# Science and technology

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# **Science and technology**

### Introduction

Science and technology directly influence the strength and competitiveness of industry by providing a basis for technological change and thereby encouraging economic growth and development. They can be seen as making major contributions to the achievement of many of Australia's social, economic and industrial goals.

# Official organisations and administration

There are many organisations in Australia concerned in some way with the development of science and technology in Australia.

The Commonwealth Government's conviction of the importance of science and technology is reflected in the functions of the Department of Industry, Science and Technology. Apart from having general responsibility for science and technology, the Department is concerned with the development and maintenance of Australia's scientific and technological capability.

A number of other Commonwealth government organisations either support or carry out scientific and technological activities. State Governments are also involved in science and technology via State government departments, science and technology councils and other organisations. Non-government organisations participating in scientific and technological activities include higher education institutions, professional and learned bodies, private organisations and industry groups.

### Department of Industry, Science and Technology

The main scientific and technological bodies and activities of the portfolio include the Commonwealth Scientific and Industrial Research Organisation, the Australian Nuclear Science and Technology Organisation, the Australian Institute of Marine Science and the 150% tax concession for research and development (R&D), which are described below. Details of others, such as R&D grants and assistance schemes; the Australian Space Office; and the National Standards Commission, are contained in *Year Book Australia 1991*.

### Commonwealth Scientific and Industrial Research Organisation (CSIRO)

CSIRO was established as an independent statutory authority by the *Science and Industry Research Act 1949*, which has been amended on a number of occasions since then. Its primary role is as an applications-oriented research organisation in support of major industry sectors and selected areas of community interest, with a strong commitment to the effective transfer of its results to users.

Briefly, CSIRO's primary statutory functions are to:

- carry out scientific research for the benefit of Australian industry, the community, national objectives, national or international responsibilities, or for any other purpose determined by the Minister; and
- encourage or facilitate the application or utilisation of the results of such research.

Other functions include dissemination and publication of scientific information, international liaison in scientific matters, and provision of services and facilities.

The research work of the organisation is carried out in Institutes, each headed by a Director and each specifically established to undertake work in support of industry or community interest sectors of the Australian economy. Institutes are composed of Divisions, which are individually responsible for broad programs of research in support of the objectives of the Institute. *Institute of Information, Science and Engineering*: Divisions of Information Technology; Radiophysics; Australia Telescope; Mathematics and Statistics.

*Institute of Industrial Technologies*: Divisions of Manufacturing Technology; Materials Science and Technology; Applied Physics; Chemicals and Polymers; Biomolecular Engineering.

Institute of Minerals, Energy and Construction: Divisions of Building, Construction and Energy (now incorporates National Building Technology Centre); Exploration and Mining; Minerals; Coal and Energy Technology; Petroleum Resources.

*Institute of Animal Production and Processing*: Divisions of Animal Health; Animal Production; Wool Technology; Tropical Animal Production; Food Science and Technology; Human Nutrition.

*Institute of Plant Production and Processing:* Divisions of Plant Industry; Tropical Crops and Pastures; Horticulture; Entomology; Soils; Forestry Products.

*Institute of Natural Resources and Environment*: Divisions of Water Resources; Fisheries; Oceanography; Atmospheric Research; Wildlife and Ecology; Centre for Environmental Mechanics; Office of Space Science and Applications.

CSIRO has a staff of approximately 7,500 in more than 70 locations throughout Australia. About one-third of the staff are professional scientists, with the others providing technical, administrative or other support. CSIRO's budget for 1994–95 was \$681.7 million.

### Australian Nuclear Science and Technology Organisation (ANSTO)

ANSTO was established as a statutory authority under the *Australian Nuclear Science and Technology Organisation Act* 1987 No. 3 as amended, and replaced the Australian Atomic Energy Commission. Its mission is to benefit the Australian community by the development and peaceful application of nuclear science and technology in industry, medicine, agriculture, science and other fields.

# Australian Institute of Marine Science (AIMS)

AIMS is the only Australian research agency committed primarily to marine research, with emphasis on tropical marine science. The Institute is a federally funded statutory authority governed by a specialist Council appointed by the Australian Government. It was established in 1972 and has its headquarters at Cape Ferguson, 50 kms south of the coastal city of Townsville. More recently a laboratory has been established in Dampier, Western Australia.

The Institute's mission is to undertake research and development for the purpose of generating new knowledge in marine science and technology, promoting its application in industry, government and environmental management, and undertaking complementary activities to disseminate knowledge; to collaborate effectively with other researchers and research organisations; to assist in the development of national marine science policy; and to enhance the Institute's standing as a centre of excellence.

Research at AIMS is focused on problems in tropical coastal and shelf environments and the applications of marine technology. Much of it involves long-term research which is geared towards an improved understanding of marine systems, including spatial patterns and dynamic processes, and the development of a capability to predict the behaviour of complex tropical marine systems. In particular it is directed at achieving four clearly defined outcomes:

- Producing an improved understanding of the complex interactions and processes in Australia's tropical coastal and continental shelf ecosystems;
- Providing high quality scientific information and advice on the condition of Australia's tropical marine ecosystems and predicting likely changes in response to major disturbances, particularly those resulting from human activities;
- Providing a database of environmental records to enhance understanding and prediction of long-term climate change; and

 Developing a range of new marine research technologies with significant application to the needs of industry and the community.

The Institute has an established record in marine science and technology, principally associated with an understanding of marine communities of tropical Australia, Southeast Asia, and in the Pacific and Indian Oceans. The Institute has conducted long-term research into complex marine ecosystems and the impacts of human activities on the marine environment. These results are used by industry and natural resources management agencies to ensure the conservation and sustainable use of marine resources in the region.

### Tax concession for Research and Development

The 150% tax concession for Research and Development (R&D) which commenced from July 1985 is the major program in the Government's package of measures to encourage R&D in Australia.

The concession allows companies incorporated in Australia, public trading trusts and partnerships of eligible companies to deduct up to 150% of eligible expenditure incurred on R&D activities when lodging their corporate tax return. This effectively reduces their after tax cost of R&D to 50.5 cents in the dollar at the 33% corporate tax rate.

The concession is broad-based, being available to the majority of companies undertaking R&D in Australia. The concession is market driven, being structured in a manner which is neither industry-oriented nor product-oriented, allowing individual companies to determine both the specific area of innovation and direction of their R&D activities. Expenditure eligible under the concession at 150% includes: salaries, wages and other overhead costs which are directly related to the company's Australian R&D activities; contract expenditure; and capital expenditure on R&D plant and equipment (over three years). Expenditure on acquiring, or acquiring the right to use, technology for the purposes of the company's own R&D activities is 100% deductible.

The R&D projects must satisfy the adequate Australian content requirement. In addition the results of the R&D must be exploited on normal commercial terms and to the benefit of Australia.

To attract the 150% deduction, annual eligible R&D expenditure must exceed \$20,000. Where R&D is contracted to an approved Registered Research Agency this expenditure threshold is waived.

### **Research and development**

### Expenditure and human resources

The statistics which follow are based on the OECD definitions for national research and development (R&D) surveys. The OECD defines R&D as comprising 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications'.

Statistics on the amount of expenditure and human resources devoted to R&D in the business enterprise sector are collected, in varying degrees of detail, annually. Comparable statistics on the general government, higher education, and private non-profit sectors are only collected biennially. Tables 22.1, 22.2, and 22.3 provide a summary of the latest statistics available for these four sectors.

		(+	·•··,			
Sector	1985-86	1986-87	1987-88	1988-89	1990-91	1992-93
Business enterprises						
Private sector	852.2	1 165. <b>1</b>	1 388.2	1 649.1	1 878.7	2 544.0
Public sector	95.7	123.5	117.6	149.2	203.6	243.9
General government						
Commonwealth	729.0	786.5	797.0	869.6	1 025.8	1 128.2
State	315.8	368.4	394.6	482.7	638.5	615.5
Higher education	(a)707.6	881.7	983.6	1 076.8	1 332.8	1 695.2
Private non-profit	47.1	49.1	53.9	53.3	70.3	81.9
Total	(a)2 747.4	3 374.3	3 734.9	4 280.7	5 149.7	6 308.8

#### 22.1 Expenditure on R&D at current prices (\$ million)

(a) Estimates for Colleges of Advanced Education are excluded as they were not collected for this year. Source: Research and Experimental Development, All-Sector Summary, Australia (8112.0).

22.2	Expenditure	on R&D a (\$ mill)	it average ion)	1989-90 j	orices	
	1985-86	1986-87	1987-88	1988-89	1990-91	1992–93
enterprises						
	4 4 4 0 4	4 400 0	4 507 0	4 700 0	4 700 4	0 040 0

Total	_ (a)3 513.2	4 012.9	4 171.5	4 586.1	4 941.3	5 753.2
Private non-profit	60.1	60.6	63.1	58.8	67.4	72.2
Higher education	(a)909.9	1 043.7	1 120.8	1 165.7	1 312.5	1 608.5
State	404.3	438.7	447.9	524.4	615.3	562.1
Commonwealth	910.9	925.7	883.3	894.4	956.9	969.7
General government						
Public sector	117.9	141.0	129.4	159.6	191.1	221.5
Private sector	1 110.1	1 403.2	1 527.0	1 783.2	1 798.1	2 319.2
Business enterprises						

(a) Estimates for Colleges of Advanced Education are excluded as they were not collected for this year. Source: Research and Experimental Development, All-Sector Summary, Australia (8112.0).

### Source of funds

Sector

In 1992–93, 94% of funding for R&D carried out by businesses came from the business sector and has remained at this level since 1988–89. General government organisations provided 2% (tables 22.4 and 22.5).

Fifty-eight per cent of general government sector R&D was funded by Commonwealth government organisations and 27% by State government organisations. These percentages have fallen slightly since 1988–89 and have been offset by increases from both business enterprises and private non-profit organisations. Ninety-one per cent of higher education funding came from the Commonwealth Government with a further 4% from the private non-profit sector. A further 2% each from State governments and business enterprises made up most of the remainder.

For the private non-profit sector, Commonwealth government organisations funded 38% of the R&D in 1992–93 (up from 31% in 1990–91) while the contribution by State Governments fell to 13% (down from 15% in 1990–91).

		(herzon	years)			
Sector	1985-86	1986-87	1987-88	1988-89	1990-91	1992-93
<b>Business Enterprises</b>						
Private sector	13 431	16 198	16 952	19 206	19 040	20 592
Public sector	1 353	1 393	1 527	1 597	1 867	2 219
General government						
Commonwealth	11 182	11 529	11 491	10 863	10 660	10 964
State	6 337	6 796	7 133	8 335	8 625	8 224
Higher education	(a)20 143	23 219	24 323	24 902	27 081	35 418
Private non-profit	812	945	1 016	1 023	1 072	1 120
Total	(a)53 258	60 080	62 442	65 926	68 345	78 538

## 22.3 Human resources devoted to R&D (person years)

(a) Estimates for Colleges of Advanced Education are excluded as they were not collected for this year. Source: Research and Experimental Development, All-Sector Summary, Australia (8112.0).

### 22.4 Expenditure on R&D — source of funds, 1990–91 (\$'000)

-					Sou	rce of funds
Sector	Commonwealth government	State government	Business enterprises	Private non-profit & other Australian(a)	Overseas	Total
Business enterprises						
Private sector	48 501	5 480	1 778 992	5 775	39 992	1 878 740
Public sector	5 611	3 319	194 491	208	_	203 629
General government						
Commonwealth	931 474	8 232	74 515	2 471	9 107	1 025 800
State	70 528	500 517	34 926	28 851	3 641	638 463
Higher education	1 190 555	29 556	29 917	73 438	9 334	1 332 799
Private non-profit	21 656	10 586	5 971	29 323	2 776	70 312
Total	2 268 325	557 691	2 118 812	140 065	64 850	<u>5 149 743</u>

(a) Includes funds provided via government levies.

Source: Research and Experimental Development, All-Sector Summary, Australia (8112.0).

### 22.5 Expenditure on R&D — source of funds, 1992–93 (\$'000) \_\_\_\_

-					Sou	rce of funds
Sector	Commonwealth	State government	Business enterprises	Private non-profit & other Australian(a)	Overseas	Total
Business enterprises						
Private sector	n.p.	n.p.	2 394 357	10 411	84 696	2 544 013
Public sector	n.p.	n.p.	229 180	7 479	—	243 913
General government						
Commonwealth	965 475	11 378	74 655	62 727	13 971	1 128 206
State	53 133	464 642	15 920	77 888	3 963	615 546
Higher education	1 544 754	34 771	41 684	63 488	10 512	1 695 209
Private non-profit	30 943	10 930	5 440	31 635	2 982	81 929
Total	2 648 093	<u>529 735</u>	2 761 235	253 628	116 125	6 308 817

(a) Includes funds provided via government levies.

Source: Research and Experimental Development, All-Sector Summary, Australia (8112.0).

enterprises
business
ą
R&D
22.6

		Enterp	rises (no.)	Ē	penditure on	R&D (\$m)	Pers	on years of eff	ort on R&D
Industry of enterprise	1990-91	1991–92	1992–93	1990-91	1991-92	1992-93	1990-91	1991-92	1992–93
Mining (excl. services to mining)	44	47	00	94.6	149.5	149.6	807	1 010	1 047
Manufacturing									
Food, beverages & tobacco	100	96	120	86.7	110.1	136.2	961	993	1 116
Textiles, clothing & footwear	33	33	42	15.0	17.2	26.3	113	139	188
Wood, wood products & furniture	36	29	30	7.3	16.8	11.0	107	102	108
Paper, paper products, printing $\&$ publishing	30	27	28	35.9	54.9	43.5	254	249	245
Chemical, petroleum & coal products	241	218	235	201.7	201.9	226.3	1 956	1 828	1 801
Non-metallic mineral products	32	32	42	17.7	24.6	29.3	165	203	281
Basic metal products	60	55	53	174.8	179.5	290.9	1 291	1 235	1 329
Fabricated metal products	115	102	133	27.1	26.9	45.2	341	311	463
Transport equipment	106	<b>6</b> 6	110	171.8	223.2	307.3	1 583	1 530	1 689
Photographic, professional & scientific equipment	64	59	99	41.9	51.1	53.0	491	522	547
Appliances & electrical equipment	530	457	478	265.0	304.0	362.0	3 458	3 306	3 588
Industrial machinery & equipment	228	190	249	61.3	67.4	75.4	669	750	931
Miscellaneous manufacturing	114	100	123	35.2	50.3	60.5	395	389	452
Total manufacturing	1 689	1 497	1 709	1 141.5	1 327.7	1 666.9	11 813	11 558	12 737
Other industries									
Wholesale & retail trade	258	234	257	184.2	203.6	219.9	1 780	1 677	1 660
Finance	32	30	28	136.3	94.5	119.9	1 596	1 422	1 468
Property & business services	457	406	501	239.7	286.2	328.6	2 479	2 983	3 342
Research & scientific institutions	64	58	65	64.3	65.7	91.0	649	719	894
Other n.e.c.	141	126	146	221.7	192.5	212.1	1 783	1 699	1 663
Total other industries	952	854	100	846.3	842.5	971.5	8 287	8 499	9 027
Total all industries	2 685	2 398	2 766	2 082.4	2 319.7	2 787.9	20 907	21 066	22 811
Private sector contribution	2 633	2 353	2 724	1 878.7	2 103.4	2 544.0	19 040	18 979	20 592
Public sector contribution	52	45	42	203.6	216.4	243.9	1 867	2 088	2 219

Source: Research and Experimental Development, Business Enterprises (Inter Year Survey), Australia (8114.0).

### **Business sector**

Business expenditure on R&D in Australia in 1992–93 (table 22.6) increased 20% over 1991–92 with a corresponding increase of 8% in human resources devoted to R&D.

Mining remained constant, Manufacturing expenditure increased 26% with a 10% increase in human resources. In the Other industries the respective increases were Property and business services 15% and 12%, Research and scientific institutions 39% and 24%, and Finance 27% and 3%. Wholesale and retail trade increased expenditure 8% although human resources decreased 1%.

Business expenditure on R&D represents 0.67% of Gross Domestic Product (GDP). After plateauing between 1988–89 and 1990–91, this ratio increased by 27% in the next two years (table 22.7).

# 22.7 Expenditure on R&D as a percentage of GDP — OECD countries

	()	
	Business	Government
Japan	2.06	0.25
United States	1.82	0.30
Germany	1.72	0.38
France	1.44	0.52
United Kingdom	1.33	3.34
Finland	1.24	0.45
Canada	0.81	0.28
Italy	0.78	0.33
Ireland	0.69	0.14
Australia	0.67	0.43
Spain	0.47	0.18
Iceland	0. <u>31</u>	0.60

Source: Research and Experimental Development, Business Enterprises (Inter Year Survey), Australia (8114.0).

### **General government sector**

Government expenditure on R&D carried out in Australia in 1992–93 was estimated to be \$1,744 million at current prices, an increase of 5% over the two years since 1990–91. At average 1989–90 prices, expenditure in 1992–93 decreased by 3% compared with 1990–91 (table 22.1).

The socio-economic objectives on which most government R&D expenditure was carried out were: Environment (\$281 million), Animal production and primary products (\$277 million), Plant production and primary products (\$247 million), Manufacturing (\$219 million) and Defence (\$201 million). Much the same pattern applies in terms of the human resources devoted to R&D. Labour costs continue to be the main component of R&D expenditure (58%). Labour costs as a proportion of total R&D costs have increased slightly after decreasing for a number of years (table 22.8).

				Type of e	expenditure
Socio-economic objective	Land & buildings	Other capital expenditure	Labour costs	Other current expenditure	Total
Defence	8 134	29 133	124 203	39 838	201 30 <del>9</del>
Economic development					
Plant — production & primary products	13 620	15 445	151 567	66 859	247 490
Animal — production & primary products	14 213	15 509	163 233	84 249	277 204
Mineral resources (excl. energy)	2 619	4 971	38 670	24 392	70 652
Energy resources	1 252	2 358	23 878	24 485	51 973
Energy supply	690	1 342	10 050	6 143	18 225
Manufacturing	9 852	16 663	117 341	75 380	219 237
Construction	1 334	2 214	23 804	11 386	38 738
Transport	420	1 148	13 811	6 095	21 474
Information & communication services	1 075	3 153	19 083	9 570	32 881
Commercial services	230	247	2 952	1 774	5 204
Economic framework	611	1 566	15 537	4 897	22 611
Total economic development	45 915	64 618	579 928	315 229	1 005 689
Society					
Health	2 659	8 209	78 962	33 828	123 657
Education & training	116	656	4 992	1 141	6 906
Social development & community services	1 250	1 148	20 697	12 000	35 094
Total society	4 025	10 012	104 651	46 969	165 657
Environment					
Environmental knowledge	5 537	8 023	75 911	50 506	139 978
Environmental aspects of economic development	5 267	6 904	63 053	40 241	115 465
Environmental management & other aspects	649	1 791	15 012	8 1 7 8	25 630
Total environment	11 453	16 719	153 975	98 926	281 073
Advancement of knowledge		-		-	
Natural sciences, technologies & engineering	5 402	6 160	43 364	33 309	88 234
Social sciences & humanities	260	85	965	481	1 791
Total advancement of knowledge	5 661	6 245	44 329	33 789	90 025
Total	75 <u>189</u>	126 726	<u>1 007 086</u>	<u>534 751</u>	1 743 752

## 22.8 Expenditure on R&D by general government organisations, 1992–93 (\$'000)

Source: Research and Experimental Development, General Government and Private Non-Profit Organisations, Australia (8109.0).

Government expenditure on R&D represents 0.43% of GDP. This ratio is at a similar level to the early 1980s after a downward trend in the

late 1980s, and is relatively high when compared with other OECD countries (table 22.7).

			Type of	employee
Socio-economic objective	Researchers	Technicians	Other supporting staff	Total
Defence	1 342	662	100	2 104
Economic development				
Plant — production & primary products	1 176	1 142	599	2 918
Animal — production & primary products	1 188	1 257	762	3 207
Mineral resources (excl. energy)	353	157	141	651
Energy resources	192	146	110	449
Energy supply	88	50	34	172
Manufacturing	974	617	501	2 092
Construction	180	114	98	392
Transport	125	54	62	241
Information & communication services	237	44	72	353
Commercial services	31	13	13	57
Economic framework	213	60	49	321
Total economic development	4 757	3 655	2 441	10 853
Society				
Health	1 066	815	216	2 097
Education & training	84	8	16	109
Social development & community services	225	61	95	381
Total society	1 376	884	327	2 586
Environment				
Environmental knowledge	653	445	296	1 3 <del>9</del> 4
Environmental aspects of economic development	529	360	246	1 136
Environmental management & other aspects	149	94	56	299
Total environment	1 332	899	598	2 829
Advancement of knowledge				
Natural sciences, technologies & engineering	429	247	120	796
Social sciences & humanities	16	3	2	21
Total advancement of knowledge	445	250	122	816
Total	9 252	6 350	<u> </u>	19 189

## 22.9 Human resources devoted to R&D by general government organisations, 1992–93 (person years)

Source: Research and Experimental Development, General Government and Private Non-Profit Organisations, Australia (8109.0).

### **Higher education sector**

The estimate of expenditure on R&D carried out in Australia by the higher education sector in 1992 (\$1,695 million) was an increase of 27% over the two years since 1990. At average 1989–90 prices, expenditure increased by 23% over the same period (table 22.1).

Table 22.10 shows that the socio-economic objectives on which most higher education expenditure was carried out in 1992 were Advancement of knowledge—natural sciences,

technologies and engineering (\$422 million), Health (\$319 million) and Advancement of knowledge—social sciences and humanities (\$279 million). These three objectives accounted for 60% of expenditure.

Labour costs as a percentage of total expenditure fell from 71% in 1986 to 63% in 1990, but increased over the period 1990 to 1992 to 64%.

	Type of expendi							
Socio-economic objective	Land & buildings	Other capital expenditure	Labour costs	Other current expenditure	Total			
Defence	79	452	1 721	675	2 926			
Economic development								
Plant — production & primary products	2 270	5 275	36 532	14 459	58 537			
Animal — production & primary products	1 965	4 009	25 658	10 607	42 239			
Mineral resources (excl. energy)	891	2 308	12 954	5 747	21 900			
Energy resources	355	1 315	4 968	2 532	9 170			
Energy supply	545	4 674	17 858	7 806	30 882			
Manufacturing	2 402	13 285	42 056	17 274	75 018			
Construction	1 199	5 280	22 519	9 515	38 513			
Transport	188	572	2 771	1 005	4 536			
Information & communication services	1 606	5 438	20 111	7 451	34 607			
Commercial services	640	1 217	9 223	3 152	14 232			
Economic framework	3 551	5 842	50 412	16 533	76 339			
Total economic development	15 613	49 216	245 062	96 081	405 971			
Society								
Health	9 331	28 783	215 397	65 464	318 975			
Education & training	4 955	6 028	53 731	16 573	81 286			
Social development & community services	3 045	3 928	35 385	11 373	53 731			
Total society	17 331	38 739	304 513	93 409	453 992			
Environment								
Environmental knowledge	4 625	8 970	51 607	19 578	84 780			
Environmental aspects of economic development	1 635	3 142	23 337	7 685	35 800			
Environmental management & other aspects	492	1 170	5 765	2 532	9 959			
Total environment	6 752	13 282	80 710	29 795	130 539			
Advancement of knowledge								
Natural sciences, technologies & engineering	18 329	56 915	261 108	85 964	422 316			
Social sciences & humanities	17 644	22 351	186 488	52 983	279 466			
Total advancement of knowledge	35 973	79 266	447 596	138 947	701 782			
Total	75 747	180 954	1 079 602	358 907	1 695 209			

### 22.10 Expenditure on R&D by higher education organisations, 1992 (\$ million)

Source: Research and Experimental Development, Higher Education Organisations, Australia (8111.0).

			Type of	employee
			Other supporting	
Socio-economic objective	Researchers	Technicians	staff	Total
Defence	61	14	4	78
Economic development				
Plant — production & primary products	867	274	63	1 204
Animal — production & primary products	649	216	75	939
Mineral resources (excl. energy)	341	61	29	431
Energy resources	163	44	19	225
Energy supply	446	83	38	567
Manufacturing	1 378	314	103	1 794
Construction	683	87	38	808
Transport	94	19	11	124
Information & communication services	792	81	68	941
Commercial services	297	31	22	350
Economic framework	1 225	104	110	1 439
Total economic development	6 935	1 314	575	8 823
Society				
Health	4 204	1 411	572	6 187
Education & training	2 079	147	177	2 402
Social development & community services	1 325	119	88	1 531
Total society	7 607	1 677	837	10 120
Environment				
Environmental knowledge	1 376	250	144	1 770
Environmental aspects of economic development	625	63	43	731
Environmental management & other aspects	190	30	14	234
Total environment	2 190	343	201	2 734
Advancement of knowledge				
Natural sciences, technologies & engineering	6 104	1 274	558	7 936
Social sciences & humanities	5 018	236	471	5 726
Total advancement of knowledge	11 123	1 510	1 030	13 662
Total	27 914	4 858	2 646	35 418

### 22.11 Human resources devoted to R&D by higher education organisations, 1992 (person years)

Source: Research and Experimental Development, Higher Education Organisations, Australia (8111.0).

### **Private non-profit sector**

Private non-profit expenditure on R&D carried out in 1992–93 (\$82 million) increased 17% at current prices and 7% at average 1989–90 prices over 1990–91 (table 22.1).

Health is the leading socio-economic objective in terms of R&D expenditure, accounting for 73% or \$59 million of total R&D expenditure in 1992–93 in the private non-profit sector. The same applies in terms of human resource usage. Labour costs continue to be the main component of R&D expenditure (59%) (tables 22.12 and 22.13).

				Type of exp	enditure
	Land &	Other capital	Labour	Other current	
Socio-economic objective	buildings	expenditure	costs	expenditure	Total
Defence	—	—	_		—
Economic development					
Plant — production & primary products	—	17	120	64	201
Animal — production & primary products	—	141	611	190	942
Mineral resources (excl. energy)		10	20	33	64
Energy resources	—	1	29	13	43
Energy supply		3	88	94	184
Manufacturing	8	31	153	86	277
Construction	12	29	100	184	325
Transport	_	3	7	22	32
Information & communication services	_	3	7	11	21
Commercial services	_	44	948	687	1 678
Economic framework	7	142	727	368	1 244
Total economic development	27	424	2 809	1 751	5 011
Society					
Health	1 345	3 974	36 267	17 882	59 468
Education & training		200	3 166	2 951	6 317
Social development & community services	9	147	720	155	1 031
Total society	1 353	4 321	40 153	20 988	66 816
Environment					
Environmental knowledge	_	35	492	347	873
Environmental aspects of economic development	_	_	8	2	10
Environmental management & other aspects	_	11	198	149	358
Total environment	_	46	697	498	1 241
Advancement of knowledge					
Natural sciences, technologies & engineering	231	1 327	4 794	2 276	8 628
Social sciences & humanities		49	159	26	234
Total advancement of knowledge	231	1 376	4 953	2 302	8 862
Total	1 611	6 166	48 613	25 539	81 929

22.12	Expenditure on R&D by private non-profit organisations, 1992–93
	(\$'000)
	(+ )

Source: Research and Experimental Development, General Government and Private Non-Profit Organisations, Australia (8109.0).

	Туре				
Socio-economic objectives	Researchers	Technicians	Other supporting staff	Total	
Defence	—	—	_	_	
Economic development					
Plant — production & primary products	2	1		3	
Animal — production & primary products	10		2	12	
Mineral resources (excl. energy)		—	·	_	
Energy resources	—	—	_	_	
Energy supply	1	-	_	2	
Manufacturing	2	—	1	3	
Construction	1	-	1	2	
Transport		_	-	_	
Information & communication services		—	<u></u>	_	
Commercial services	8	4	5	17	
Economic framework	17	1	2	19	
Total economic development	43	6	10	59	
Society					
Health	393	273	198	865	
Education & training	24	12	10	46	
Social development & community services	12	1	4	17	
Total society	428	286	212	927	
Environment					
Environmental knowledge	13	_	2	15	
Environmental aspects of economic development	-	_	_	_	
Environmental management & other aspects	5		_	6	
Total environment	18	_	2	21	
Advancement of knowledge					
Natural sciences, technologies & engineering	45	50	15	110	
Social sciences & humanities	2	1	1	3	
Total advancement of knowledge	47	50	16	113	
Total	536	343	241	1 120	

## 22.13 Human resources devoted to R&D by private non-profit organisations, 1992–93 (person years)

Source: Research and Experimental Development, General Government and Private Non-Profit Organisations, Australia (8109.0).

### Home computing in Australia

"These new services and technologies will change the way we live, work and play. Their effect on our business, our schools and universities, our hospitals, our government, and many other aspects of our daily lives, will be profound." (Prime Minister's April 1995 Statement, A National Strategy for Information and Communications Services and Technologies).

"The great benefit of the current 'information age' is not simply that there is a fast growing technical capacity to communicate or send information from anywhere to anywhere. Providing capacity is not sufficient to ensure that the community is better off. It does not indicate how that vast ability is best used within the limits of time, convenience and budget .... The development of publicly-available quantitative and qualitative indicators of emerging Australian demand patterns... will ensure that both winners and losers in any eventual broadband revolution can clearly and quickly be identified." (Bureau of Transport and Communications Economics 1994).

The two quotes above show the importance of Information Technology & Telecommunications (IT&T) developments to Australian industry and consumers generally. The importance of statistics to the overall process described by the Prime Minister was emphasised by the Bureau of **Transport and Communications Economics** (BTCE) in presenting its research into 'Communications Futures'. It indicated the need for better statistical information generally on IT&T and related issues. BTCE further indicated that the household sector, as consumers of IT, would have a significant influence in determining which IT&T goods and services predominate in the economy, affordability being one of the main issues determining the pace and direction of change.

In 1992–93 the ABS commenced work on a program of development to establish a set of official IT&T statistics for Australia. One of the outputs from this program is

Information Technology in Australia 1992-93 (8126.0). This publication reported on the characteristics of businesses which form the IT&T industries (i.e. the producers of IT goods and services including manufacturers, wholesalers and other service sector businesses).

A second output, *Housebold Use of Information Technology* (8128.0), is the result of a survey conducted in February 1994 and is the main focus of this article. Although the rapid uptake of technology by households will quickly render the results out of date, the data nevertheless will provide an important benchmark to which future statistics can be related.

### The survey

The February 1994 household survey was conducted using the ABS's Population Survey Monitor, a flexible household survey vehicle used to conduct surveys of households for users on a fee for service basis. The survey is constrained by its relatively small sample size, returning 2,300 household observations, compared to the approximately about 30,000 in the ABS's monthly population sample. The sample permits data to be aggregated to State levels and, within States, to capital cities and remainder of State. The small number of observations indicates the need for some caution in interpreting the results.

### **Uptake of computers**

From the February 1994 survey, it was estimated that there are about 6.4 million households in Australia. The total number of households frequently using a computer was estimated to be about 1.5 million. This represented an uptake by nearly 23% of households. Looked at from a potential demand point of view, the survey showed that there were close to 5 million households without a computer. (For the purpose of this survey, a computer was taken to include any portable or desktop computer, excluding dedicated games machines.)

### **Distribution of home computers**

Table 22.14 below shows the estimated number of households in each State (divided between State capital cities and remainder of State), and the number which frequently used a general purpose computer.

22.14	Number	of hous	eholds	with	computers,	February	1994

	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT	Total
State capital cities									
No. of households ('000)	1 194	1 156	492	454	512	63	25	103	3 999
No. with computers ('000)	353	322	122	104	114	14	7	37	1 071
Percentage with computers (%)	30	28	25	23	22	22	26	36	27
Remainder of State									
No. of households ('000)	985	466	625	90	83	110	30		2 389
No. with computers ('000)	169	62	104	8	23	19	5		389
Percentage with computers (%)	17	13	17	9	27	17	16		16
Total									
No. of households ('000)	2 179	1 622	1 117	544	594	173	56	103	6 388
No. with computers ('000)	522	384	226	112	136	33	11	37	1 460
Percentage with computers (%)	24	24	20	21	23	19	20	36	23

Source: Household Use of Information Technology (8128.0), unpublished and published data.

The figures above indicate that the incidence of computers in households was not evenly spread across States or within States. The Australian Capital Territory had the highest incidence at 35.8%. The incidence in other States was significantly lower overall, ranging from New South Wales with 23.9% down to Tasmania with 18.9%. Computers had penetrated into a far greater proportion of households in capital cities than in country areas. In total, capital cities had a 26.8% penetration rate while country areas had a rate of only 16.3%. This difference was consistent across all States, except Western Australia where country households had a slightly higher penetration rate of 27.4%. This estimate is, however, subject to high relative standard errors and care should be used in drawing conclusions from it.

### Family types

Table 22.15 analyses computer usage within households by family type.

### 22.15 Computer usage by family/household type, February 1994

Family/household type	No. of households ('000)	No. with computers ('000)	Percentage with computers (%)
Married, no dependants	1 494	216	14.5
Married, with dependants	2 314	883	38.1
Single, with dependants	509	104	20.4
Other families/households	2 070	258	12.4
Total	6 388	1 460	22.9

Source: Household Use of Information Technology (8128.0), unpublished and published data.

This table shows that households occupied by married couples with dependants were more likely to have a computer than other family types. 38.1% of these families used a computer compared to 14.5% of married couples without dependants, 20.4% of households with single parent families and 12.4% of other types. On this basis, it is reasonable to conclude that a large motivation to acquire household computing facilities arises from the presence of children.

This finding is supported by the main use given for home computers, namely education purposes (24.9%) followed closely by entertainment (22.5%). These uses might be expected to be more closely related to children's use of computers than adults' use.

### **Household income**

Table 22.16 shows that, in general, the proportion of households with computers increased as household incomes increased. Of the 538,000 households which had an income of more than \$74,000, nearly 56% frequently used a computer. In households which had an income between \$57,001 and \$74,000, just over 38% used a computer. Most other income categories were fairly near the overall average of 22.9% except for those households which had an income of \$7,000 to \$16,000 where the percentages are very small (and are also subject to quite high standard errors).

			Percentage with
	No. of households	No. of computers	computers
Household income	('000')	('000')	(%)
\$0 \$7 000	162	29	17.6
\$7 001 \$13 000	814	24	3.0
\$13 001 \$16 000	533	43	8.1
\$16 001 \$24 000	587	104	17.8
\$24 001 \$30 000	554	105	18.9
\$30 001 \$38 000	563	115	20.4
\$38 001 — \$46 000	559	162	29.0
\$46 001 \$57 000	508	140	27.5
\$57 001 \$74 000	538	205	38.1
More than \$74 000	538	301	55.9
Not stated	1 031	232	22.5
Total	6 388	1 460	22.9

### 22.16 Distribution of computers by household income

Source: Household Use of Information Technology (8128.0), unpublished and published data.

### Home based business

Of the 742,000 households which had a home based business, 46% had a computer. This compared with 23% for all households in Australia (table 22.16). For households without a home based business, only about 20% had a computer. A comparison of the data in tables 22.16 and 22.17 shows that, for each household income range, a greater proportion of households with a home based business had a computer than those which did not, irrespective of the size of the household income.

nome based business								
Household income Range	No. with home business ('000)	No. with computers ('000)	Percentage with computers (%)					
	(000)	(000)	(/0)					
\$0 \$7 000	11	6	56.8					
\$7 001 — \$13 000	13		_					
\$13 001 — \$16 000	15	5	31.5					
\$16 001 — \$24 000	29	17	56.8					
\$24 001 \$30 000	65	20	31.3					
\$30 001 \$38 000	49	23	48.0					
\$38 001 \$46 000	104	43	41.5					
\$46 001 — \$57 000	58	38	65.2					
\$57 001 — \$74 000	99	56	56.9					
More than \$74 000	87	58	66.2					
Not stated	213	78	36.6					
Total	742	344	46.3					

## 22.17 Distribution of computers in households with a home based business

Source: Household Use of Information Technology (8128.0), unpublished and published data.

Clearly the existence of a home based business within a household was a significant motivation to acquire a home computer.

### Use of modems

Modems enable access to computers and facilities outside the home (such as the Internet). Modems are an essential item of equipment for householders who decide to avail themselves of a range of services, many of which are in development presently. These will encompass a range of electronic services from information to entertainment and home shopping. There is also a trend towards the convergence of data and voice services into a range of diverse everyday products.

At the survey date, a relatively small proportion of households with a computer had also acquired a modem. Only 17% of these households also had a modem. In total only about 4% of households had a modem.

Not surprisingly, modems were much more prevalent in households which had a home based business as can be seen from table 22.18 below.

	Without home business	With home business	Total						
Households with a computer ('000) Households with a modem	5 645	742	6 388						
No. ('000)	168	80	248						
Proportion (%)	3.0	10.8	3.9						

### 22.18 Households with a modem

Source: Household Use of Information Technology (8128.0), unpublished and published data.

Households which had a home business were three to four times more likely to have a modem. They accounted for about one third of households with a modem (i.e. 80,000 compared to 248,000). Nevertheless, only 10.8% of households which had a home business had a modem.

Of the 80,000 households which had a home based business and a modem, the main use of the computer was for 'business records' in 25% of households, 'other home based business' in 28% of cases and for 'other reasons' in 47% of households. In all, just over half these households acquired the computing equipment for business reasons, 28% specifically for home based business use. For all households which had a computer, the main use given was 'educational purposes' (24.9%) followed by 'entertainment' (22.5%). 'Business records' was the main use given by only 12.5% of households and 'other home based business' was given by 4.8% of households.

### The future

The survey sought information on the number of households expecting to spend money on computing equipment over the two year period from February 1994 to February 1996. Overall, 1.7 million households, or 26% of all households, indicated their intention to make some expenditure on computing equipment. Of these 0.8 million already had a computer and a further 0.9 million did not. The following table focuses on households which reported they did not have a computer at the survey date but which intended to spend money on computing equipment. These households represent potential new entrants to the home computing market.

ZZ.13 FOIEntial new entrants to nome computing									
	NSW	Vic.	Qid	SA	WA	Tas.	NT	ACT	Total
Households without computer equipment									
Total number ('000)	1 658	1 238	891	432	458	141	44	66	4 928
No. intending to spend on computer equipment ('000)	270	224	238	55	77	26	5	18	913
Proportion intending to spend on computer equipment (%)	16.3	18.1	26.8	12.6	16.9	1.9	1.1	27.7	18.5

### 22.19 Potential new entrants to home computing

Source: Household Use of Information Technology (8128.0), unpublished and published data.

In total, about 913,000 households without computing facilities at the survey date (February 1994) planned to spend on home computing equipment in the ensuing two years. These represent 18.5% of all households without computing facilities at the survey date (or 14.3% of all Australian households). Australian Capital Territory and Queensland appeared to be likely to have a greater take up rate than other States.

The survey suggests that there is the potential for substantial growth in the number of households with computers over the two years from February 1994. If most of these expenditure plans were to go ahead, the total number of households with home computer access would be in the order of 2 to 2.5 million by 1996.

### **Expenditure level**

On the assumption that these expectations were realised, it is possible to make an estimate of the expenditure that was made by households in the 12 month period between February 1994 and February 1995 using the data in the above table. By taking the midpoint of each range, multiplying by the number of households, and summing across size ranges one can estimate that there would have been expenditure of about \$1.6 or 1.7 billion. This is the equivalent of \$100 for every man, woman and child in Australia.

#### 22.20 Planned expenditure in the 12 months from February 1994

	No, of households
Expenditure range	('000')
\$1\$1000	457
\$1 001 \$3 000	382
\$3 001 \$5 000	108
More than \$5 000	36
Don't know	60
Total	1 043
Source: Household Lise of Information Technology	

Source: Household Use of Information Technology (8128.0), unpublished and published data.

Of course, this figure does not take into account any influences which have occurred since February 1994 which may have caused households to alter expenditure plans (e.g. publicity surrounding revelations about the information superhighway, which the survey predates).

Whichever measure you use, it is impossible to come to any other conclusion than that the home computing market is large and expanding rapidly.

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### **Additional information**

Additional information on topics presented in this chapter may be found in the annual reports of the organisations mentioned, particularly the Department of Industry, Science and Technology, the CSIRO, and in the annual Science and Technology Statements. Statistical information on R&D for the years 1968–69, 1973–74 and 1976–77 may be found in the reports on Project SCORE published by the (then) Department of Science. Statistical information on R&D relating to 1978–79, 1981–82, and 1984–85 to 1993–94 may be obtained from the Australian Bureau of Statistics. Further statistical information on higher education is obtainable from the Department of Employment, Education and Training.

The Department of Industry, Technology and Regional Development's *Australian Science and Innovation Resources Brief 1994*, uses science and technology indicators to give a good overview and analysis of science and technology information in Australia. It presents information on R&D effort and expenditure; science and technology work force; science and technology information resources; scientific equipment and facilities; patent activity; technology training; financial support for technological development; and transfer of technical knowledge. .