments and apparatus for product testing and development. Exxon Chemical affiliates and customers in Asia Pacific have the opportunity to use the laboratory as a technology and training center.

The Center expressed a willingness to transfer technology to appropriate organizations.

Contact:

Dr. Lee Wee Sun, Thomas
INTEC Manager
Intermediates Technology Center
Exxon Chemicals SIMCO Pte Ltd
14 Science Park Drive
#02-02, The Maxwell
Singapore 0511
Tel: 65-7795388 Fax: 65-7773556

3) **Lam Soon Oil and Soap Manufacturing (S) Pte Ltd** is a local company that deals in vegetable oils and fats. They undertake R&D in palm oil and is especially strong in developing cocoa butter substitutes and other specialty fats.

They have expressed an interest in engaging in technology transfer.

Contact: **Mr Wong Mong Hong**
Chief Engineer
Lam Soon Oil and Soap Manufacturing
15 Scotts Road
#05-01
Singapore 0922
Tel: 65-7371311 Fax: 65-7376388

4) **Polysar Asia Pacific** was established to provide technical service and product and application development to support the Polysar synthetic rubber business in Asia Pacific. Further developments will encourage analytical and research activities that will focus on the petrochemical needs of the region.

The firm is a subsidiary of Polysar of Canada and thus did not express any interest in technology transfer.

Contact: **Mr. D. J. Threadingham**
Technical Director
Polysar Asia Pacific Pte Ltd
Technical Center
14 Science Park Drive
#04-03/04, The Maxwell
Singapore 0511
Tel: 65-7779322 Fax: 65-7787956

5) **Union Carbide Asia Pacific Inc** has been set up as a research and development facility to provide technical support and consultancy services for Union Carbide's manufacturing operations in the region. It will develop, supervised by technical experts, new chemical products as well as improve existing ones to suit the regional climate and conditions. The facility will concentrate its R&D in the emulsion polymer business, solvents-based coating polymers, organosilicones, water soluble polymers and biocides. Future plans are to establish links with academic and research institutions in Singapore for mutually beneficiary research endeavors.

The company being a subsidiary of Union Carbide, did not express any interest in technology transfer.

Contact:

Dr. M. L. Farmer
Technical Director
Union Carbide Asia Pacific Inc
16 Science Park Drive
#04-01/02, The Pasteur
Singapore 0511
Tel: 65-7782630

Source: Synergy, Science Council of Singapore, May/June 1990.

Unless otherwise noted, company information for Section II was obtained from Science Park Tenants, The Science Council of Singapore, 1990.

SECTION III

GOVERNMENTAL BODIES INVOLVED IN R&D PROMOTION ACTIVITIES

GOVERNMENTAL BODIES INVOLVED IN R&D PROMOTION ACTIVITIES

NATIONAL SCIENCE AND TECHNOLOGY BOARD

63 Science Park Drive
The Fleming
Singapore 0511
Fax: 65-7771711

Assistant Director
(Technology Promotion)

Mdm Lee Swee Khuan

65-7797066

Replacing the Singapore Science Council, the NSTB was created to plan and promote all R&D programs and enhance the scientific and technological capabilities in Singapore. The NSTB may form companies and participate in technology licensing and joint R&D efforts.

The Grant Schemes of **SECTION III** R&D programs both in the public and private sector. Expert committees have been formed to help bridge the gap between basic and applied research to facilitate the commercialisation of high

GOVERNMENTAL BODIES INVOLVED IN R&D PROMOTION ACTIVITIES

Human Resource Development is also a priority area. "Attracting and retaining talent" is a major challenge in Singapore with its "limited pool of scientists and engineers".

The Science Habitat, or Phase II of the Science Park, will be cultivated as a centre integrating R&D, academic and business activities with living and social amenities. The intention is to transform the Park into an environment conducive for innovation and discovery, business start-ups and recreational pursuits.

The ASEAN Committee on Science and Technology (COST) promotes cooperation throughout the region on science and technology development projects. Through this Committee and several ASEAN-Australia Projects, Singapore is involved in 23 R&D projects in areas such as Food Habits, Food Technology, Energy Conservation Technology, Coastal Resources Management, Marine Science, Regional Ocean Dynamics, Materials Science & Technology, Microelectronics, Energy Conservation in Buildings, and Biotechnology.

Several organizations participated in the region and world-wide courses held for members of the International Atomic Energy Agency (IAEA). The IAEA's objective is to transfer nuclear technology to its members by providing training, expert services and equipment. The SGH Department of Nuclear Medicine, the

GOVERNMENTAL BODIES INVOLVED IN R&D PROMOTION ACTIVITIES

NATIONAL SCIENCE AND TECHNOLOGY BOARD

63 Science Park Drive
The Fleming
Singapore 0511
Fax: 65-7771711

Assistant Director
(Technology Promotion)

Mdm Lee Swee Khuen

65-7797066

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NUS Departments of Civil Engineering and Physics, Radiation Protection Inspectorate, Setsco Services, and Singapore Test Services Pte Ltd were all participants in the IAEA Courses in 1989/90.

Other promotions of Science and Technology include an R&D Seminar Series, regional seminars on specific subjects, Technology Month and a program of Distinguished Visitors.

Sources: "Operation Research", Lifel, The Straits Times, January 28, 1991.
Annual Report 1989/90, Singapore Science Council, June 1990.

ECONOMIC DEVELOPMENT BOARD

250 North Bridge Road #24-00
Raffles City Tower
Singapore 0617
Fax: 65-3396077

Technology Promotion Group

Senior Industry Officer Mr Sim See Hwee 65-3306655

- * One of the objectives of this new department is to coordinate Singapore's R&D activities. At present, the Group is researching all the companies involved in R&D: what R&D they are undertaking, what level of technology, their manpower skill, their capabilities, and the geographical application of their research i.e., Singapore, Regional, or Global.

Training Institutes & Specialized Units

French Singapore Institute
12 Science Center Road
Singapore 2260
Fax: 65-5621492

Director Mr Michel Ligier 65-5611400
Deputy Director Norman Cheung Chak Ming

- * Research: electronics and computers, manpower training in these two industries. Development: application of new and emerging technologies such as Machine Vision Technology and AI expert systems.

German Singapore Institute
10 Science Center Road
Singapore 2260
Fax: 65-5621189

Director
Deputy Director

Mr Klaus Krueger
Mr Hq Hooi Min

65-5613866

- Production methods and plastics.

Applied Technology Group
(Technology Development and Industrial Projects - EDB)
10 Science Centre Road
Singapore 2260
Fax: 65-5621189
Deputy Director
(Technology Innovation)

Mr Fong Alk Meng

65-2731477

- Manufacturing, Automation, Flexible Robotics (robots with sensory capabilities), Automated Guide Vehicles (AGV), and Factor Data Acquisition Systems.

NATIONAL COMPUTER BOARD

71 Science Park Drive
NCB Building
Singapore 0511
Fax: 65-7789641

General Manager

Mr. Lim Swee Say

65-7720202

- R&D activities are undertaken by the Information Technology Institute (see Information Technology #4 above).

SINGAPORE INSTITUTE OF STANDARDS & INDUSTRIAL RESEARCH (SISIR)

1 Science Park Drive
Singapore 0511
Fax: 65-7780086

Technology Transfer Division
Director

Fax: 65-7730672
CPT (Res) Teo Nam Kuan 65-7729518

• The institute is the national standards authority and undertakes work in industrial R&D, design and development technical consultancy, technology transfer testing and evaluation, failure analysis and diagnosis. The areas where such work is handled are in Materials technology, Product and Process technology, Electronic and Computer Application.

SISIR's R&D efforts are mainly client-sponsored. They have undertaken R&D projects for various local and foreign companies in the above fields. However as well as undertaking contract R&D and consultancy work, SISIR has also been involve in developing its own line of industrial products some of which like the SISIR orchid, algae-resistant paint and waste oil treatment have already been commercially available or could be customized to meet clients requirements. Currently the areas of expertise are in microelectronics, surface technology, computer simulation for mechanical devises and structures and chemical-electro plating.

SISIR plans to open a food biotechnology centre in June, an EMC (Electro-Magnetic Compatibility) research centre in the third quarter, and begin a three-year program to bring in a panel of international advisers.

The food biotechnology centre will concentrate on food taste enhancement and "basic" food research rather than on automation and packaging. The EMC centre will "...test electronic products which emit electro-magnetic signals to check the extent of disruption caused to neighbouring electronic equipment." The centre will have the capability to determine if products comply with specific international standards. The panel of international advisers stands currently at six, a strengthening of the overseas network established over the years.

With possible funding from the European Community (EC), SISIR may set up a National Institute of Environmental Technology. The proposed institute "...will focus on the treatment of industrial waste, industrial pollution and other related environmental matters such as waste recycling." The Institute will be a training

ground for environmental experts around the region and by 1995, through consultancy work, should be self-financing.

Source: Annual Report 1989/90, Singapore Institute of Standards and Industrial Research
SISIR Plans Two New Research Centres, Business Times, January 23, 1991.
"EC May Help Fund Institute of Environmental Technology", Business Times, January 23, 1991.

SINGAPORE POLYTECHNIC

500 Dover Road
Singapore 0513

Technology Transfer Centre

Director: Dr Philip Chin
Tel: 65-7721055 Fax: 65-7721963

* The Singapore Polytechnic engages in consultancy work for design, manufacturing and engineering. They have recently set up the Technology Transfer Centre to facilitate to transfer of technology from the Polytechnic to the commercial sector.

NATIONAL UNIVERSITY OF SINGAPORE CONTACTS AND CURRENT RDAS WORKS IN PROGRESS AT NUS

NATIONAL UNIVERSITY OF SINGAPORE

Kent Ridge Campus
Singapore 0511

Faculty of Medicine

Dean

Professor Edward Jack

65-7756885

Fax:

65-7755743

* NUS has begun, in the last decade, to recognize the importance of research in improving medical technology and has received funding, facilities and staff to facilitate research programs. Several areas have been highlighted as "niche" areas where NUS has strengths: Transplantation, Ophthalmology, Cancers, Assisted reproduction, Prosthetics, Vaccines, and Rehabilitation. To succeed, researchers need to be encouraged to stay in Singapore while more need to be attracted to the field.

SECTION IV

NATIONAL UNIVERSITY OF SINGAPORE CONTACTS AND CURRENT RDAS WORKS IN PROGRESS AT NUS

Faculty of Science

Dean

Professor Bernard Tan

65-7756068

Fax:

65-7774278

* Currently, areas "where our strengths lie and where we have chances of attaining world-class status" are being defined. The Faculty will concentrate on multi-disciplinary synergistic efforts to realize their objective. Advances in recent years were in areas such as information technology, molecular and cell biology, materials and surface science, polymer science, plant tissue culture and image processing.

* NUS has established the Center for Industrial Collaboration to build links with industry to keep research in line with technological and industrial progress in Singapore.

Source: "Operation Research", *Lat Pau*, Singapore, January 28, 1991.

NATIONAL UNIVERSITY OF SINGAPORE CONTACTS AND CURRENT RDAS WORKS IN PROGRESS AT NUS

NATIONAL UNIVERSITY OF SINGAPORE

Kent Ridge Campus
Singapore 0511

Faculty of Medicine

Dean

Professor Edward Tock

65-7756666

Fax:

65-7785743

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Source: "Operation Research", Life, The Straits Times, January 28, 1991.

Faculty of Science

Dean

Professor Bernard Tan

65-7756666

Fax:

65-7774279

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Source: "Operation Research", Life, The Straits Times, January 28, 1991.

RDAS GRANTS - PROJECTS IN PROGRESS

Electrical Engineering Department

Dr. Chow Hon Yean
Fax:

65-7722108
65-7791103

- * "Machine Vision Systems for IC Inspection", a project involving the development of image processing and lighting techniques for the automation of integrated circuit inspection.

Professor Tjhung Tjeng Thiang
Fax:

65-7722108
65-7791103

- * "Optical Fibre Local Subscriber Network" is a project undertaken jointly by the Electrical Engineering Department, NUS, and the Telecommunication Authority of Singapore in an effort to research the Integrated Services Digital Network (ISDN). In an information based society, this Network will be an instrumental part of the communications infrastructure.

Dr. Lim Yong Ching
Fax:

65-7722108
65-7791103

- * "Development of VLSI Design Tools and Implementation Scheme" will involve Chartered Semiconductor Pte Ltd in the creation of a set of CAD tools that are required for the design of the VLSI.

Department of Pathology (National University Hospital)

Professor R. Sinniah
Fax:

65-7724300
65-7780671

- * "Imaging and Computerized Cell Analysis Systems in Pathology" is a collaboration between the Departments of Pathology and Electrical Engineering, NUS, and Silicon Graphics Pte Ltd. The objective of this research is to discover ways, through the development of imaging systems and automated quantitative analysis, to analyze human diseases such a cervical cancer and kidney disease.

Department of Microbiology

Dr. Ren Ee Chee

Fax:

65-7723276

65-7785743

- "Development of Immunotoxins as Antitumor Reagents" aims to develop immunotoxins that will kill tumor cells in cancers such as liver, breast, and T-leukemia.

Source of RDAS Projects in Progress: Research and Development Assistance Schemes, Project Summaries Volume III (1989), Science Council of Singapore, December 1989.

ANNEX I

SUMMARY PROFILE OF SINGAPORE HIGH
TECHNOLOGY R&D COMPANIES

ANNEX I

SUMMARY PROFILE OF SINGAPORE HIGH TECHNOLOGY R&D COMPANIES

SECTOR/ORGANIZATION	LEVEL OF TECH	COMMERCIALIZATION	INTEREST IN TECH TRANSFER	RECORD OF TECH TRANSFER
BIOTECHNOLOGY/BIOMEDICAL				
DEPT OF MICROBIOLOGY, NUS	W	C	4	Y
DEPT OF SURGERY, NUH	W	C	4	N
DIAGNOSTIC BIOTECHNOLOGY	A	C	4	Y
IMCB	W	C	4	Y
PACIFIC BIOMEDICAL	D	P	3	Y
PLANTECK	A	C	2	S
RHONE MERIEU	W	P	3	S
SCITECH GENETICS	A	C	3	S
SHIMADZU	A	C	2	S
SINGAPORE BIOTECH	A	C	4	N
SINGAPORE NATIONAL EYE CENTER	A	C	4	N
SINGAPORE NATIONAL EYE CENTER ELECTRONICS/COMPUTER SYS	W	C	5	N
AT&T	A	D	2	S
FLOTRONIC TECHNOLOGY	W	C	4	N
IPACS	A	C	3	N
LECTRET PRECISION	W	C	4	P
LOGICRAFT	A	C	4	N
MAXTOR	W	C	3	Y
SNOWFLAKE	W	D	4	Y
TATA-ELXSI	W	C	5	Y
TERADYNE	A	C	2	S
ROBOTICS/AI	A	C	3	Y
ARTIFICIAL INTELLIGENCE CENTER	D	D	3	S
AUTOMATION APPLICATIONS CENTER	A	C	4	N
GINTIC	A	C	4	N
LIFE TECHNOLOGIES	W	C	2	N
SW INTERNATIONAL	A	C	3	N

ANNEX I

SUMMARY PROFILE OF SINGAPORE HIGH TECHNOLOGY R&D COMPANIES

SECTOR/ORGANIZATION	LEVEL OF TECH	COMMERCIALIZATION	INTEREST IN TECH TRANSFER	RECORD OF TECH TRANSFER
INFORMATION TECHNOLOGY				
BIZPOINT	D	C	2	N
EDS ELECTRONIC DOCUMENT SYS	A	P	4	N
INFORMATION ENGINEERING SCIENCE	A	C	4	Y
INFORMATION TECHNOLOGY INSTITUTE	W	P	4	Y
ISS	A	C	3	N
MENTOR GRAPHICS	A	C	2	S
ONTRAX	D	D	4	N
SCS	A	C	3	N
SNS	W	C	4	Y
COMMUNICATIONS TECHNOLOGY				
CHARTERED MICROWAVE	W	C	5	Y
DORART	A	C	3	Y
PETROCHEMICALS/CHEMICALS				
ENCAP	A	C	2	S
INTEC	W	C	4	Y
LAM SOON OIL & SOAP	A	C	4	Y
POLYSAR	A	C	2	S
UNION CARBIDE	D	D	2	S

W - WORLD CLASS C - COMMERCIAL

1 - NOT INTERESTED

Y - HAS TECH TRANSFER EXPERIENCE

A - ADVANCED

P - PRE-COMMERCIAL

5 - VERY INTERESTED

N - DOES NOT HAVE TT EXPERIENCE

D - DEVELOPING

D - DEVELOPING

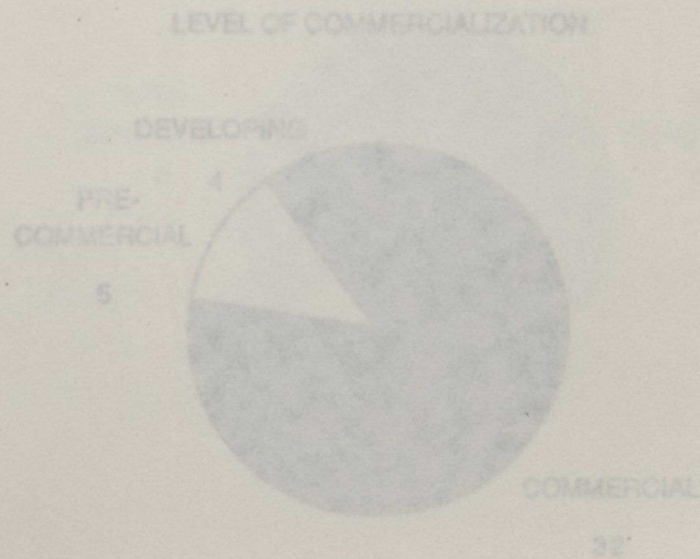
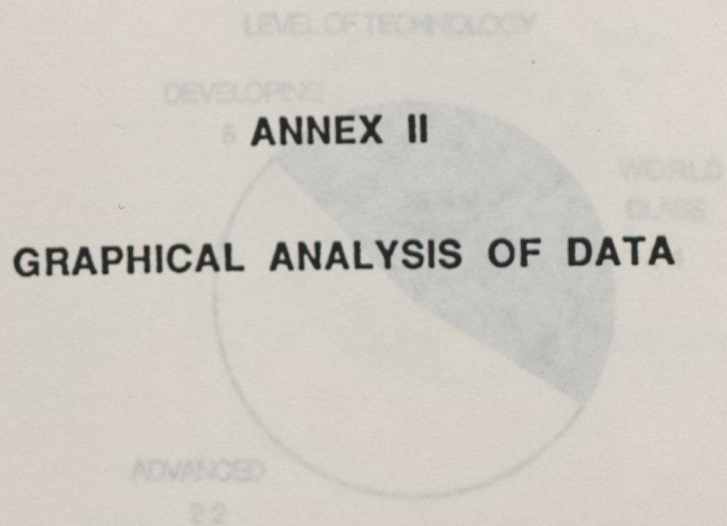
S - PARENT TO SUBSIDIARY TT EXP

P - PARENT HAS TT EXPERIENCE

ANNEX II

The following is a graphical analysis of the data table (shown in Annex I) of the 41 companies that participated in the survey.

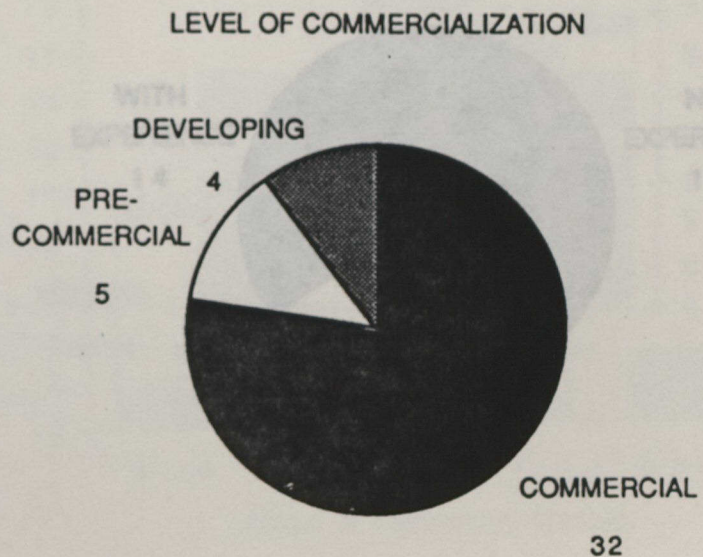
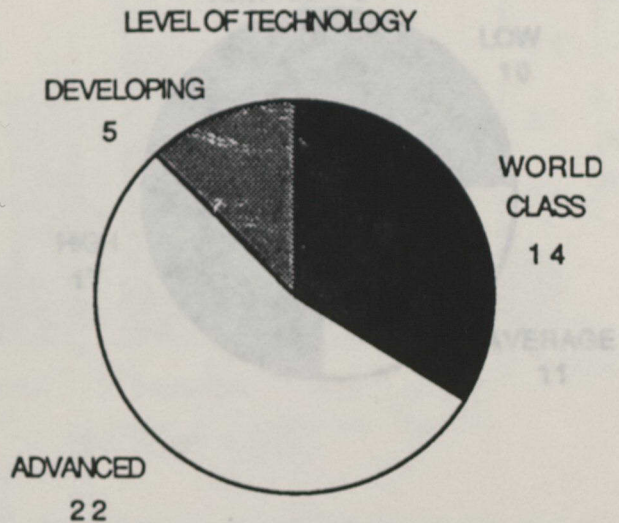
1. Breakdown of the number of companies by :



ANNEX II

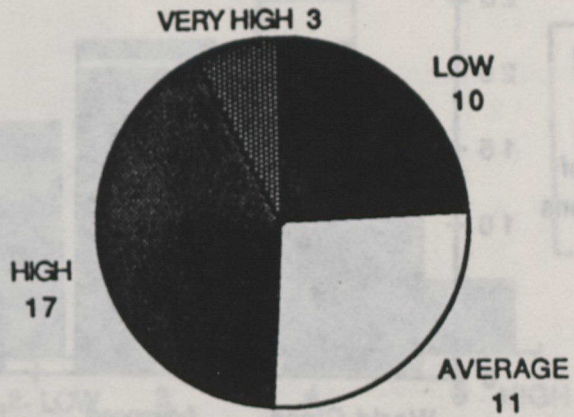
The following is a graphical analysis of the data table (shown in Annex I) of the 41 companies that participated in the survey.

1. Breakdown of the number of companies by :

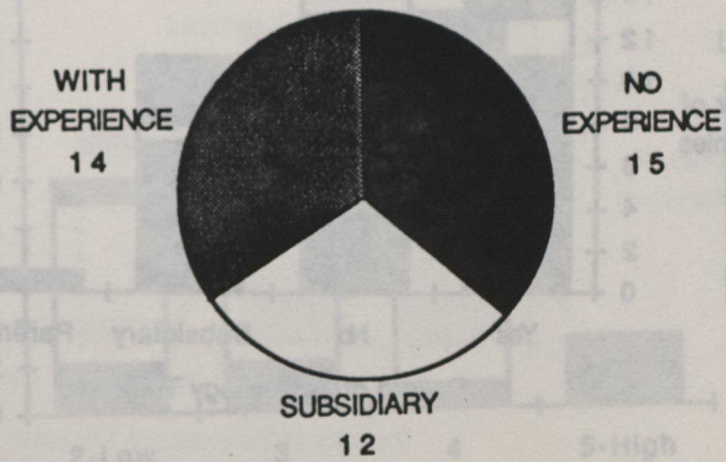


1. Breakdown of the number of companies by :

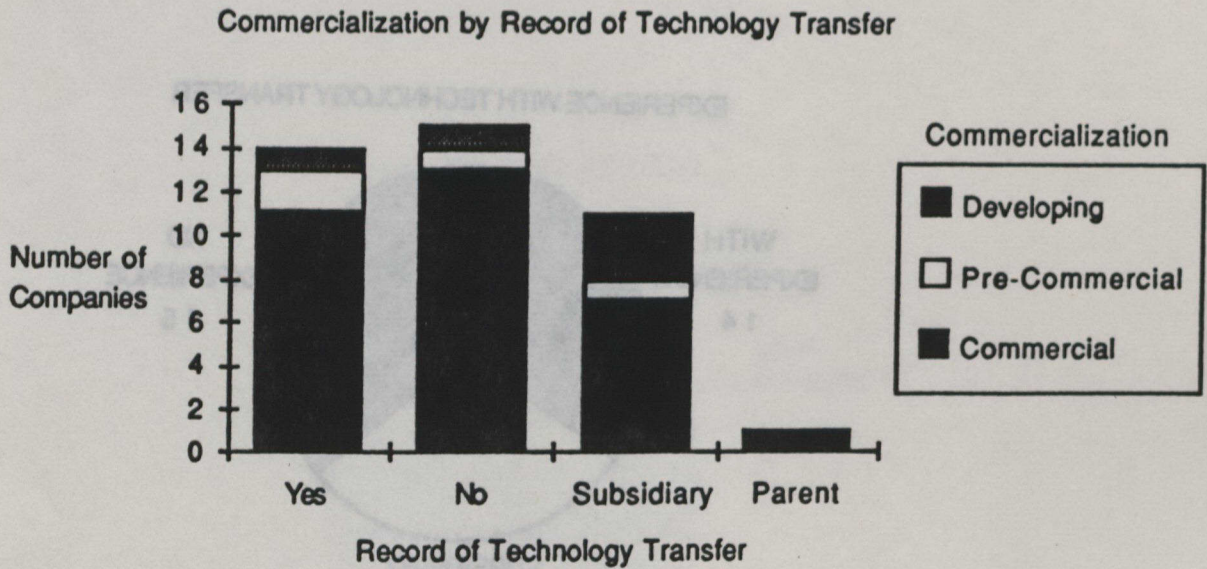
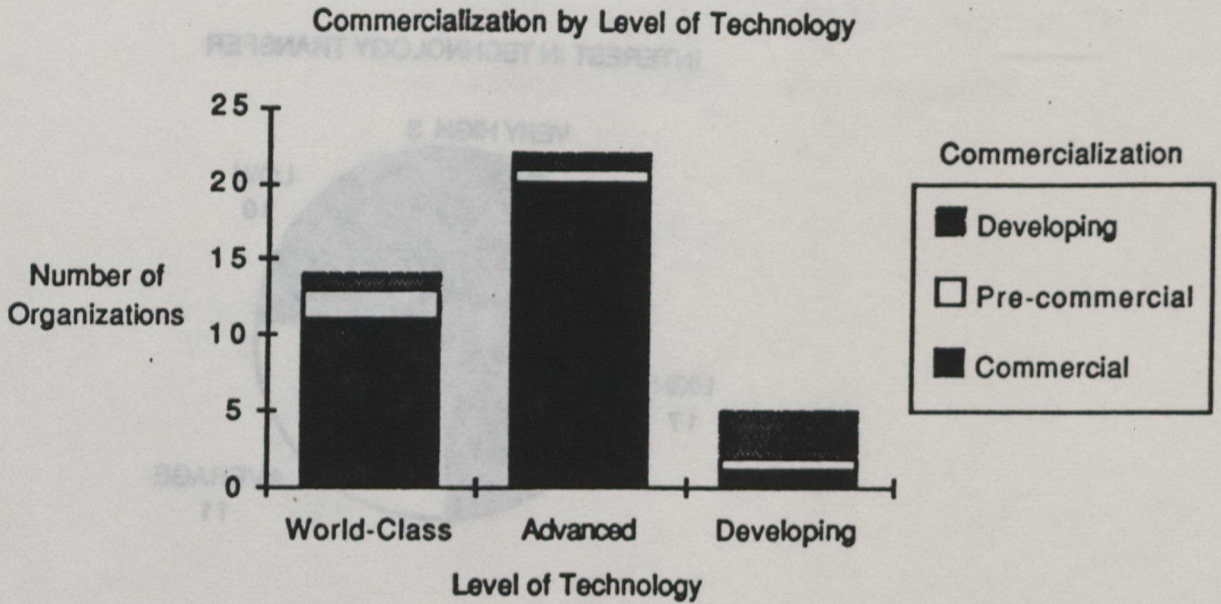
INTEREST IN TECHNOLOGY TRANSFER



EXPERIENCE WITH TECHNOLOGY TRANSFER

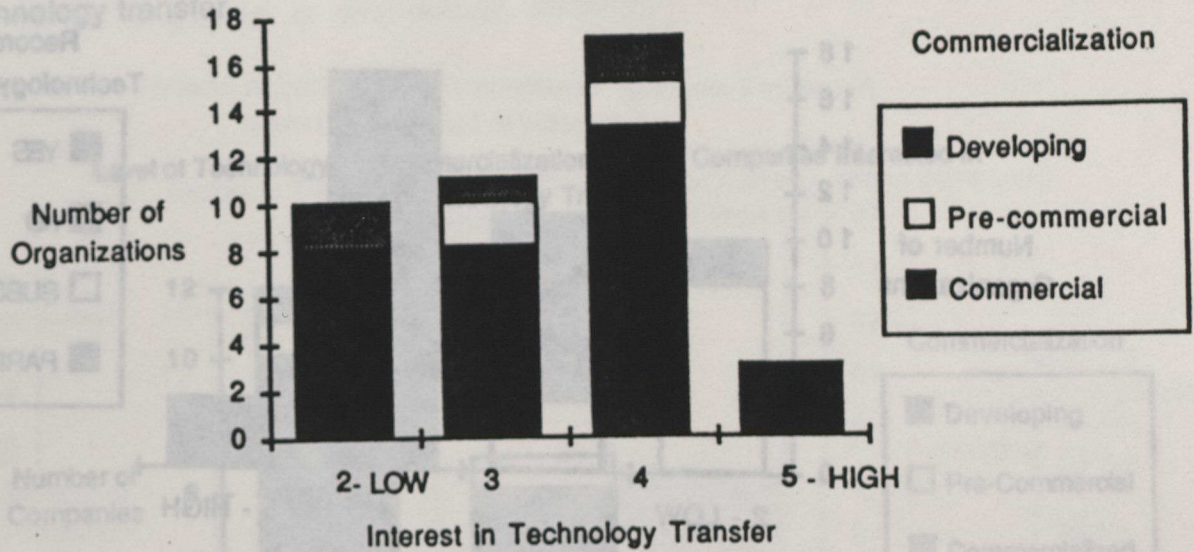


2. The following graphs show the cross-tabulation of :

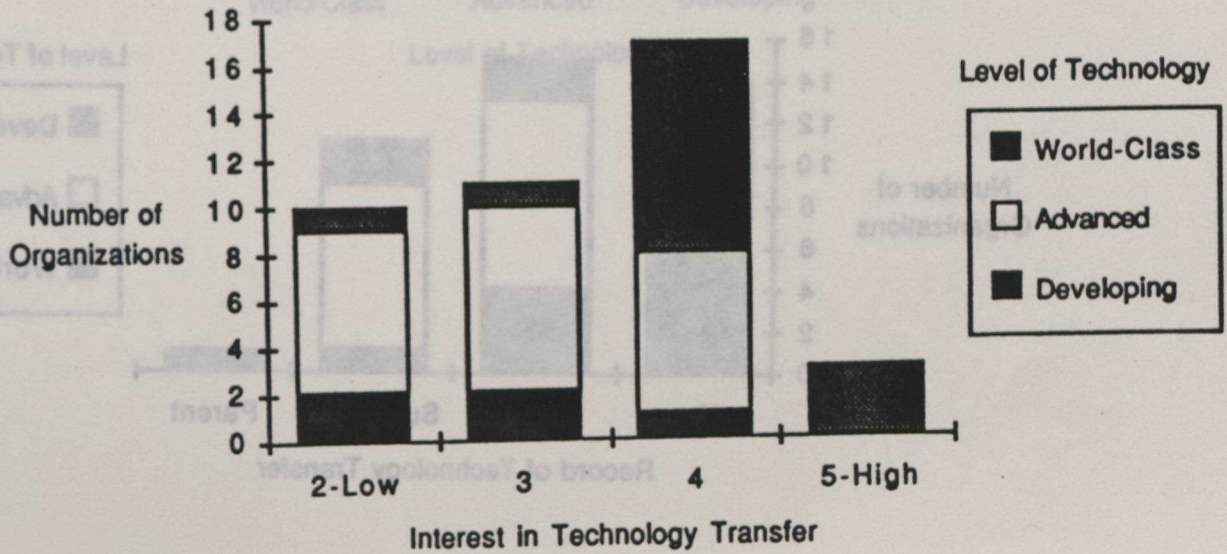


2. The following graphs show the cross-tabulation of:

Commercialization by Interest in Technology Transfer

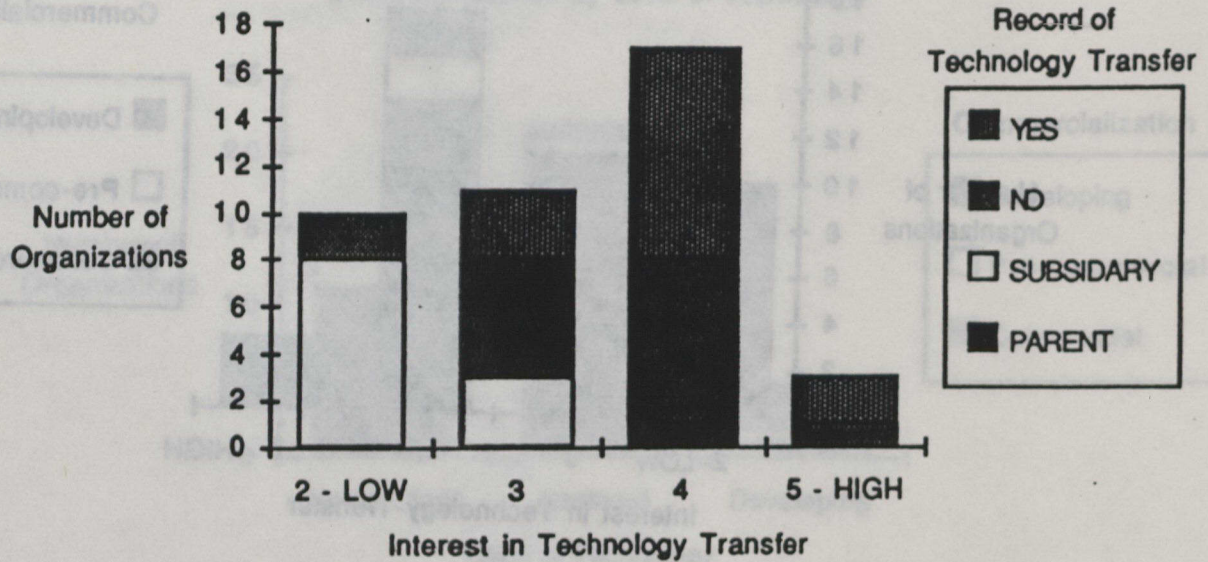


Level of Technology by Interest in Technology Transfer

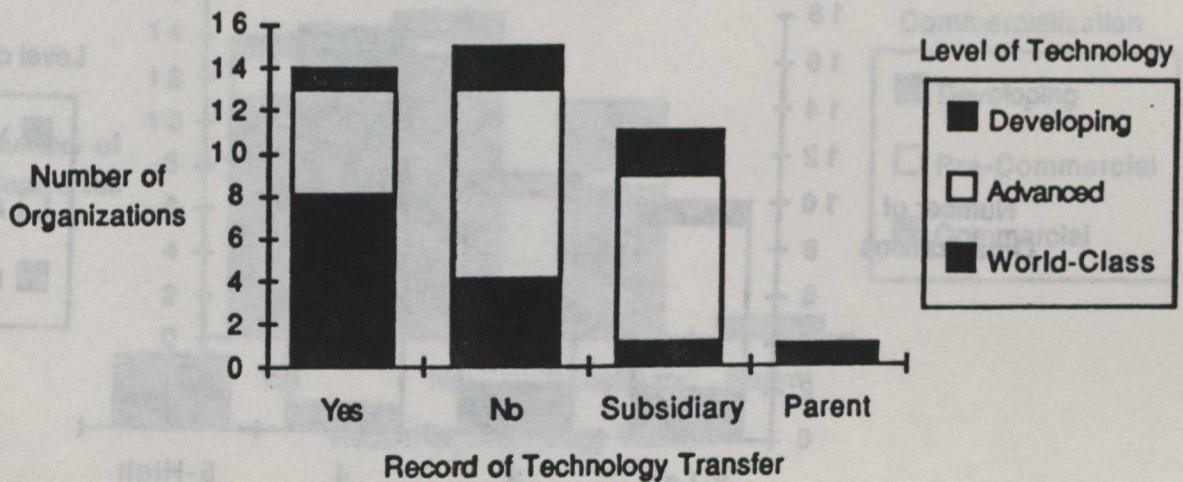


2. The following graphs show the cross-tabulation of :

Record of Technology Transfer by Interest in Technology Transfer



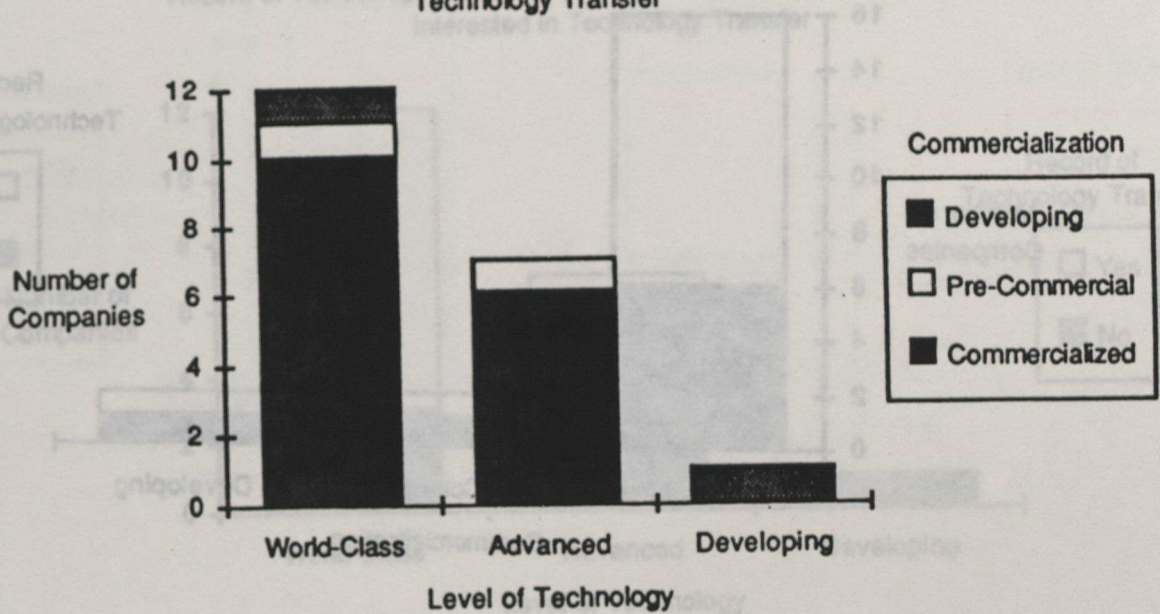
Level of Technology by Record of Technology Transfer



3. The graphs that follow reflect the profile of subsets of the surveyed companies.

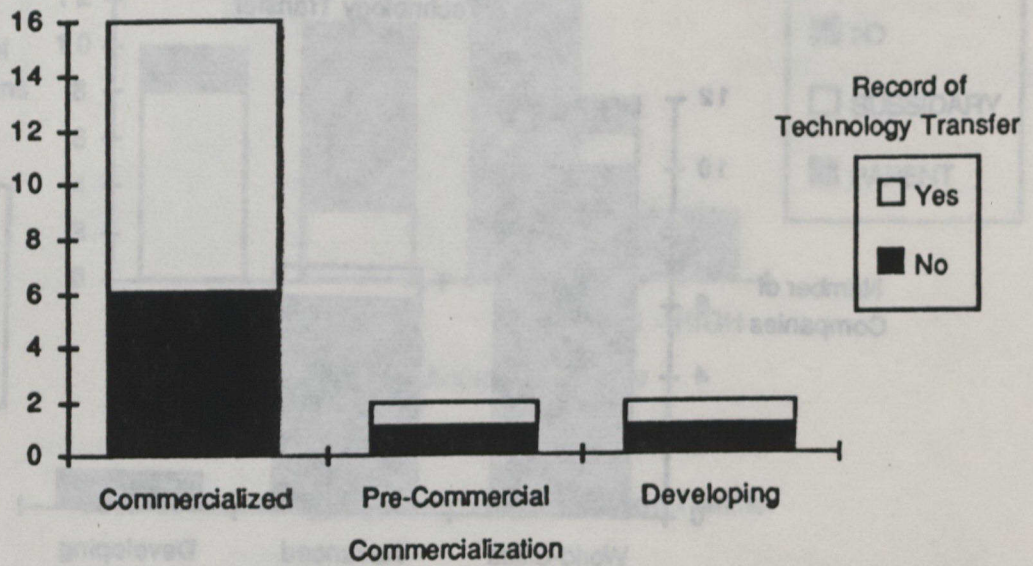
3.1 These graphs show the characteristics of the 20 companies that have indicated a high or very high interest (ie those coded 4 and 5) in engaging in technology transfer.

Level of Technology by Commercialization Among Companies Interested in Technology Transfer



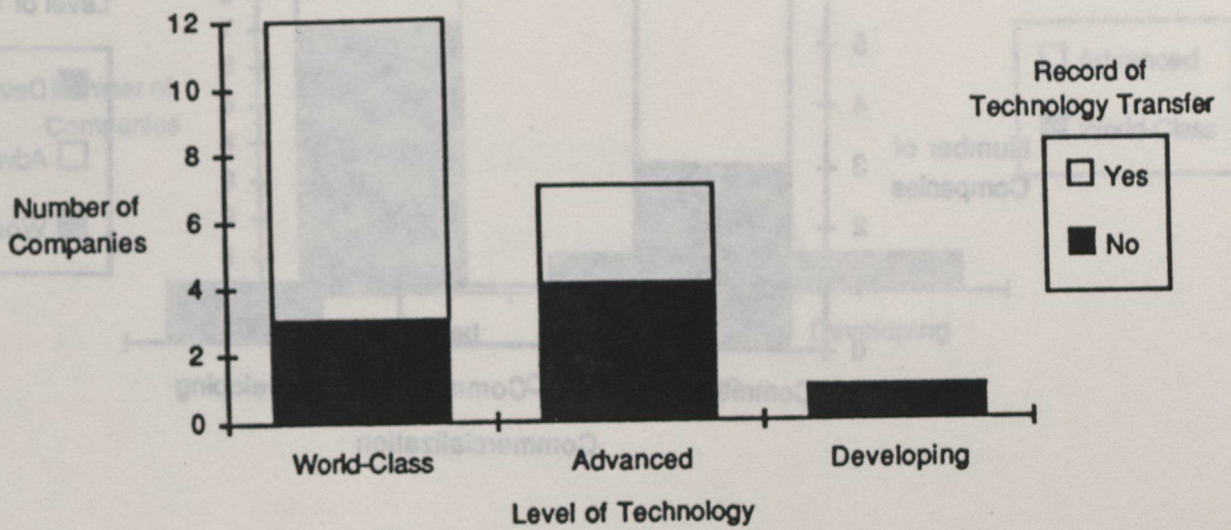
3.1 These graphs show the characteristics of the 20 companies that have indicated a high or very high interest (ie those coded 4 and 5) in engaging in technology transfer.

Record of Technology Transfer by Commercialization Among Companies Interested in Technology Transfer



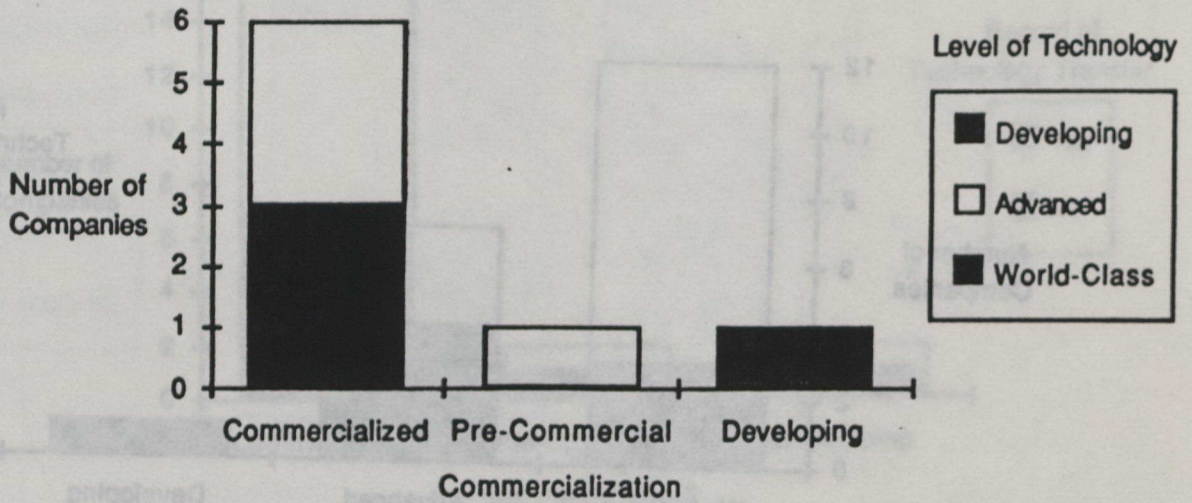
3.1 These graphs show the characteristics of the 20 companies that have indicated a high or very high interest (ie those coded 4 and 5) in engaging in technology transfer.

Record of Technology Transfer By Level of Technology Among Companies Interested in Technology Transfer



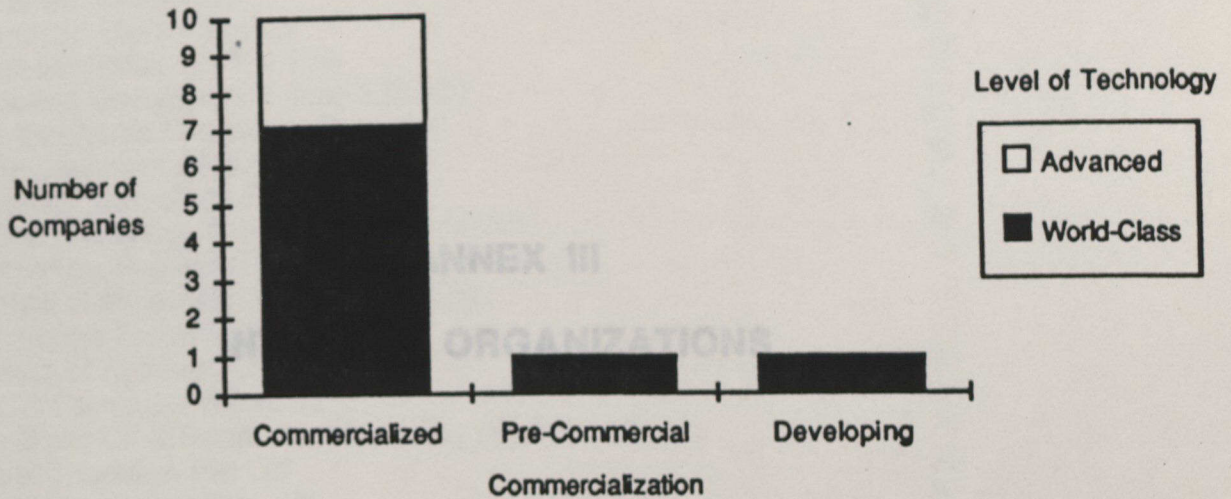
3.2 Among the 20 companies interested in technology transfer, 8 do not have a track record of such transfers. The chart shows the level and commercialization of technology.

Level of Technology by Commercialization for Companies Without Experience but Interested in Technology Transfer



3.3 Among the 20 companies interested in technology transfer, 12 have a track record of such transfers. The chart shows the level and commercialization of technology.

Level of Technology by Commercialization for Companies With Experience and Interest in Technology Transfer



ANNEX III - INDEX OF ORGANIZATIONS

Organization	Page
AT & T Microelectronics Design Center	24
Artificial Intelligence Center	29
Automation Applications Center	29
Bizpoint System Pte Ltd	32
Chartered Microwaves	37
Diagnostic Biotechnology	19
Dorant Industries (S) Pte Ltd	37
Economic Development Board (EDB)	43
EDS Electronic Document Systems	32
Exxon Chemical SIMCO Pte Ltd	38
Flotronic Technology Pte Ltd	24
GINTIC, Nanyang Technological Institute	30
Information Engineering Services	33
Institute of Molecular and Cell Biology	19
Information Technology	33
Institute of Systems Science, NUS	34
IPACS Computer Services	25
Lam Soon Oil & Soap Manufacturing (S) Pte Ltd	39
Lectrel Precision Pte Ltd	29
Life Technologies Pte Ltd	31
Logicraft Products Manufacturing Pte Ltd	28
Mandor Singapore	26
Mentor Graphics (Singapore)	35
National Computer Board (NCB)	44
National Science and Technology Board (NSTB)	42
Department of Electrical Engineering, NUS	40
Department of Microbiology, NUS	18
Department of Pathology, NUH	40
Department of Surgery, NUS	18
Faculty of Medicine, NUS	48
Faculty of Science, NUS	48
Ontrex Systems	35
Pacific Biomedical Enterprises	20
Plantek International	21
Polytar Asia Pacific	39
Rhone Merieux Asia Pacific Pte Ltd	21

ANNEX III

INDEX OF ORGANIZATIONS

ANNEX III - INDEX OF ORGANIZATIONS

<i>Organization</i>	<i>Page</i>
AT & T Microelectronics Design Center	24
Artificial Intelligence Center	29
Automation Applications Center	29
Bizpoint System Pte Ltd	32
Chartered Microwave	37
Diagnostic Biotechnology	19
Dorart Industries (S) Pte Ltd	37
Economic Development Board (EDB)	43
EDS Electronic Document Systems	32
Exxon Chemical SIMCO Pte Ltd	38
Flotronic Technology Pte Ltd	24
GINTIC, Nanyang Technological Institute	30
Information Engineering Services Pte Ltd	33
Institute of Molecular and Cell Biology	19
Information Technology Institute	33
Institute of Systems Science, NUS	34
IPACS Computer Services	25
Lam Soon Oil & Soap Manufacturing (S) Pte Ltd	39
Lectret Precision Pte Ltd	25
Life Technologies Pte Ltd	31
Logicraft Products Manufacturing Pte Ltd	26
Maxtor Singapore	26
Mentor Graphics (Singapore)	35
National Computer Board (NCB)	44
National Science and Technology Board (NSTB)	42
Department of Electrical Engineering, NUS	49
Department of Microbiology, NUS	18
Department of Pathology, NUH	49
Department of Surgery, NUS	18
Faculty of Medicine, NUS	48
Faculty of Science, NUS	48
Ontrax Systems	35
Pacific Biomedical Enterprises	20
Plantek International	21
Polysar Asia Pacific	39
Rhone Merieux Asia Pacific Pte Ltd	21

Organization

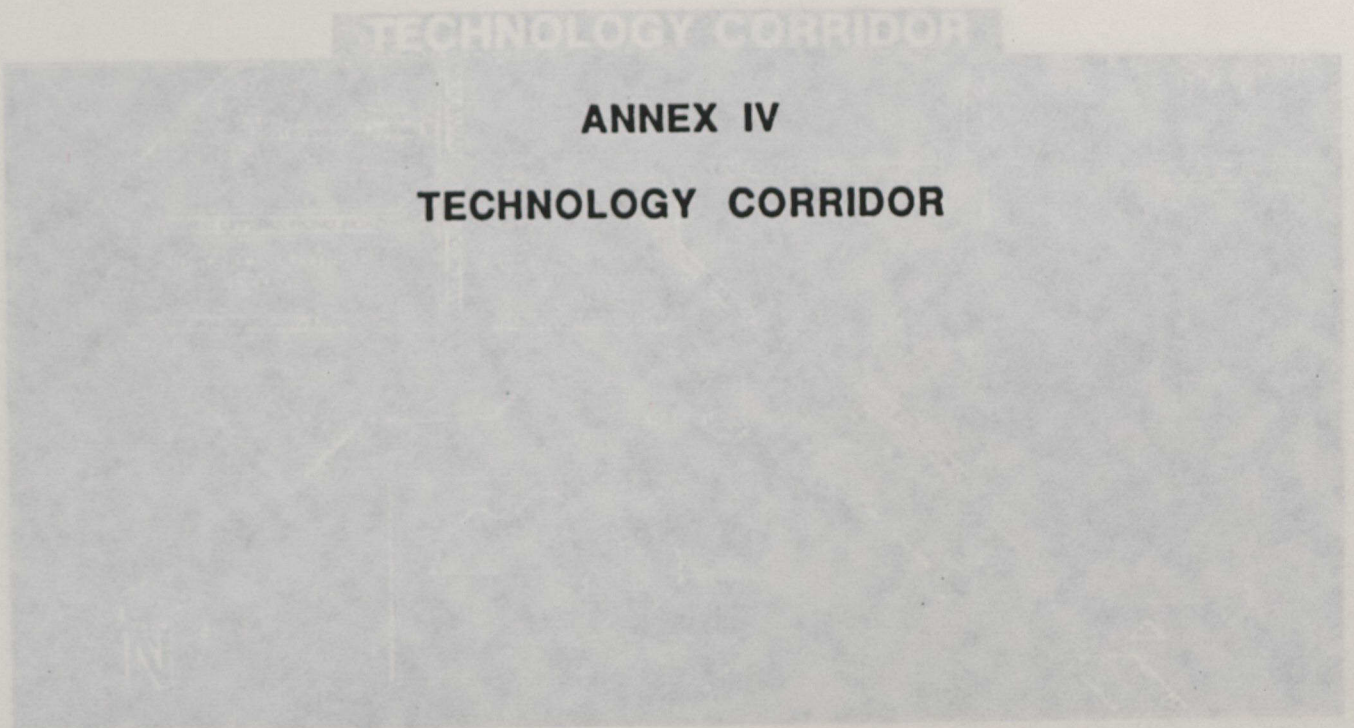
Page

Scitech Genetics Pte Ltd	21
Shimadzu Asia Pacific Pte Ltd	22
Singapore BioInnovations	20
Singapore Biotech Pte Ltd	22
Singapore Computer Systems (Pte) Ltd	35
Singapore Institute of Standards and Industrial Research (SISIR)	45
Singapore National Eye Center	23
Singapore Network Services Pte Ltd	36
Singapore Polytechnic	46
Snowflake Technology Pte Ltd	26
SW International Systems Pte Ltd	31
Tata-Elxsi	27
Teradyne Singapore Ltd	28
Union Carbide Asia Pacific Inc	39

ANNEX III - INDEX OF ORGANIZATIONS

ANNEX IV

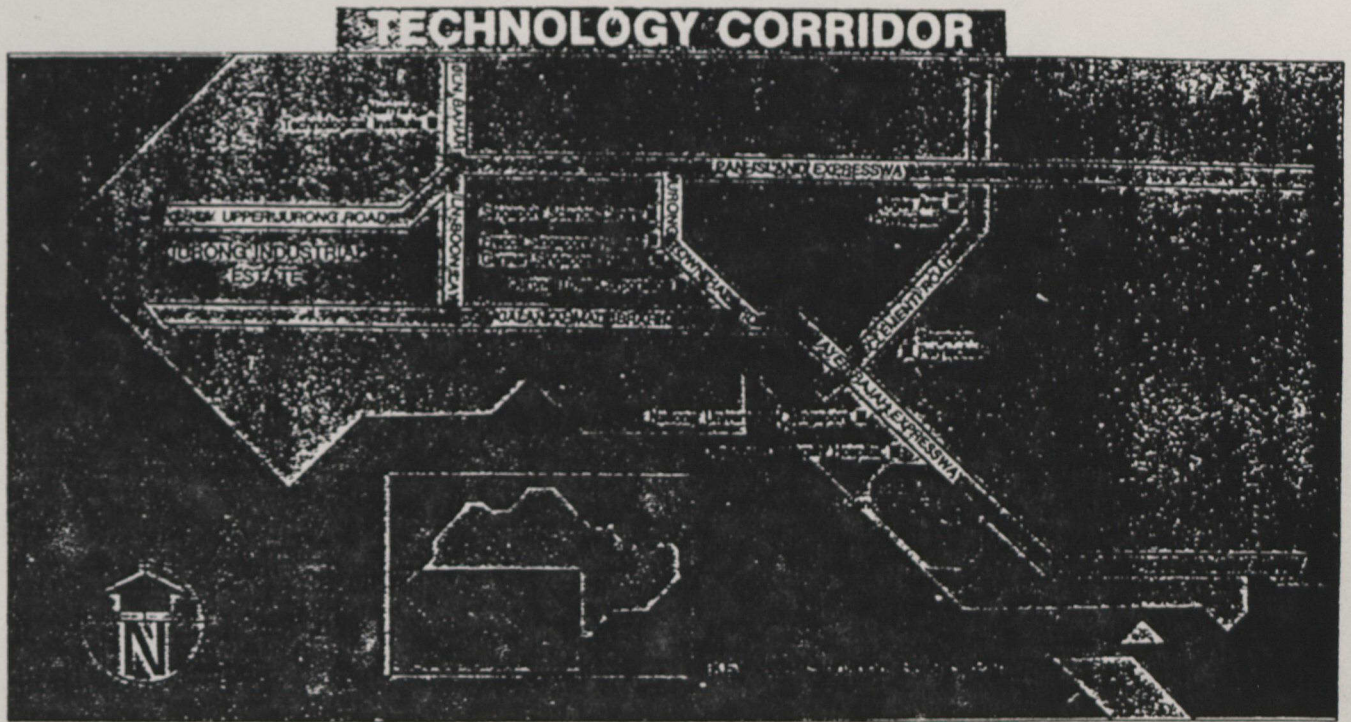
The following map shows the approximate location of several key research centers involved in technology development in Singapore.



Source: Window on the Future: The Singapore Science Park, Science Council of Singapore

ANNEX IV

The following map shows the approximate location of several key research centers involved in technology development in Singapore.



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