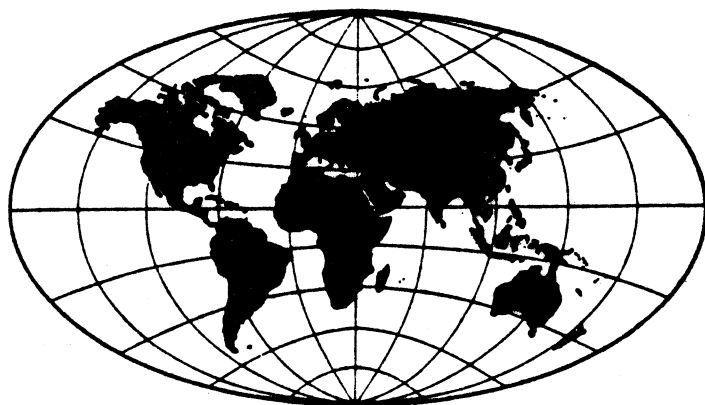


SCIENTISTS AND ENGINEERS IN SINGAPORE: 1990

by

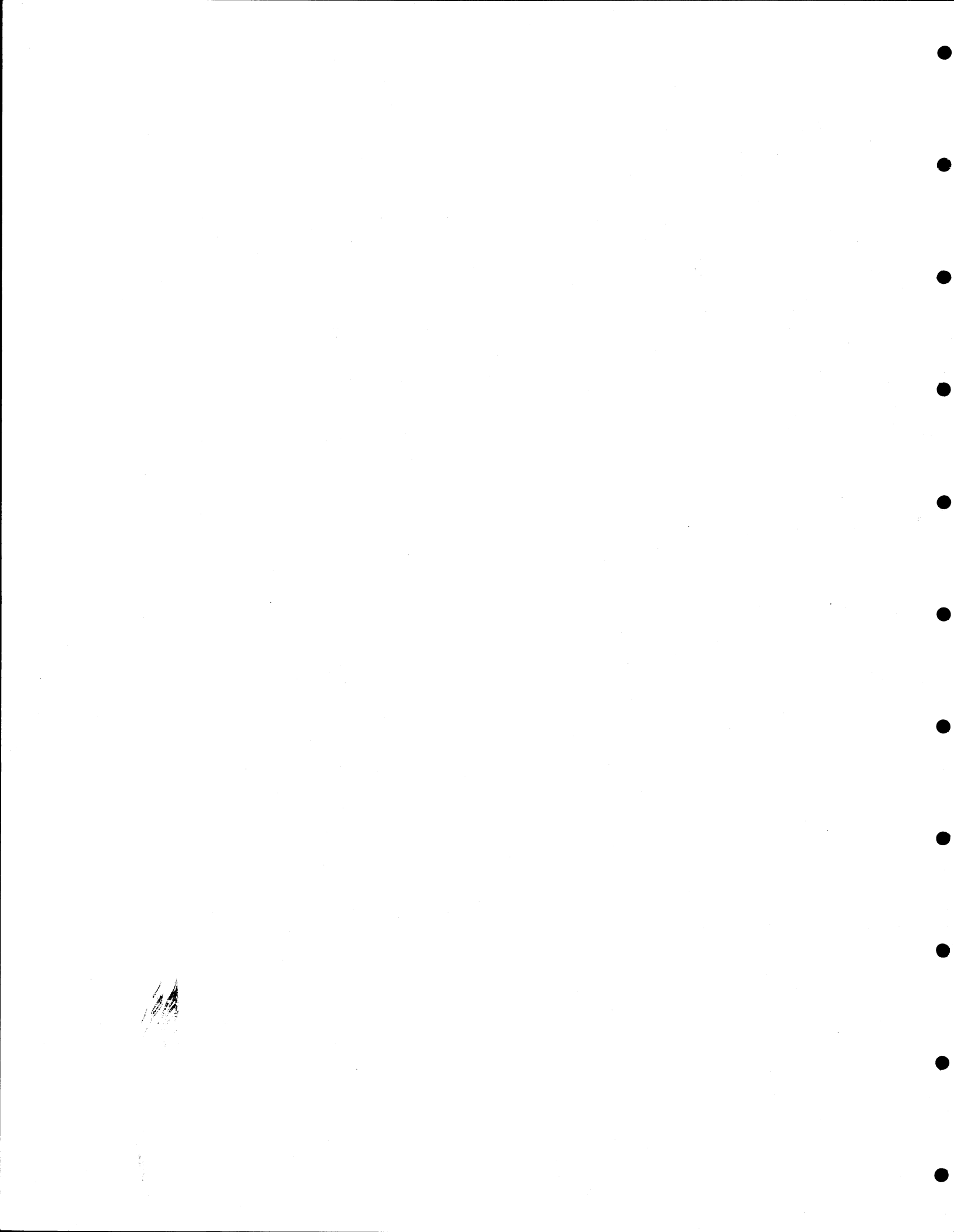
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EXECUTIVE SUMMARY

The typical member of the group "Scientists and Engineers (S/E)" in Singapore is male, in his late 20's or early 30's, and likely to be engaged in engineering within the manufacturing branch of the economy, after a college education (university graduate). There are exceptions to this characterization, since females, who account for one-quarter of scientists and engineers, are more likely to work in the sciences, particularly computer science, and less likely to have a university degree. Female scientists and engineers generally are even younger than their male colleagues, suggesting that females may account for an increasing share of scientists and engineers in the future. Other key findings are that the share of Singapore's labor force engaged in science and engineering trails many leading industrial countries, possibly deterring investment by foreign multi-national firms. This apparently has limited the role of Singapore's scientists and engineers in the development of new technologies.

PREFACE

The International Programs Center conducts economic and demographic studies, some of which are issued as Staff Papers. A complete list is included at the end of this report. The use of data not generated by the U.S. Bureau of the Census precludes performing the same statistical reviews the Bureau does on its own data.

We are grateful to the Singapore Department of Statistics, Ministry of Trade and Industry, for their assistance in providing data from the 1990 census upon which the tables and charts in this report are based. Within the International Programs Center, thanks are due to Lois Darmohray and Beverly Mathis for secretarial support. Any shortcomings in the report are the responsibility of the author.

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INTRODUCTION

This report presents statistics on scientists and engineers (S/E)¹ for Singapore, based on the 1990 census. It begins with a graphic comparison among countries, including the United States. This is followed by sections describing new data for Singapore. Data tables provide detailed information upon which the graphic presentation is based. Users who wish to more closely compare data presented in this report with those of other countries should consult the list of IPC/CIR Staff Papers in the back of this report. The most recent report is "Scientists and Engineers in Australia: 1991."

Singapore has fewer scientists and engineers, relative to its labor force, than do many leading industrial countries with which Singapore competes for high technology employment or upon which Singapore relies as an export market. In 1990, Singapore had just 16 scientists and engineers per 1,000 members of its labor force (Table Sing-1(90) and International Database). In contrast, Japan had 36, and the U.S. had 29 scientists and engineers per 1,000 persons in the labor force in 1990. Only Australia had fewer scientists and engineers, relative to its labor force (Figure 1). This low level, particularly of engineers, reportedly has deterred investment in Singapore by foreign, high-technology firms ("Manpower," 1988, p. 96). The impact of a supposed shortage of scientists and engineers may be particularly harmful to a city-state such as Singapore, which lacks a large national labor force, and thus cannot hope to attract labor-intensive, low-technology production. Therefore, Singapore is attempting to attract industries that employ skilled workers (Tan, 1988, p. 94).

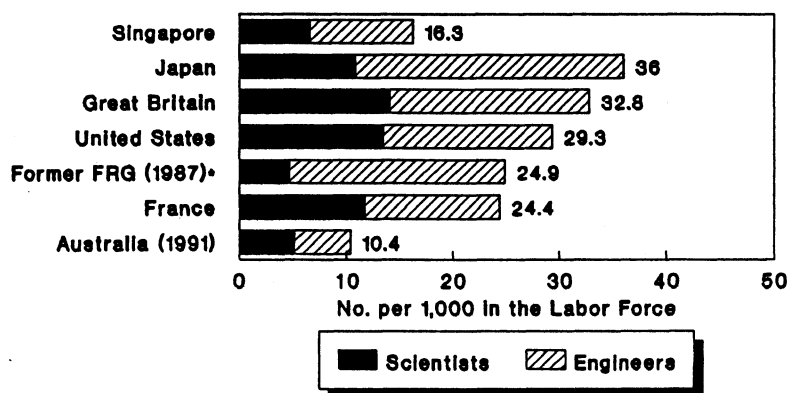
Singapore's scientists and engineers apparently are not yet broadly engaged in developing new technologies. Instead, production-related S/E more commonly found in manufacturing are operating with existing technologies. In response to this shortcoming, the Singaporean government began a program in the early 1990's to accelerate the growth of the country's research and development (R&D) establishment. It is premature to assess whether the program is succeeding.

This thumbnail description of scientists and engineers in Singapore, as well as the graphic presentation and appendix tables to follow, is based upon the 1990 Singapore Population Census and other sources.

1

See appendix tables for list of occupations included among scientists and engineers.

Figure 1. Scientists and Engineers per 1,000 Members of the Labor Force, for Selected Countries: 1990



• West Germany (with 1949-1990 borders).
Source: Zaslav, 1990, p. 2;
Table Sing-1(90); International Database

Computer science is the largest of the science and engineer fields.

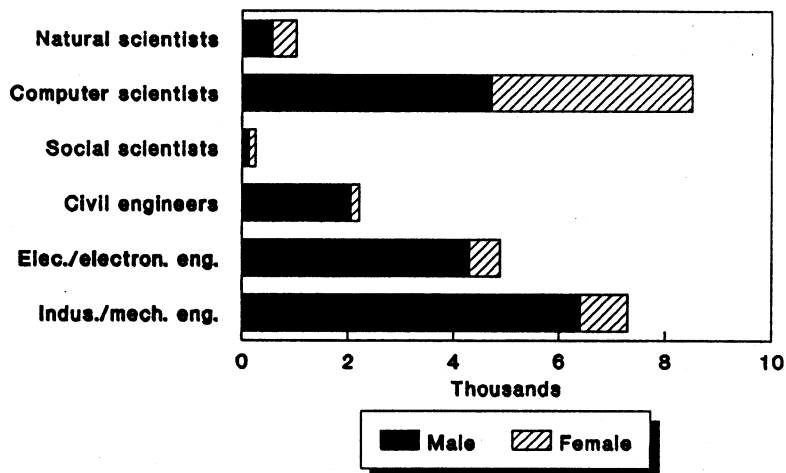
Within the employment category "Scientists and Engineers," those with specialization in computer science and industrial/mechanical engineering predominate¹ (Figure 2). Over 11,000 men and 4,000 women, accounting for 65 percent of the employment category, work in these fields. Among males, there are also large numbers of electrical/electronic engineers and civil engineers, accounting for 35 percent of all male scientists and engineers (Table Sing-1(90)). This substantial representation of electrical/electronic engineers and civil engineers is to be expected. The manufacture of computer-related components (particularly disk drives)² is an important export manufacturing sector, and employment opportunities exist for civil engineers due to the country's extremely high road density, although future growth possibilities are limited by the island's small size (*The World Factbook 1993*, p. 347 and Selwyn, 1992, p. 31). Among females, nearly two-thirds (63 percent) of S/E are computer scientists (Figure 3). Therefore, females are less evenly distributed among the science and engineering occupations than are males.

There is a perception in Asia that Singapore's computer scientists are incapable of conducting advanced research and development. Foreign companies reportedly are not interested in carrying out advanced research and development work in Singapore, except to curry favor with the government ("Is Singapore," 1993, p. 20). For instance, the Omron Corporation, a Japanese software development firm, is known to assign its less challenging research and development work to Singapore (Worthy, 1991, p. 163). The perception that Singapore's scientists and engineers are not on a par with their counterparts in other developed Pacific Rim countries (notably Japan) is reinforced by the Singaporean government's remedial plans to bolster research and development (a role the government is forced to play due to insufficient R&D efforts by private industry).

¹ See Table Sing(1) for a list of occupations that are included in this report on scientists and engineers.

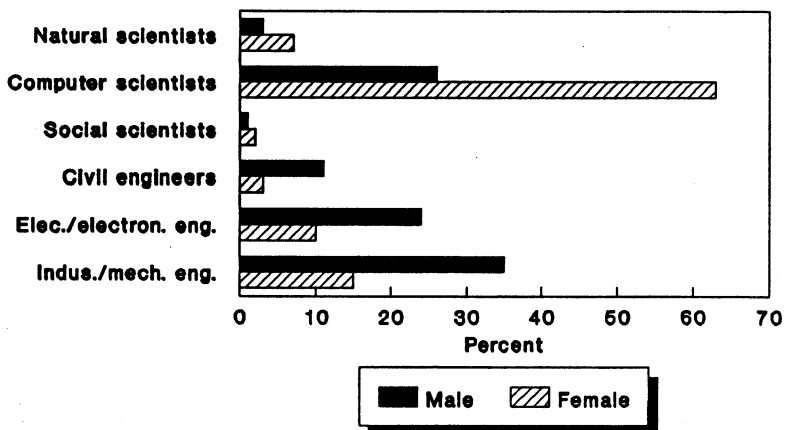
² For instance, as of 1988, the US-owned disk drive manufacturer, Seagate, was Singapore's largest private sector employer ("Manpower," 1988, p. 98). Also, in 1992, disk drives accounted for half of Singapore's nearly US \$11 billion exports of computer equipment (East Asian Executive Report, May 1993, p. 20).

Figure 2. Scientists and Engineers, by Specialty and Sex, for Singapore: 1990



Source: Table Sing-1(90).

Figure 3. Percent Distribution of Scientists and Engineers by Specialty and Sex, for Singapore: 1990



Source: Table Sing-1(90).

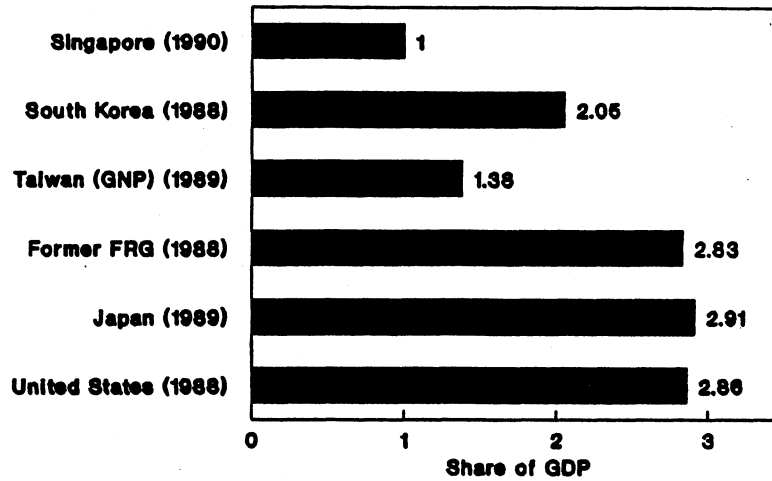
Research and development in Singapore has lagged behind that in other developed countries.

Singapore's ability to increase and expand the breadth of high technology exports depends in large part on the country's commitment to research and development. Japan, the leading source of new technology in the region, has not transferred development or manufacturing of leading technologies to other countries. This lack of integration reportedly has fostered ill-will between Japan and the newly industrializing countries (NIC's) which have not matched Japan's technological development (Selwyn, 1992, p. 29). In terms of financial commitment to R&D and R&D scientists and engineers, in 1990, Singapore badly trailed its regional competitors, as well as the US and former West Germany (Figures 4 and 5)³.

Realizing that insufficient attention to R&D was likely to keep Singapore from developing its high technology industries at a pace to compete with other countries in the region, Singapore's government announced a plan in September 1991 to significantly bolster the R&D sector. The government opened new R&D institutes in support of the country's key computer component export industries, and planned to double Singapore's share of GDP devoted to research and development. These actions were intended to provide sufficient employment opportunities in R&D, so that the share of R&D scientists and engineers would rise from 2.8 to 4, per 1,000 workers by 1995 (Selwyn, 1992, p. 29). Although the infrastructure to expand R&D has grown, it is unclear if other targets of the government's effort have been reached.

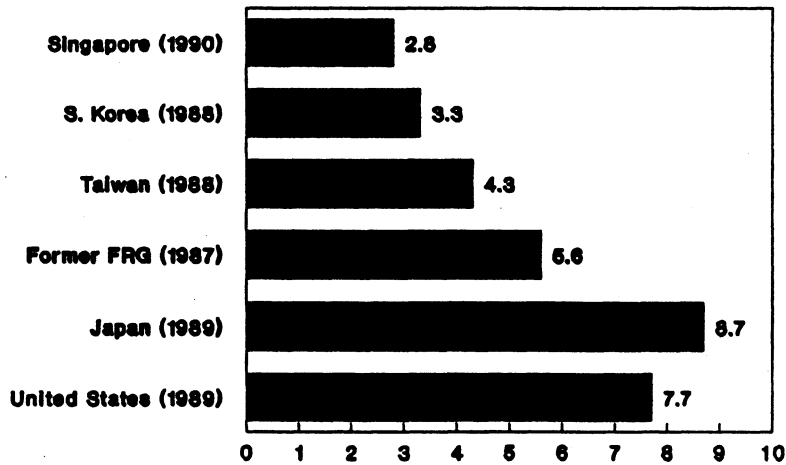
³ The information in Figure 5 probably are not comparable to data elsewhere in this report, as Figure 5 may include academic scientists and engineers, who are not considered elsewhere in this report.

Figure 4. Share of Gross Domestic Product Used for R&D*



* Research and Development
Source: Selwyn, 1992, p. 27.

Figure 5. R&D* Scientists and Engineers, per 1,000 Workers



* Research and Development
Source: Selwyn, 1992, p. 28.

Most scientists and engineers are young.

The vast majority (74 percent) of scientists and engineers are below age 35 (Figure 6 and Table Sing-1(90)). More specifically, the largest number of scientists and engineers, by five-year age cohort, are 25-29 year olds, who account for 36 percent of all S/E (Table Sing-1(90)). Computer scientists are particularly concentrated in the younger age groups, with 84 percent below age 35 (Table Sing-1(90)). These concentrations of computer scientists among the younger age groups exceed those in Japan, where 78 percent were under age 35 in 1990 (Zaslow, 1995, p. 14).

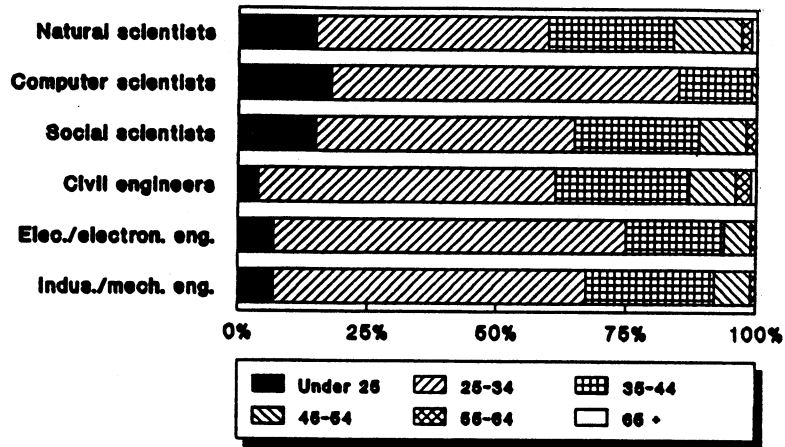
Scientists and engineers are concentrated at younger age groups to a greater extent than the country's overall economically active population. In 1990, 58 percent of Singapore's economically active population were below age 35 (Census Bureau International Database).

The ages of those in the S/E occupation fields vary significantly by sex. In all scientist and engineer fields, females are younger than their male colleagues (Table Sing-1(90)). Females who are less than 35 years old account for 89 percent of female scientists and engineers, compared to 69 percent for males (Table Sing-1(90)). As in other countries studied in this series, this most likely reflects females' more recent entry into the work place.⁴

There is a weak correlation between the age distribution of female scientists and engineers, and that of females with a higher than secondary school education (a .237 correlation using 1990 data). Female S/E are more concentrated in the younger age cohorts than is the number of females with higher than secondary school education. This weak correlation is to be expected, as opportunities for females in the scientist and engineering fields lagged behind improved educational opportunities. Presumably, the correlation will strengthen as women become more established in the scientist and engineer workforce.

⁴ The percentage of females in Singapore, aged 15 and older, who are economically active (either working, looking for work, or planning to start a business) nearly doubled between 1970 and 1990, from 26.9 percent to 50.3 percent ("Estimates and Projections," 1993, Table S-H1).

Figure 6. Scientists and Engineers, by Age Group, for Singapore: 1990

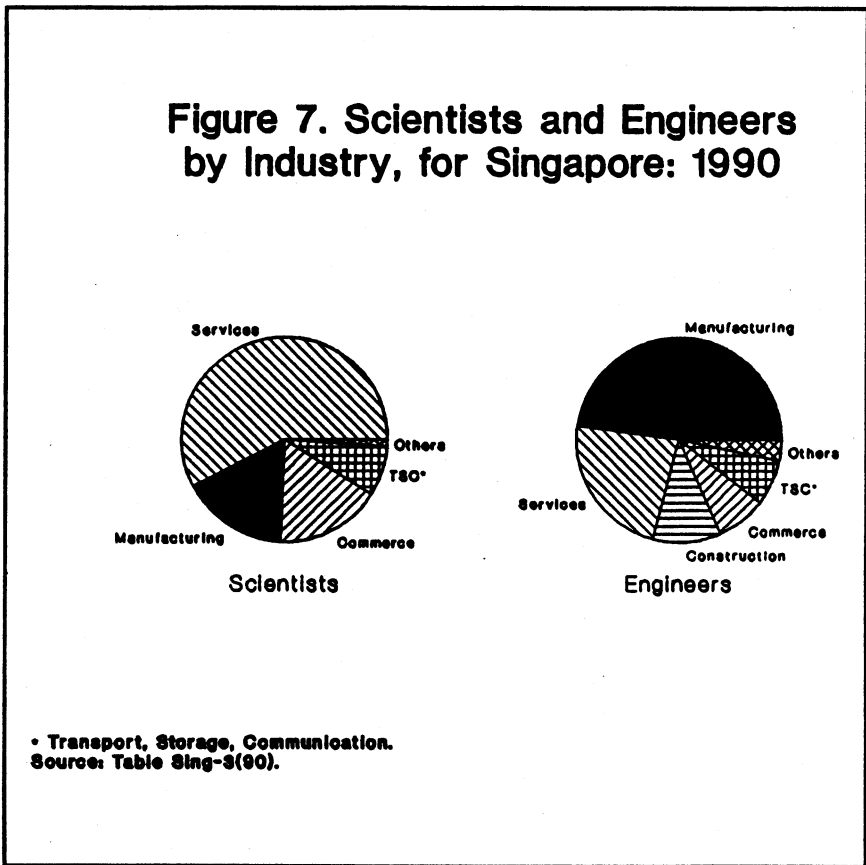


Source: Table Sing-1990.

Services and manufacturing industries dominate employment of scientists and engineers.

The services⁵ and manufacturing industries employ 75 percent of scientists and 71 percent of engineers (Table Sing-1(90)). Thus, scientists and engineers are more concentrated in these two sectors than the country's overall labor force, 59 percent of which worked in services and manufacturing in 1990 (*The World Factbook 1993*, p. 347). Most scientists (58 percent) work in services and nearly half of all engineers (48 percent) work in manufacturing (Figure 7 and Table Sing-1(90)).

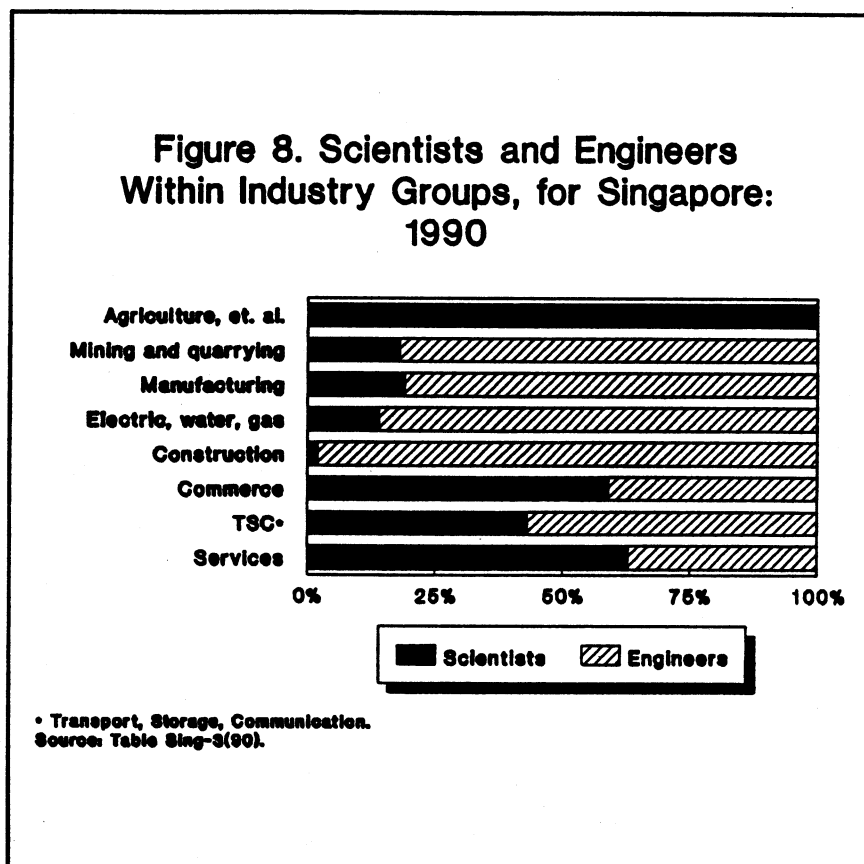
Figure 7. Scientists and Engineers by Industry, for Singapore: 1990



⁵ Singapore's data combine finance, insurance, real estate (which in the US Standard Industrial Classification are not considered to be services), with business services. For this report, all are considered to be services.

Most industries exhibit a strong preference for either scientists or engineers.

In their employment of scientists and engineers, most industries tend to favor strongly either one group or the other (scientists or engineers) (Figure 8)⁶. Since scientists and engineers study different disciplines, and develop different skills, the fact that many industries primarily hire scientists or engineers reflects the types of skills that each industry considers most relevant to improving its production processes or provision of services. The agriculture,⁷ commerce, and services sectors favor scientists. Conversely, mining and quarrying, manufacturing, electric, water, and gas, construction, and transport, storage, and communication are skewed towards employment of engineers.



⁶ The categories "Financial, insurance, real estate and business services," and "Community, social, and personal services," comprise the "services" sector.

⁷ The agriculture sector includes agriculture, fishing, forestry, and hunting.

Most scientists and engineers in the services sector work in business-related establishments.

The vast majority (75 percent) of service sector scientists and engineers are employed in the provision of financial, insurance, real estate, and business services. The remaining one-fourth of scientists and engineers are engaged in community, social, and personal services. Among the individual occupational categories, most civil engineers and computer scientists find employment in the financial (and related) services (Table Sing-5(90)). Sex selection does not appear to determine the general service sector groups in which a scientist or engineer is likely to work, since males and females have the same 75-25 split between the service sector groups (Table Sing-5(90)).

Both groups of service industries employ more scientists than engineers. In 1990, scientists accounted for 63 percent of scientist and engineer employment among the service industries (Table Sing-5(90)).

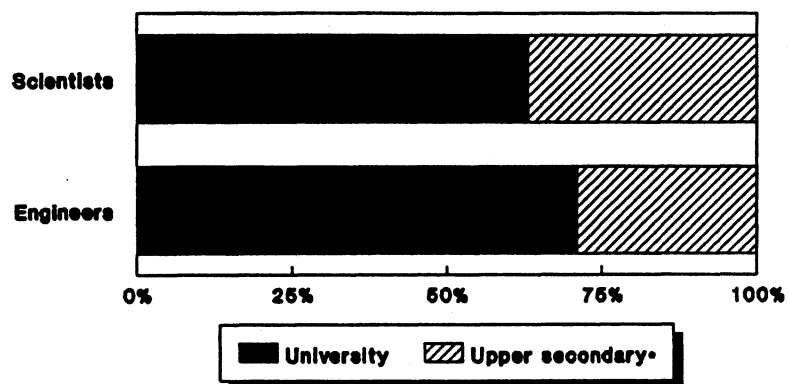
Most scientists and engineers have earned a university degree.

More than two-thirds (68 percent) of scientists and engineers have a university degree. While most scientist and engineering occupational categories have vast majorities that have earned a university degree, the occupational categories which account for most of the employment are more evenly split between attainment of a university degree or an upper secondary education (Table Sing-6(90)). Engineers are more likely than scientists to have a university degree, as 71 percent of engineers had earned a university degree, compared to 63 percent of scientists (Figure 9 and Table Sing-6(90)). In addition, males are more likely to have earned a university degree than females (71 percent compared to 60 percent) (Table Sing-6(90)).

Singapore's high level of educational attainment among scientists and engineers⁸ supports the country's efforts to expand high technology exports. Singapore's share of its scientists and engineers who have a university degree is higher than that of Japan (68 percent vs. 63 percent) (even including Japan's graduates of junior college and higher professional schools) (Zaslow, 1995, p. 24). Therefore, this high level of educational attainment supports the Singaporean government's focus on improving employment opportunities in advanced R&D as a means to improve the country's competitiveness in developing technology fields.

⁸ Singapore's overall population has a far lower share with at least a college degree. In 1990, just 3.7 percent of the country's population, aged 10 and over (or 8 percent of males and females aged 25-29), had earned a college degree, although these levels represent a significant jump from 1980 levels ("Estimates and Projections," 1993, pp. IV-14, 17).

Figure 9. Distribution of Scientists and Engineers by Level of Education, for Singapore: 1990



• Includes those with polytechnic institute degrees.
Source: Table Sing-8(90).

CONCLUSIONS

Singapore has a lower concentration of scientists and engineers among its workforce than do leading industrial countries (Figure 1). Singapore's scientists and engineers are young, and concentrated in key industries, such as services and manufacturing (Figure 7). In addition, more than two-thirds of Singapore's scientists and engineers have earned a university degree. This concentration of scientists and engineers at the younger age groups, coupled with a high level of education, probably stems from the Singaporean government's efforts to foster development of high technology industries. Males predominate among scientists and engineers, accounting for three-fourths of all S/E (Table Sing-1). This share, while high, is far less than for Japan (Zaslow, 1996, p. 2). Female scientists and engineers are even younger than males, and unlike males, are concentrated in the sciences (particularly computer science).

Tables⁹

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Sing-1(90)	Scientists and Engineers by Age and Sex, for Singapore: 1990	16-18
Sing-3(90)	Scientists and Engineers by Industry and Sex, for Singapore: 1990 . . .	19-21
Sing-5(90)	Scientists and Engineers by Service Industry and Sex, for Singapore: 1990	22-24
Sing-6(90)	Scientists and Engineer by Educational Attainment and Sex, for Singapore: 1990	25-27

⁹ Tables are numbered so as to be consistent with those of tables in previous reports in the scientists and engineers series (see list at end of this report). Any breaks in sequential order are due to a lack of data.

Table Sing-1(90)
Scientists and Engineers by Age and Sex, for Singapore: 1990

Both Sexes

Sex and Occupation	Total	Under 25	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
TOTAL SCIENTISTS AND ENGINEERS	24,186	2,561	8,824	6,473	3,171	1,648	756	460	192	60	41
SCIENTISTS	9,778	1,686	3,803	2,468	989	502	181	99	30	10	10
Natural scientists	1,015	155	265	193	123	124	74	56	16	3	6
Computer scientists	8,508	1,494	3,465	2,220	835	347	95	32	11	5	4
Social scientists	255	37	73	55	31	31	12	11	3	2	0
ENGINEERS	14,408	875	5,021	4,005	2,182	1,146	575	361	162	50	31
Civil engineers	2,221	81	623	657	389	179	112	91	63	13	13
Electrical/electronic engineers	4,886	319	1,976	1,349	642	307	145	111	26	7	4
Industrial/mech. eng.	7,301	475	2,422	1,999	1,151	660	318	159	73	30	14

Table Sing-1(90)

Scientists and Engineers by Age and Sex, for Singapore: 1990--Continued

Male

Sex and Occupation	Total	Under 25	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
TOTAL SCIENTISTS AND ENGINEERS	18,205	1,035	6,333	5,142	2,743	1,494	724	445	189	59	41
SCIENTISTS	5,427	542	2,006	1,526	685	375	159	87	28	9	10
Natural scientists	571	41	111	116	76	94	62	49	14	2	6
Computer scientists	4,729	499	1,856	1,381	597	261	86	29	11	5	4
Social scientists	127	2	39	29	12	20	11	9	3	2	0
ENGINEERS	12,778	493	4,327	3,616	2,058	1,119	565	358	161	50	31
Civil engineers	2,063	62	569	593	375	174	111	90	63	13	13
Electrical/electronic engineers	4,299	191	1,726	1,213	585	293	144	110	26	7	4
Industrial/mech. eng.	6,416	240	2,032	1,810	1,098	652	310	158	72	30	14

Table Sing-1(90)

Scientists and Engineers by Age and Sex, for Singapore: 1990--Continued

Female

Sex and Occupation	Total	Under 25	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+
TOTAL SCIENTISTS AND ENGINEERS	5,981	1,526	2,491	1,331	428	154	32	15	3	1	0
SCIENTISTS	4,351	1,144	1,797	942	304	127	22	12	2	1	0
Natural scientists	444	114	154	77	47	30	12	7	2	1	0
Computer scientists	3,779	995	1,609	839	238	86	9	3	0	0	0
Social scientists	128	35	34	26	19	11	1	2	0	0	0
ENGINEERS	1,630	382	694	389	124	27	10	3	1	0	0
Civil engineers	158	19	54	64	14	5	1	1	0	0	0
Electrical/electronic engineers	587	128	250	136	57	14	1	1	0	0	0
Industrial/mech. eng.	885	235	390	189	53	8	8	1	1	0	0

Source: 1990 Census (Annex A) Table 1.

Table Sing-3(90)

Scientists and Engineers, by Industry and Sex, for Singapore: 1990

Both Sexes

Sex and Occupation	Total	Agri., Fishing, Forestry, and Hunting	Mining and Quarrying	Manufac- turing	Electric, Water, and Gas	Constr- uction	Commerce	Transport, Storage and Commun.	Services
TOTAL SCIENTISTS AND ENGINEERS	24,186	10	17	8,553	531	1,568	2,751	1,806	8,950
SCIENTISTS	9,778	10	3	1,662	72	27	1,611	768	5,625
Natural scientists	1,015	10	2	245	13	3	49	35	658
Computer scientists	8,508	0	1	1,403	57	24	1,557	733	4,733
Social scientists	255	0	0	14	2	0	5	0	234
ENGINEERS	14,408	0	14	6,891	459	1,541	1,140	1,038	3,325
Civil engineers	2,221	0	3	129	80	837	24	120	1,028
Electrical/electronic engineers	4,886	0	1	2,660	240	114	620	454	797
Industrial/mech. eng.	7,301	0	10	4,102	139	590	496	464	1,500

Table Sing-3(90)
Scientists and Engineers, by Industry and Sex, for Singapore: 1990—Continued

Sex and Occupation	Total	Agri., Fish., Forestry, and Hunting	Mining and Quarrying	Manufac- turing	Electric, Water, and Gas	Constr- uction	Commerce	Transport, Storage and Commun.	Services
TOTAL SCIENTISTS AND ENGINEERS	18,205	5	16	7,125	476	1,287	2,000	1,388	5,908
SCIENTISTS	5,427	5	2	981	40	20	989	436	2,954
Natural scientists	571	5	2	114	11	3	26	27	383
Computer scientists	4,729	0	0	863	27	17	962	409	2,451
Social scientists	127	0	0	4	2	0	1	0	120
ENGINEERS	12,778	0	14	6,144	436	1,267	1,011	952	2,954
Civil engineers	2,063	0	3	126	74	778	24	114	944
Electrical/electronic engineers	4,299	0	1	2,349	230	107	532	387	693
Industrial/mech. eng.	6,416	0	10	3,669	132	382	455	451	1,317

Table Sing-3(90)

Scientists and Engineers, by Industry and Sex, for Singapore: 1990--Continued

Sex and Occupation	Total	Agri., Fish., Forestry, and Hunting	Mining and Quarrying	Manufac- turing	Electric, Water and Gas	Constr- uction	Commerce	Transport, Storage and Commun.	Female
									Services
TOTAL SCIENTISTS AND ENGINEERS	5,981	5	1	1,428	55	281	751	418	3,042
SCIENTISTS	4,351	5	1	681	32	7	622	332	2,671
Natural scientists	444	5	0	131	2	0	23	8	275
Computer scientists	3,779	0	1	540	30	7	595	324	2,282
Social scientists	128	0	0	10	0	0	4	0	114
ENGINEERS	1,630	0	0	747	23	274	129	86	371
Civil engineers	158	0	0	3	6	59	0	6	84
Electrical/electronic engineers	587	0	0	311	10	7	88	67	104
Industrial/mech. eng.	885	0	0	433	7	208	41	13	183

Source: 1990 Census (Appendix A), Table 3.

Table Sing-5(90)

Scientists and Engineers by Service Industry and Sex, for Singapore, 1990

Both Sexes

Sex and Occupation	Total	Finance, Insurance, Real Estate, and Business Services	Community, Social and Personal Services
TOTAL SCIENTISTS AND ENGINEERS	8,950	6,693	2,257
SCIENTISTS	5,625	4,207	1,418
Natural scientists	658	246	412
Computer scientists	4,733	3,870	863
Social scientists	234	91	143
ENGINEERS	3,325	2,486	839
Civil engineers	1,028	906	122
Electrical/electronic engineers	797	557	240
Industrial/mech. eng.	1,500	1,023	477

Table Sing-5(90)

Scientists and Engineers by Service Industry and Sex, for Singapore, 1990--Continued

Male

Sex and Occupation	Total	Finance, Insurance, Real Estate, and Business Services	Community Social, and Personal Services
TOTAL SCIENTISTS AND ENGINEERS	5,908	4,418	1,490
SCIENTISTS	2,954	2,227	727
Natural scientists	383	164	219
Computer scientists	2,451	2,005	446
Social scientists	120	58	62
ENGINEERS	2,954	2,191	763
Civil engineers	944	833	111
Electrical/electronic engineers	693	482	211
Industrial/mech. eng.	1,317	876	441

Table Sing-5(90)
 Scientists and Engineers by Service Industry and Sex, for Singapore, 1990--Continued

Sex and Occupation	Female	
	Total	Community, Social, and Personal Services
TOTAL SCIENTISTS AND ENGINEERS	3,042	2,275
SCIENTISTS	2,671	1,980
Natural scientists	275	82
Computer scientists	2,282	1,865
Social scientists	114	33
ENGINEERS	371	295
Civil engineers	84	73
Electrical/electronic engineers	104	75
Industrial/mech. eng.	183	147

Source: 1990 Census (Appendix A), Table 4.

Table Sing-6(90)

Scientists and Engineers by Educational Attainment and Sex, for Singapore, 1990

Both Sexes

Sex and Occupation	Total	University	Upper Secondary*
TOTAL SCIENTISTS AND ENGINEERS	24,186	16,453	7,733
SCIENTISTS	9,778	6,194	3,584
Natural scientists	1,015	965	50
Computer scientists	8,508	4,977	3,531
Social scientists	255	252	3
ENGINEERS	14,408	10,259	4,149
Civil engineers	2,221	1,960	261
Electrical/electronic engineers	4,886	3,544	1,342
Industrial/mech. eng.	7,301	4,755	2,546

Table Sing-6(90)
 Scientists and Engineers by Educational Attainment and Sex, for Singapore: 1990
 --Continued

Sex and Occupation	Male		
	Total	University	Upper Secondary*
TOTAL SCIENTISTS AND ENGINEERS	18,205	12,882	5,323
SCIENTISTS	5,427	3,564	1,863
Natural scientists	571	541	30
Computer scientists	4,729	2,896	1,833
Social scientists	127	127	0
ENGINEERS	12,778	9,318	3,460
Civil engineers	2,063	1,835	228
Electrical/electronic engineers	4,299	3,156	1,143
Industrial/mech. eng.	6,416	4,327	2,089

Sing-6(90)

Table 6. Scientists and Engineers by Educational Attainment and Sex, for Singapore: 1990

--Continued

Sex and Occupation	Female		
	Total	University	Upper Secondary*
TOTAL SCIENTISTS AND ENGINEERS	5,981	3,571	2,410
SCIENTISTS	4,351	2,630	1,721
Natural scientists	444	424	20
Computer scientists	3,779	2,081	1,698
Social scientists	128	125	3
ENGINEERS	1,630	941	689
Civil engineers	158	125	33
Electrical/electronic engineers	587	388	199
Industrial/mech. eng.	885	428	457

* Upper Secondary qualification includes those with diplomas from polytechnic institutes.

Source: 1990 Census (Appendix A, Table 2).

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