1996–97 8112.0

Australian Bureau of Statistics

RESEARCH & EXPERIMENTAL DEVELOPMENT

ALL SECTOR SUMMARY

AUSTRALIA

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CONTENTS

- For further information about these and related statistics, contact Derek Byars on Canberra 02 6252 5627.
- For further information about constant price estimates, contact Paul Curran on Canberra 02 6252 6801.

NOTES

RESEARCH AND DEVELOPMENT (R&D) GUIDELINES

Australian Bureau of Statistics (ABS) surveys of R&D are conducted in accordance with standard guidelines promulgated by the Organisation for Economic Co-operation and Development (OECD).

SYMBOLS AND OTHER USAGES

–	nil or rounded to zero
n.a.	not available
n.e.c.	not elsewhere classified
r	revised since previous issue

W. McLennan
Australian Statistician

MAIN FEATURES

EXPENDITURE ON R&D

Gross expenditure on R&D (GERD) carried out by organisations in Australia during 1996–97 was estimated to be $8,693m at current prices. This represented an increase of 16% over the two years since 1994–95. At average 1989–90 prices, R&D expenditure was estimated to be $7,214m, an increase of 11% since 1994–95.

GERD represented 1.68% of Gross Domestic Product (GDP), up slightly from 1.62% in 1994–95.

The 16% increase in GERD at current prices between 1994-95 and 1996-97 was due to increases of:

- 18% in the Business sector;
- 5% in the General government sector;
- 26% in the Higher education sector; and
- 10% in the Private non-profit sector.

The increase in expenditure by the Business sector resulted from:

- a record increase of 24% between 1994-95 and 1995-96; and
- a fall of 5% between 1995-96 and 1996-97 (the first fall since the ABS surveys commenced).

HUMAN RESOURCES DEVOTED TO R&D

Human resources devoted to R&D in Australia in 1996–97 were estimated to be 90,519 person years. This represented an increase of 4% over 1994–95.

PURPOSE OF RESEARCH

The majority of expenditure was directed towards:

- Economic development, $5,316m or 61%;
- Advancement of knowledge, $1,188m or 14%; and
- Society, $1,097m or 13%.

FIELD OF RESEARCH

The main fields of research were:

- Information, computer and communication technologies, $1,502m or 17%;
- Applied sciences and technologies, $1,453m or 17%;
- General engineering, $1,406m or 16%; and
- Medical and health sciences, $982m or 11%.

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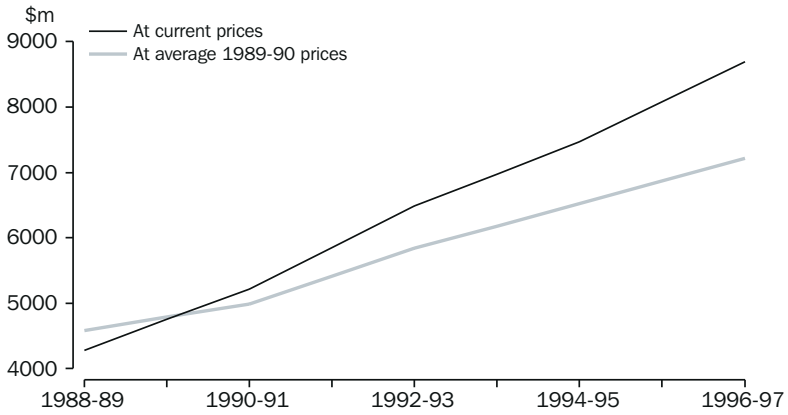
INTRAMURAL R&D

GROSS EXPENDITURE ON R&D

GERD has steadily increased each year since 1988–89 in both current prices and average 1989–90 prices. The average annual rate of growth over that period was 9.3% in current price terms and 5.8% in constant price terms.

In 1996–97, 47% of GERD in current prices was expended in the Business sector, 27% in the Higher education sector, 24% in the General government sector and 2% in the Private non-profit sector. By comparison, in 1988–89, 42%, 25%, 32% and 1% of GERD was expended in these sectors respectively.

EXPENDITURE ON R&D



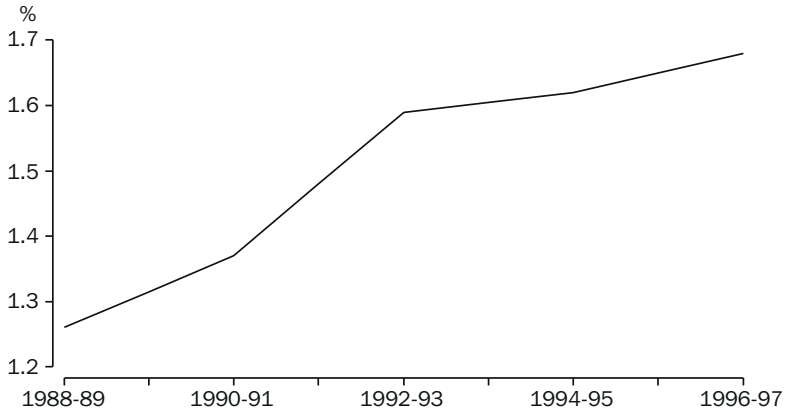
1.1 GROSS EXPENDITURE ON R&D

	1988–89r	*1990–91r*	*1992–93r*	*1994–95r*	*1996–97*
Sector	*$m*	*$m*	*$m*	*$m*	*$m*
		AT CURRENT PRICES			
Business	1 798.3	2 099.8	2 861.9	3 498.7	4 123.9
General government					
Commonwealth	869.6	1 034.0	1 155.4	1 196.7	1 265.6
State	482.7	670.0	668.5	785.9	824.6
Higher education	1 076.8	1 332.8	1 695.2	1 829.6	2 307.6
Private non-profit	53.3	85.4	101.9	155.7	171.4
Total	**4 280.7**	**5 222.0**	**6 482.9**	**7 466.6**	**8 693.0**
		AT AVERAGE 1989–90 PRICES			
Business	1 944.9	2 000.6	2 584.7	3 070.0	3 426.5
General government					
Commonwealth	914.4	989.2	1 039.6	1 045.9	1 062.3
State	510.9	630.0	591.1	681.3	676.5
Higher education	1 159.6	1 291.6	1 531.5	1 587.0	1 909.7
Private non-profit	57.5	81.2	90.7	136.9	139.4
Total	**4 587.3**	**4 992.6**	**5 837.6**	**6 521.1**	**7 214.4**

GERD/GDP RATIOS OF OECD COUNTRIES

GERD as a percentage of GDP has increased from 1.26% in 1988–89 to 1.68% in 1996–97. The average annual rate of growth over this period was 3.7%.

GERD AS A PERCENTAGE OF GDP



Australia's GERD/GDP ratio, compared with some other OECD countries, is shown in the table below. Australia is ranked slightly above Canada but well below some of the leading industrialised countries such as Japan, Korea, the United States of America, Germany and the United Kingdom. Australia's ranking reflects the low R&D expenditure to GDP ratio of the Business sector which, in addition to being below the ratios for the large industrialised countries, is also lower than that for Canada.

1.2 GERD/GDP RATIOS OF OECD COUNTRIES

Country	*1994–95r*	*1996–97*
Japan	2.84	2.83
Korea	n.a.	2.79
Switzerland	n.a.	2.75
United States of America	2.52	2.62
Finland	2.34	2.59
France	2.38	2.32
Germany	2.32	2.28
Denmark	n.a.	2.01
United Kingdom	2.11	1.94
Australia	**1.62**	**1.68**
Canada	1.64	1.66
Iceland	1.39	1.51
Czech Republic	1.14	1.07
Italy	1.06	1.03
Spain	0.84	0.87
Poland	0.82	0.76
Turkey	0.36	0.45

HUMAN RESOURCES DEVOTED TO R&D

In 1996–97, 90,519 person years were devoted to R&D. The majority of these resources were expended by Higher education organisations (47%), and Businesses (29%).

From 1994-95 to 1996-97, human resources devoted to R&D increased in all sectors:

- Higher education by 7% (2,643 person years);
- Business by 2% (394 person years);
- General government by 1% (158 person years); and
- Private non-profit by 25% (421 person years).

For the period 1988–89 to 1996–97 human resources devoted to R&D have increased by 37% or 24,593 person years. The average annual rate of growth over that period was 4.0%. The largest increase was in the Higher education sector which increased by 72% or 17,837 person years. In contrast human resources expended by the Commonwealth government decreased by 521 person years or 5%.

1.3 HUMAN RESOURCES DEVOTED TO R&D

	1988–89	*1990–91*	*1992–93r*	*1994–95r*	*1996–97*
Sector	*person years*	*person years*	*person years*	*person years*	*person years*
Business	20 803	21 025	22 919	25 744	26 138
General government					
Commonwealth	10 863	10 670	11 019	10 665	10 342
State	8 335	8 990	8 785	8 695	9 176
Higher education	24 902	27 081	35 418	40 096	42 739
Private non-profit	1 023	1 282	1 369	1 703	2 124
Total	**65 926**	**69 048**	**79 510**	**86 903**	**90 519**

TYPE OF EXPENDITURE

Current expenditure accounted for 89% of gross R&D expenditure, with capital expenditure accounting for the remaining 11%. Labour costs accounted for 43% of total expenditure.

Labour costs accounted for 38% of expenditure by the Business sector, down from 41% in 1994-95. Other current expenditure accounted for 50%, up from 46% in 1994-95.

Labour costs continued to be the main component of General government R&D expenditure (49%), up from 46% in 1994–95. Capital expenditure remained the same as in 1994–95 accounting for 13%.

Current expenditure accounted for 92%, up from 91% in 1994–95, of Higher education R&D expenditure. Labour costs accounted for 45% of total expenditure.

1.4 GROSS EXPENDITURE, BY TYPE OF EXPENDITURE

	Total	*Land and buildings*	*Other capital expenditure*	*Labour costs(a)*	*Other current expenditure(b)*
Sector	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
		1994–95r			
Business	3 498 677	78 945	353 254	1 440 852	1 625 627
General government					
Commonwealth	1 196 712	49 502	89 557	554 291	503 362
State	785 923	73 714	52 366	364 395	295 448
Higher education	1 829 580	47 933	117 037	913 201	751 409
Private non-profit	155 733	16 826	13 441	69 451	56 015
Total	**7 466 625**	**266 920**	**625 655**	**3 342 190**	**3 231 861**
		1996–97			
Business	4 123 854	34 116	478 799	1 564 778	2 046 160
General government					
Commonwealth	1 265 578	110 763	76 559	616 700	461 556
State	824 614	49 639	37 925	403 959	333 091
Higher education	2 307 578	47 404	130 967	1 049 143	1 080 064
Private non-profit	171 370	8 224	13 074	87 629	62 443
Total	**8 692 994**	**250 146**	**737 324**	**3 722 209**	**3 983 314**

(a) Includes wages and salaries, overtime allowances, penalty rates, leave loadings, bonuses, commission payments, all paid leave, employer contributions to superannuation and pension schemes, payroll tax, fringe benefits tax, payments to contract staff on the payroll, severance, termination and redundancy payments and workers compensation insurance.

(b) For higher education sector, includes scholarships for research higher degrees.

SOURCE OF FUNDS

The major sources of funds for R&D expenditure in Australia in 1996–97 were Businesses 47% ($4,087m), up from 46% in 1994–95, and Commonwealth government 39% ($3,354m), up from 38% in 1994–95. State government as a source of funds provided 8%, down slightly from 9% in 1994–95. In 1986–87, these sectors provided 37%, 50% and 10% of funding respectively.

1.5 GROSS EXPENDITURE, BY SOURCE OF FUNDS

Sector	*Total* $'000	*Commonwealth government* $'000	*State government* $'000	*Businesses* $'000	*Private non-profit and other Australian(a)* $'000	*Overseas* $'000
			1994–95r			
Business	3 498 677	94 399	12 783	3 248 088	33 254	110 153
General government						
Commonwealth	1 196 712	1 025 230	11 401	85 216	63 044	11 821
State	785 923	70 413	587 373	31 957	92 463	3 717
Higher education	1 829 580	1 633 713	42 204	63 940	71 224	18 500
Private non-profit	155 733	45 670	22 946	14 104	68 312	4 701
Total	**7 466 625**	**2 869 425**	**676 707**	**3 443 305**	**328 297**	**148 892**
			1996–97			
Business	4 123 854	101 587	4 788	3 817 882	65 361	134 236
General government						
Commonwealth	1 265 578	1 105 203	9 100	76 636	61 583	13 057
State	824 614	64 718	596 631	42 297	115 270	5 698
Higher education	2 307 578	2 033 105	50 977	120 674	78 186	24 637
Private non-profit	171 370	48 964	18 105	29 899	67 934	6 467
Total	**8 692 994**	**3 353 577**	**679 601**	**4 087 388**	**388 334**	**184 095**

(a) Includes funds provided via government levies.

TYPE OF ACTIVITY

Experimental development remained the predominant activity on which R&D funds were expended, accounting for 39% ($3,347m) of gross expenditure on R&D, up from 38% in 1994–95. Applied research accounted for 35% of gross R&D expenditure in 1996–97, as it did in 1994–95. Strategic basic research accounted for 15%, compared to 16% in 1994–95, and Pure basic research accounted for 11%, as it did in 1994–95.

In 1996–97, the Higher education sector contributed 82% ($787m) of expenditure on Pure basic research and 44% ($576m) of expenditure on Strategic basic research, and was the main contributor to both of these activities. The General government sector accounted for 40% ($1,230m) of expenditure on Applied basic research and was the major contributor to this activity. The Business sector undertook 87% of Experimental development activity with expenditure of $2,924m.

1.6 GROSS EXPENDITURE, BY TYPE OF ACTIVITY(a)

Sector	*Total* $'000	*Pure basic research* $'000	*Stategic basic research* $'000	*Applied research* $'000	*Experimental development* $'000
		1994–95r			
Business	3 498 677	23 641	191 872	873 460	2 409 705
General government					
Commonwealth	1 196 712	68 250	360 002	625 064	143 396
State	785 923	45 649	111 176	495 084	134 015
Higher education	1 829 580	652 246	461 147	602 832	113 354
Private non-profit	155 733	45 897	66 305	31 309	12 222
Total	**7 466 625**	**835 682**	**1 190 502**	**2 627 749**	**2 812 692**
		1996–97			
Business	4 123 854	27 378	173 255	999 353	2 923 868
General government					
Commonwealth	1 265 578	57 811	391 433	671 277	145 057
State	824 614	50 211	99 308	558 611	116 484
Higher education	2 307 578	786 938	576 429	800 680	143 530
Private non-profit	171 370	37 780	67 574	47 544	18 471
Total	**8 692 994**	**960 118**	**1 307 999**	**3 077 465**	**3 347 410**

(a) Data within this classification are subjectively allocated by respondents at the time of reporting, using OECD/ABS definitions. Analysts using this classification should bear the original subjectivity in mind. See paragraph 7 of the Explanatory Notes.

LOCATION OF EXPENDITURE

The leading States in terms of location of gross R&D expenditure in 1996–97 were New South Wales at $2,624m and Victoria at $2,485m, accounting for 30% and 29% of total expenditure on R&D respectively. Next in order were Queensland (13%), Western Australia (10%), South Australia (7%), the Australian Capital Territory and External Territories (7%), Tasmania (2%) and the Northern Territory (1%). The 1996–97 ranking was the same as in 1994–95.

1.7 GROSS EXPENDITURE, BY LOCATION OF EXPENDITURE(a)

	Total	*NSW*	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT and Ext Terr.*	*Overseas*
Sector	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
				1994–95r						
Business	3 498 677	1 313 055	1 273 603	264 408	207 732	341 017	35 905	11 743	26 853	24 361
General government										
Commonwealth	1 196 712	258 742	298 958	102 549	167 571	47 629	73 001	17 507	222 452	8 304
State	785 923	244 519	137 216	169 281	86 884	94 961	21 810	25 347	3 728	2 177
Higher education	1 829 580	511 326	393 234	300 551	129 965	167 746	49 198	8 718	268 841	–
Private non-profit	155 733	53 386	80 850	4 959	2 271	10 559	676	832	1 371	829
Total	**7 466 625**	**2 381 027**	**2 183 861**	**841 748**	**594 423**	**661 911**	**180 590**	**64 147**	**523 245**	**35 672**
				1996–97						
Business	4 123 854	1 451 522	1 419 350	433 853	199 241	491 550	58 256	17 436	27 550	25 096
General government										
Commonwealth	1 265 578	232 846	311 018	112 212	167 441	63 700	76 205	12 828	284 794	4 534
State	824 614	234 181	166 584	202 915	77 647	95 502	15 421	26 421	3 030	2 912
Higher education	2 307 578	661 105	485 379	385 634	188 161	226 069	51 527	15 172	294 531	–
Private non-profit	171 370	44 428	102 454	5 404	3 644	12 161	82	51	1 908	1 238
Total	**8 692 994**	**2 624 082**	**2 484 785**	**1 140 018**	**636 134**	**888 982**	**201 491**	**71 908**	**611 813**	**33 780**

(a) Location of the expenditure. This may not be the location of the organisation's head office.

TYPE OF R&D STAFF

Total person years of effort for 1996–97 was 90,519, an increase of 4% over 1994–95. The effort by researchers increased by 7% from 56,858 to 60,890 person years, while that of Technicians and Other supporting staff decreased by 1% from 30,045 to 29,629 person years.

Researchers were the predominant type of employee in total person years for all sectors, accounting for approximately 83% of Higher education person years, 58% of Business person years, 47% of General government person years, and 56% of Private non-profit person years of effort.

1.8 HUMAN RESOURCES DEVOTED TO R&D, BY TYPE OF EMPLOYEE

Sector	*Total* *person years*	*Researchers* *person years*	*Technicians* *person years*	*Other supporting staff* *person years*
		1994–95r		
Business	25 744	14 840	7 057	3 847
General government				
Commonwealth	10 665	4 445	3 581	2 639
State	8 695	4 384	3 282	1 029
Higher education	40 096	32 272	(a)	7 824(a)
Private non-profit	1 703	917	547	239
Total	**86 903**	**56 858**	**14 468(a)**	**15 577(a)**
		1996–97		
Business	26 138	15 054	7 436	3 648
General eovernment				
Commonwealth	10 342	4 516	3 257	2 570
State	9 176	4 655	3 450	1 071
Higher education	42 739	35 472	(a)	7 266(a)
Private non-profit	2 124	1 193	657	274
Total	**90 519**	**60 890**	**14 800(a)**	**14 829(a)**

(a) Technicians for the Higher education sector not separately identified. They are included in other supporting staff.

EXPENDITURE BY PURPOSE OF RESEARCH

In 1996–97, 61% ($5,316m) of R&D expenditure was directed towards Economic development. Advancement of knowledge accounted for a further 14% of R&D expenditure, followed by Society (13%), Environment (8%) and Defence (5%). Within Economic development, 45% ($2,369m) of R&D expenditure was directed towards Manufacturing.

Economic development accounted for the majority of expenditure on R&D in the Business sector with 90%, in the Commonwealth government sector with 53% and in the State government sector with 56%.

The Higher education sector directed 46% of its R&D expenditure towards Advancement of knowledge.

In the Private non-profit sector, Society accounted for 86% of total expenditure.

1.9 GROSS EXPENDITURE, BY SOCIO-ECONOMIC OBJECTIVE

			General government			
	Total	*Businesses*	*Common-wealth*	*State*	*Higher education*	*Private non-profit*
Socio-economic objective	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Defence	434 626	193 432	228 687	5 317	7 190	—
Economic development						
Plant—production and primary products	396 991	32 786	76 246	217 578	70 381	—
Animal—production and primary products	356 503	26 361	95 571	184 647	49 906	18
Mineral resources (excl. energy)	586 644	466 904	75 540	7 459	36 741	—
Energy resources	321 910	211 141	91 007	2 791	16 971	—
Energy supply	132 911	85 804	21 842	2 113	22 902	250
Manufacturing	2 368 995	2 053 879	198 666	13 123	100 358	2 968
Construction	113 893	45 062	28 913	6 963	32 254	701
Transport	119 284	92 861	8 332	7 321	10 651	119
Information and communication services	606 502	515 243	32 869	11 833	46 160	397
Commercial services	181 835	156 042	9 243	1 426	14 397	727
Economic framework	130 692	6 821	35 577	2 974	84 481	840
Total	*5 316 161*	*3 692 905*	*673 805*	*458 227*	*485 203*	*6 020*
Society						
Health	853 268	102 704	19 659	179 586	413 458	137 861
Education and training	128 598	2 421	2 651	10 950	105 326	7 249
Social development and community services	114 852	12 777	22 610	13 800	63 317	2 349
Total	*1 096 718*	*117 902*	*44 920*	*204 336*	*582 101*	*147 459*
Environment						
Environmental knowledge	425 258	25 795	183 036	97 748	116 738	1 941
Environmental aspects of economic development	153 418	30 727	75 923	18 234	28 301	234
Environmental management and other aspects	78 897	15 415	16 521	20 891	25 713	357
Total	*657 573*	*71 936*	*275 480*	*136 874*	*170 753*	*2 531*
Advancement of knowledge						
Natural sciences, technologies and engineering	845 472	47 607	39 795	16 313	726 471	15 285
Social sciences and humanities	342 444	73	2 891	3 546	335 861	74
Total	*1 187 916*	*47 680*	*42 686*	*19 860*	*1 062 332*	*15 359*
Total	**8 692 994**	**4 123 854**	**1 265 578**	**824 614**	**2 307 578**	**171 370**

HUMAN RESOURCES BY PURPOSE OF RESEARCH

Of the total of 90,519 person years expended on R&D, Economic development accounted for 46%, Advancement of knowledge for 24%, Society for 18%, Environment for 8% and Defence for 3%. This pattern is noticeably different to that for expenditure reflecting the fact that average R&D expenditure per person year of effort differs across the sectors. In particular, it is considerably lower for the Higher education sector because a major part of the R&D is carried out by postgraduates and the research is generally directed towards less capital intensive objectives.

1.10 HUMAN RESOURCES DEVOTED TO R&D, BY SOCIO-ECONOMIC OBJECTIVE

			General government			
	Total	Businesses	Common-wealth	State	Higher education	Private non-profit
Socio-economic objective	person years	person years	person years	person years	person years	person years
Defence	3 139	1 015	1 954	52	118	—
Economic development						
Plant—production and primary products	4 611	334	739	2 368	1 170	—
Animal—production and primary products	3 736	207	898	1 868	762	1
Mineral resources (excl. energy)	2 262	1 197	567	52	446	—
Energy resources	1 170	483	377	14	296	—
Energy supply	1 050	492	188	14	356	1
Manufacturing	17 111	13 434	1 786	136	1 716	39
Construction	1 355	384	264	50	648	9
Transport	1 072	778	78	38	176	3
Information and communication services	5 643	4 396	283	62	897	4
Commercial services	1 795	1 425	75	15	273	7
Economic framework	2 235	64	380	33	1 748	9
Total	*42 038*	*23 192*	*5 634*	*4 651*	*8 489*	*72*
Society						
Health	11 949	757	198	2 769	6 487	1 739
Education and training	2 933	46	24	118	2 690	55
Social development and community services	1 843	144	235	159	1 282	22
Total	*16 724*	*947*	*456*	*3 046*	*10 459*	*1 816*
Environment						
Environmental knowledge	4 329	156	1 193	879	2 062	40
Environmental aspects of economic development	1 590	239	666	155	527	3
Environmental management and other aspects	880	108	118	184	465	5
Total	*6 799*	*503*	*1 977*	*1 218*	*3 054*	*47*
Advancement of knowledge						
Natural sciences, technologies and engineering	13 255	479	289	186	12 113	187
Social sciences and humanities	8 563	2	31	24	8 506	1
Total	*21 817*	*481*	*320*	*210*	*20 619*	*188*
Total	**90 519**	**26 138**	**10 342**	**9 176**	**42 739**	**2 124**

EXPENDITURE BY FIELD OF RESEARCH

Expenditure on R&D activity by all sectors in 1996–97 was estimated to be $8,693m of which 91% was directed towards Natural sciences, technologies and engineering and 9% towards Social sciences and humanities.

The bulk of the Business sector's R&D expenditure was in Information, computer and communication technologies (29%), Applied sciences and technologies (28%) and General engineering (27%).

The Fields of research (FOR) in which most Commonwealth government expenditure occurred were Earth sciences (18%), Applied sciences and technologies (14%) and Information, computers and communication technologies (13%).

State government expenditure on R&D was predominantly expended in Agricultural sciences (56%), Medical and health sciences (20%) and Biological sciences (10%).

The FORs in which most higher education expenditure occurred were Medical and health sciences (21%), Biological sciences (12%) and Humanities (8%).

The majority of the Private non-profit sector's R&D expenditure was in Medical and health sciences (71%) and Biological sciences (18%).

1.11 GROSS EXPENDITURE, BY FIELD OF RESEARCH

			General Government			
	Total	*Businesses*	*Common-wealth*	*State*	*Higher Education*	*Private non-profit*
Field of research	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Natural sciences, technologies and engineering						
Mathematical sciences	100 604	11 891	31 550	1 496	55 667	—
Physical sciences	235 827	43 493	87 631	967	102 301	1 436
Chemical sciences	369 466	177 915	70 943	9 836	109 816	955
Earth sciences	463 593	91 520	232 046	28 370	110 021	1 637
Information, computer and communication technologies	1 501 569	1 183 181	163 444	14 976	139 265	703
Applied sciences and technologies	1 453 355	1 170 137	178 567	12 028	92 179	444
General engineering	1 406 049	1 121 727	104 983	14 568	163 313	1 459
Biological sciences	616 059	58 419	155 857	83 898	286 265	31 618
Agricultural sciences	825 793	80 589	157 191	459 621	127 834	560
Medical and health sciences	981 689	177 529	24 970	166 130	491 378	121 683
Total	*7 954 005*	*4 116 401*	*1 207 182*	*791 890*	*1 678 037*	*160 494*
Social sciences and humanities						
Accounting and finance	21 348	1 124	—	98	20 125	—
Economics	97 094	2 605	31 546	3 199	59 745	—
Political sciences	35 011	288	2 237	1 017	31 324	144
Sociology	33 069	4	3 712	2 047	27 244	63
Law	43 375	13	4 673	880	37 211	598
Psychology	58 906	12	5 038	1 358	52 111	388
Education	104 776	247	—	9 072	88 457	7 000
Other social sciences	154 364	2 303	9 462	11 668	129 730	1 202
Humanities	191 046	860	1 728	3 386	183 593	1 479
Total	*738 989*	*7 454*	*58 396*	*32 723*	*629 541*	*10 875*
Total	**8 692 994**	**4 123 854**	**1 265 578**	**824 614**	**2 307 578**	**171 370**

HUMAN RESOURCES BY FIELD OF RESEARCH

The total human resource effort for all sectors was estimated to be 90,519 person years. Natural sciences, technologies and engineering accounted for 82% of these resources, with Social sciences and humanities accounting for the remainder.

The majority of the Business sector's human resource effort was in Information, computer and communication technologies (37%), Applied sciences and technologies (23%) and General engineering (23%).

The Commonwealth government sector's human resource effort was mainly directed towards Applied sciences and technologies (15%), Information, computers and communication technologies (14%) and Agricultural sciences (14%).

The FORs in which most State government human resource effort occurred were Agricultural sciences (51%), Medical and health sciences (28%) and Biological sciences (10%).

The Higher education sector devoted 18% of R&D human resources to Medical and health sciences, 12% to Humanities and 11% to Biological sciences.

Some 73% of the Private non-profit sector's human resources were devoted to Medical and health sciences and 19% to Biological sciences.

1.12 HUMAN RESOURCES DEVOTED TO R&D, BY FIELD OF RESEARCH

			General government			
	Total	*Businesses*	*Common-wealth*	*State*	*Higher education*	*Private non-profit*
Field of research	*person years*	*person years*	*person years*	*person years*	*person years*	*person years*
Natural sciences, technologies and engineering						
Mathematical sciences	1 485	78	371	19	1 017	—
Physical sciences	2 579	308	750	12	1 495	14
Chemical sciences	3 839	1 091	640	101	1 997	10
Earth sciences	3 502	348	1 172	218	1 739	24
Information, computer and communication technologies	13 757	9 790	1 447	95	2 418	7
Applied sciences and technologies	9 409	6 134	1 538	126	1 604	7
General engineering	9 995	6 130	918	97	2 838	12
Biological sciences	7 773	427	1 286	875	4 773	412
Agricultural sciences	8 946	590	1 412	4 711	2 227	6
Medical and health sciences	13 079	1 161	234	2 564	7 575	1 544
Total	*74 365*	*26 056*	*9 769*	*8 818*	*27 684*	*2 037*
Social sciences and humanities						
Accounting and finance	355	10	—	1	344	—
Economics	1 456	22	311	41	1 082	—
Political sciences	736	2	23	11	698	2
Sociology	662	—	41	24	597	1
Law	720	1	36	13	665	5
Psychology	1 169	—	46	12	1 106	5
Education	2 613	8	—	105	2 446	53
Other social sciences	3 289	25	101	125	3 025	12
Humanities	5 154	14	14	25	5 091	9
Total	*16 154*	*82*	*572*	*358*	*15 055*	*87*
Total	**90 519**	**26 138**	**10 342**	**9 176**	**42 739**	**2 124**

R&D BY BUSINESSES

For the first time since the ABS surveys of R&D commenced, estimates for Business Expenditure on R&D (BERD) have fallen compared with the previous year. BERD at current prices was $4,124m, a 5% decrease on 1995–96. This fall followed a record increase of 24% between 1994–95 and 1995–96.

For 1996–97, Manufacturing industries accounted for 59% of BERD expenditure. The largest other industries were Mining (13% of total expenditure) and Property and business services (12%).

The average expenditure on R&D per person year of R&D effort in 1996–97 for all businesses which conducted R&D was approximately $158,000.

The proportion of effort by Researchers to total human resource effort for all industries was 58%. It ranged from 39% in Motor vehicle and part and other transport equipment manufacturing to 70% in Printing, publishing and recorded media.

1.13 R&D BY BUSINESSES, BY INDUSTRY(a)

ANZSIC Code & Description	Businesses	Expenditure	Human resources	Researchers
	no.	*$'000*	*person years*	*person years*
B Mining (including services to mining)	117	545 951	1 099	652
Manufacturing				
21 Food, beverages and tobacco	179	227 301	1 304	681
22 Textile, clothing, footwear and leather	65	21 734	199	89
23 Wood and paper products	35	189 965	249	110
24 Printing, publishing and recorded media	47	17 201	179	126
25 Petroleum, coal, chemical and associated product	348	320 815	2 442	1 397
26 Non-metallic mineral product	85	67 174	500	233
27 Metal product	220	370 995	1 694	904
281–282 Motor vehicle and part and other transport equipment	146	397 277	2 658	1 041
283 Photographic and scientific equipment	114	79 604	791	472
284–285 Electronic and electrical equipment and appliance	432	587 102	4 435	3 011
286 Industrial machinery and equipment	309	137 196	1 249	623
29 Other manufacturing	94	17 977	210	110
C Total	*2 074*	*2 434 341*	*15 909*	*8 796*
Other industries				
F–G Wholesale and retail trade	242	201 068	1 444	899
K Finance and insurance	39	93 830	1 097	558
77, 782–786 Property and business services	704	513 516	4 740	3 016
781 Scientific research	86	152 037	976	600
(b) Other n.e.c.	145	183 112	873	533
D-Q Total	*1 216*	*1 143 562*	*9 130*	*5 606*
TOTAL ALL INDUSTRIES	**3 407**	**4 123 854**	**26 138**	**15 054**

(a) Excludes businesses in ANZSIC Division A.
(b) ANZSIC codes D, E, H–J, M–Q.

EXTRAMURAL R&D

Details of extramural R&D payments (i.e. payments made to other organisations to conduct R&D) were not collected from the Higher education sector. Extramural payments for R&D by the General government, Business and Private non-profit sectors in 1996–97 were estimated to be $2,211m, or equivalent to 25% of GERD. Some 95% of these payments were received by organisations within Australia.

The General government sector accounted for 66% of total extramural payments, the Business sector 32%, and the Private non-profit sector 2%.

2.1 EXTRAMURAL R&D EXPENDITURE(a), BY LOCATION OF RECIPIENT

	Total payments	*Australia*	*Africa*	*Asia*	*Canada*	*Europe*	*New Zealand*	*Oceania*	*U.K.*	*U.S.A.*	*Other countries*
Sector	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Business	703 027	642 749	1 724	1 353	1 430	24 769	2 385	—	4 244	23 262	1 111
General government											
Commonwealth	1 398 868	1 360 004	3 735	21 915	126	139	1 606	3 804	854	847	5 838
State	69 093	68 400	—	—	20	206	5	—	50	382	30
Private non-profit	39 580	38 967	25	—	—	20	44	—	135	274	115
Total	**2 210 568**	**2 110 120**	**5 484**	**23 268**	**1 576**	**25 134**	**4 040**	**3 804**	**5 283**	**24 765**	**7 094**

(a) Expenditure on R&D which is funded by an organisation but carried out by other organisations. Extramural R&D expenditure is not available for the Higher education sector.

TECHNICAL KNOW-HOW

PAYMENTS FOR TECHNICAL KNOW-HOW (TKH)

Details on payments for TKH were not collected from the Higher education sector. Payments for TKH by the General government, Business and Private non-profit sectors in 1996–97 were estimated to be $471m of which 94% ($441m) were payments made to overseas recipients. These receipts are equivalent to 5.4% and 5.1% of GERD respectively.

Businesses paid $465m for TKH, accounting for 99% of TKH payments.

Total TKH comprised Patent licence fees and royalties (53%) and Other technical know-how (47%).

3.1 PAYMENTS FOR TECHNICAL KNOW-HOW(a)

		Type of technical know-how		*Location of recipient*	
	Total	*Patent licence fees and royalties*	*Other technical know-how*	*Australia*	*Overseas*
Sector	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Business	464 891	245 384	219 506	24 069	440 822
General government					
Commonwealth	1 581	491	1 090	1 485	96
State	3 956	1 687	2 269	3 806	150
Private non-profit	191	168	23	147	44
Total	**470 619**	**247 730**	**222 888**	**29 507**	**441 112**

(a) Payments for technical know-how are not available for the Higher education sector.

RECEIPTS FOR TKH

Details on receipts for TKH were not collected from the Higher education sector. Receipts for TKH by the General government, Business and Private non-profit sectors in 1996–97 were estimated to be $292m, of which $166m (57%) were received from overseas. These receipts are equivalent to 3.4% and 1.9% of GERD respectively.

The Business sector received payments of $271m for TKH, accounting for 93% of total receipts.

Receipts for TKH comprised Patent licence fees and royalties (30%) and Other technical know-how (70%).

3.2 RECEIPTS FOR TECHNICAL KNOW-HOW(a)

		Type of technical know-how		*Location of paying organisation*	
	Total	*Patent licence fees and royalties*	*Other technical know-how*	*Australia*	*Overseas*
Sector	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Business	271 389	78 004	193 385	107 864	163 525
General government					
Commonwealth	15 766	7 417	8 349	13 644	2 122
State	4 254	560	3 694	3 868	386
Private non-profit	146	135	11	90	56
Total	**291 555**	**86 116**	**205 439**	**125 466**	**166 089**

(a) Receipts for technical know-how are not available for the Higher education sector.

PATENT ACTIVITY

Details of patent activity were not collected from the Higher education sector. Organisations with R&D activity within the General government, Business and Private non-profit sectors during 1996–97 lodged 1,025 patent applications in Australia and 3,797, designating 27,798 countries, overseas, during the period 1 July 1995 to 30 June 1997. Organisations in the Business sector lodged 85% of the patent applications lodged in Australia and 79% of those lodged overseas.

During the period 1 July 1995 to 30 June 1997, these organisations were granted 875 patents in Australia and 1,904 patents overseas. 86% of the patents granted in Australia and 79% of the patents granted overseas were granted to organisations in the Business sector.

4.1 PATENT ACTIVITY BY ORGANISATIONS UNDERTAKING R&D, JULY 1995 TO JUNE 1997(a)

	Australia		*Overseas*		
			Patents lodged(b)		
	Patents lodged	Patents granted	Applications	Countries designated	Patents granted
Sector	no.	no.	no.	no.	no.
Business	867	753	3 017	16 509	1 500
General government					
Commonwealth	141	97	676	10 040	374
State	7	16	31	577	8
Private non-profit	10	9	73	672	22
Total	**1 025**	**875**	**3 797**	**27 798**	**1 904**

(a) Patent activity is not available for the Higher education sector.
(b) See paragraph 9 of the Explanatory Notes.

EXPLANATORY NOTES

INTRODUCTION

1 This publication presents summary statistics of expenditure and human resources devoted to R&D carried out in Australia by businesses/organisations within the Business, General government and Private non-profit sectors during 1996–97 and the Higher education sector during the 1996 calendar year.

2 Statistics are included for extramural R&D activity, payments and receipts for technical know-how and patent activity.

3 The statistics presented in this publication have previously been published (at a more detailed level) on an individual sector basis (see paragraph 21).

DATA SOURCES

4 Information relating to data sources for the individual sectors is contained in the individual sector publications (see paragraph 21).

5 The GDP(I) figures used to derive GERD/GDP ratios are current at the time of manuscript finalisation *(Australian National Accounts: National Income, Expenditure and Product, March Quarter 1998*, (Cat. no. 5206.0)), and, at current prices, are as follows: $339,881m (1988–89); $380,761m (1990–91); $407,952m (1992–93); $460,292m (1994–95); and $517,401m (1996–97). The available GERD/GDP ratios for other OECD countries are current at the time of manuscript finalisation and are sourced from Main Science and Technology Indicators, 1998–1, OECD, Paris, 1998.

DEFINITIONS

6 R&D is defined in accordance with the OECD standard 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.

7 Type of R&D activity (TOA) comprises pure basic research, strategic basic research, applied research and experimental development. Data in this classification are subjectively allocated by respondents at the time of reporting, using OECD/ABS definitions. The ABS makes every effort to ensure correct and consistent interpretation and reporting of this data and applies consistent processing methodologies. Analysts using this classification should bear the original subjectivity in mind.

8 For a more comprehensive interpretation of the definition of R&D activity, contact the ABS or refer to the OECD publication, The Measurement of Scientific and Technological Activities ('Frascati Manual' 1993), OECD, Paris, 1994.

9 The question relating to lodgement of patent applications overseas specifically asks for both the number of applications and the number of countries in which protection was initially sought. For example, if four countries were designated in an application (a Patent Co-operation Treaty application or a European Patent application) then the business, General government organisation or Private non-profit organisation was asked to record this as one patent application with four countries designated.

SCOPE

10 The sector classification used in the compilation of these statistics is adapted from the guidelines specified by the OECD for use in the conduct of R&D surveys.

Four sectors are recognised:

- Business—includes all businesses whose primary activity is the production of goods or services for sale to the general public at a price intended to cover at least the cost of production, and the private non-profit institutions mainly serving them.
- General government—includes all Commonwealth, State and local government departments and authorities.
- Higher education—is defined by the OECD as including all universities and other institutions of post-secondary education whatever their source of finance or legal status.
- Private non-profit—includes private or semi-public incorporated organisations which are established with the intention of not making a profit.

COVERAGE

11 Exclusions from the survey are:

- Business sector for the R&D surveys excludes businesses mainly engaged in agriculture, forestry, and fishing (i.e. industries in Division A of the *Australian and New Zealand Standard Industrial Classification (ANZSIC), 1993* (Cat. no. 1292.0)), partly because of collection difficulties and partly because such businesses are believed to have very low R&D activity (agricultural R&D activity is generally carried out by specialised research institutes not included in ANZSIC Division A).
- General government sector excludes local government organisations because it is considered that their contribution to total R&D activity would be minimal. Public sector organisations mainly engaged in higher education (e.g. universities) are included in the Higher education sector whilst those mainly engaged in trading or financial activities are included in the Business sector.
- Higher education sector for the R&D surveys only includes universities. Technical and Further Education colleges and other post secondary institutions are excluded because it is considered that their contribution to total R&D activity would be minimal.

SOCIO-ECONOMIC OBJECTIVE AND FIELD OF RESEARCH CLASSIFICATIONS

12 Statistical information for the Business, General government, Higher education and Private non-profit sectors is classified by both Socio-economic objective (SEO) and Field of research (FOR). For more information on these classifications see the *Australian Standard Research Classification, 1993* (Cat. no. 1297.0).

COMPARABILITY WITH PREVIOUS STATISTICS

13 The statistics for Higher education presented in this publication may not be strictly comparable due to changes in collection methodology. The 1994, 1995 and 1996 statistics were compiled from data collected by the ABS, whereas both the 1990 and 1992 statistics were compiled from data collected from universities by the Department of Employment, Education, Training and Youth Affairs (DEETYA). Statistics for earlier years were derived from ABS Research and Development Surveys in conjunction with general expenditure estimates obtained from DEETYA.

AUSTRALIAN AND NEW ZEALAND STANDARD INDUSTRIAL CLASSIFICATION (ANZSIC)

14 In table 1.13, R&D by the Business sector has been classified by the industry of the business in accordance with the 1993 edition of the ANZSIC.

15 Each management unit is classified by the ABS to the industry in which it mainly operates even though one or more of its component establishments (factories, shops, etc.) may be classified to other industries. In cases where an organisation sets up a dedicated research unit, that unit is classified to the predominant industry of the organisation rather than to ANZSIC 7810 Scientific research, in accordance with standards laid down in the Frascati Manual.

CONSTANT PRICE ESTIMATES

16 Estimates of total R&D expenditure are shown at average 1989–90 prices in table 1.1. In concept, constant price estimates are measures from which direct effects of price change have been eliminated. Although expressed in monetary terms, the constant price measures shown vary only with changes in the underlying quantities of inputs purchased (including labour). In effect, quantities of broadly defined categories of inputs are weighted by their prices in the base year (1989–90). Because the measures relate to input quantities, they do not reflect changes in the efficiency with which labour, capital and other inputs are used.

17 In revaluing R&D expenditure, extensive use has been made of price series used in deriving constant price national accounts estimates. The constant price estimate for the labour costs component was obtained by deflating by a wage rate index. Constant price estimates for the non-labour costs components were derived by deflating each by a composite price index of relevant materials or capital expenditure items.

18 For a more comprehensive description of constant price concepts and estimation procedures see *Australian National Accounts: Concepts, Sources and Methods* (Cat. no. 5216.0).

RELIABILITY OF STATISTICS

19 The statistics in this publication should be used with caution for the following reasons:

- Many data providers had to make estimates because their accounts do not separately record data on R&D activity, receipts and payments for technical know-how or patent activity.
- The OECD standard definition of R&D used in this survey differs in some respects from what respondents may regard as R&D activity, particularly since the definitions used within the Grants for Industry R&D scheme for the allocation of grants, and the 125% Tax Concession Scheme for tax deductibility for specific R&D activities undertaken within Australia, differ slightly from the R&D survey definition.

UNPUBLISHED STATISTICS

20 Limited additional detailed R&D statistics are available at a charge from the ABS.

RELATED PUBLICATIONS

21 Users may also wish to refer to the following publications:

Australian Standard Research Classification (ASRC), 1993 (Cat. no. 1297.0)

Research and Experimental Development, Business Enterprises, Australia, 1996–97 (Cat. no. 8104.0)

Research and Experimental Development, General Government and Private Non-profit Organisations, Australia, 1996–97 (Cat. no. 8109.0)

Research and Experimental Development, Higher Education Organisations, Australia, 1996 (Cat. no. 8111.0)

Main Science and Technology Indicators 1998–1, OECD, Paris, 1998

The Measurement of Scientific and Technological Activities ('Frascati Manual' 1993) OECD, Paris, 1994

22 Current publications issued by the ABS are listed in the *Catalogue of Publications and Products* (Cat. no. 1101.0). The ABS also issues, on Tuesdays and Fridays, a *Release Advice* (Cat. no. 1105.0) which lists publications to be released in the next few days. The Catalogue and Release Advice are available from any ABS office.

23 Where figures have been rounded, discrepancies may occur between sums of the component items and totals.

GLOSSARY

Applied research Original work undertaken in order to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and predetermined objectives.

Basic research Experimental and theoretical work undertaken primarily to acquire new knowledge without a specific application in view. It consists of pure basic research and strategic basic research. Pure basic research is carried out without looking for long-term benefits other than the advancement of knowledge. Strategic basic research is directed into specified broad areas in the expectation of useful discoveries. It provides the broad base of knowledge for the solution of recognised practical problems.

Capital expenditure Expenditure on the acquisition of fixed tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity.

Current expenditure Expenditure on labour costs, materials, fuels, rent, leasing, repairs, maintenance and data processing etc. and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

Experimental development Systematic work, using existing knowledge gained from research or practical experience, for the purpose of creating new or improved products/processes.

Extramural R&D R&D activity funded by an organisation but carried out by other organisations, institutions or individuals.

Field of research Field in which the R&D activity was performed. The FOR classification is primarily structured around disciplines or activities. It describes what research is being performed.

FOR Field of research

GDP Gross Domestic Product.

GERD - Gross expenditure on R&D The sum of intramural R&D expenditures incurred by all organisations in the survey.

Human resources devoted to R&D The effort of researchers, technicians and other staff directly involved with R&D activity. Overhead staff (e.g. administrative and general service employees such as personnel officers, janitors etc.) whose work indirectly supports R&D, are excluded.

Intramural R&D R&D carried out by an organisation on its own behalf or on behalf of other organisations, institutions or individuals.

Labour costs Wages and salaries, overtime allowances, penalty rates, leave loadings, bonuses, commission payments, all paid leave, employer contributions to superannuation and pension schemes, payroll tax, fringe benefits tax, payments to contract staff on the payroll, severance, termination and redundancy payments and workers compensation insurance.

OECD Organisation for Economic Co-operation and Development.

Other current expenditure Expenditure on materials, fuels, rent, hiring, repairs, maintenance and data processing etc. and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

Other supporting staff Skilled and unskilled craftspersons, secretarial and clerical staff directly associated with R&D activity.

R&D activity Systematic investigation or experimentation involving innovation or technical risk, the outcome of which is new knowledge, with or without a specific practical application, or new or improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products/processes. R&D activity ceases and pre-production begins when work is no longer experimental.

Researchers Those involved with the conception and/or development of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.

SEO Socio-economic objective.

Socio-economic objective The area of expected national benefit rather than the immediate objectives of the researcher. The SEO classification defines the main areas of Australian economic and social activity to which the results of research programs are applied. It describes the purpose of the research; i.e. why the research is being performed.

Technical know-how (TKH) Specialised technical knowledge required to successfully produce a product or implement a process, etc. (e.g. patent licences; technical data and information; scientific, technical or engineering assistance) that increases technical knowledge and understanding in an organisation. Payments are those made directly to the holders of TKH which is new to an organisation. They exclude non-monetary transfers, and costs incurred by an organisation in obtaining TKH, such as overseas travel costs.

Technicians Those performing technical tasks in support of R&D activity, normally under the direction and supervision of a researcher. These tasks include the preparation of experiments, the taking of records, the preparation of charts and graphs, and the coding of data.

Type of R&D activity Comprises basic research, applied research and experimental development.

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POST Client Services, ABS, PO Box 10, Belconnen, ACT 2616

EMAIL client.services@abs.gov.au

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