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RESEARCH AND EXPERIMENTAL DEVELOPMENT AUSTRALIA

HIGHER EDUCATION ORGANISATIONS

EMBARGO: 11:30AM (CANBERRA TIME) FRI 8 MAY 1998

CONTENTS

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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). These guidelines say that the expenditure on R&D should include both direct expenditure and an estimate for indirect (overhead) expenditure in support of R&D.

COMPARABILITY

Data on human resources devoted to R&D were not available for 1995. The 1996 statistics presented in this publication may not be strictly comparable with those prior to 1994 due to changes in collection methodology. See paragraph 11 of the Explanatory notes.

SYMBOLS AND OTHER USAGES

— nil or rounded to zero
n.a. not available

W. McLennan
Australian Statistician

MAIN FEATURES

EXPENDITURE ON R&D

Higher education expenditure on R&D (HERD) in Australia in 1996 was estimated to be $2,308m at current prices. This represented an increase of 13% over 1995.

At average 1989–90 prices, R&D expenditure was estimated to be $1,910m, an increase of 11% compared with 1995.

HERD as a percentage of Gross Domestic Product (GDP) increased from 0.41% in 1995 to 0.45% in 1996.

HUMAN RESOURCES DEVOTED TO R&D

Human resources devoted to R&D in Australia in 1996 by higher education organisations was estimated to be 42,739 person years. This represented an increase of 7% over 1994.

PURPOSE OF RESEARCH

Most R&D expenditure by higher education organisations was directed towards Advancement of knowledge ($1,062m or 46%) and Society ($582m or 25%).

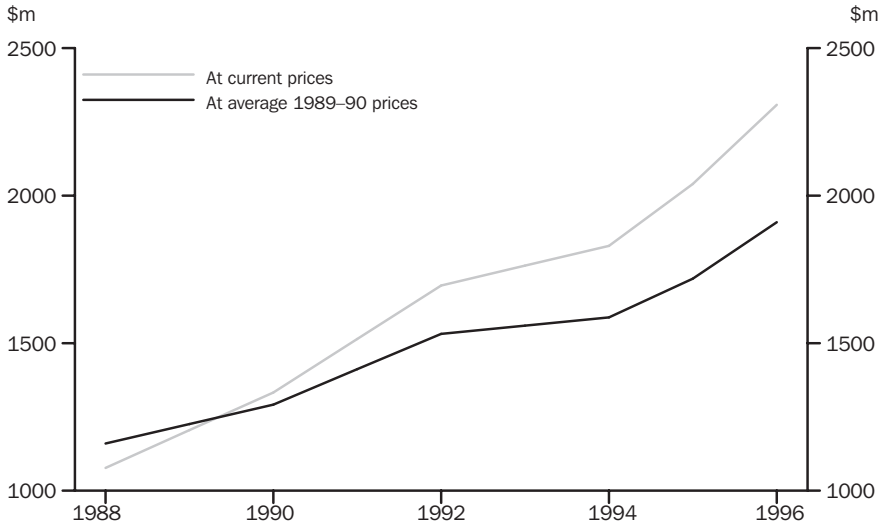
FIELD OF RESEARCH

Medical and health sciences ($491m or 21%), Biological sciences ($286m or 12%), Humanities ($184m or 8%) and General engineering ($163m or 7%) were the main fields of research by higher education organisations.

EXPENDITURE ON R&D

HERD has steadily increased every year since 1988 in both current prices and average 1989–90 prices. The average annual rate of growth over that period has been 10.0% in current price terms and 6.4% in constant price terms.

EXPENDITURE ON R&D



1 EXPENDITURE ON R&D

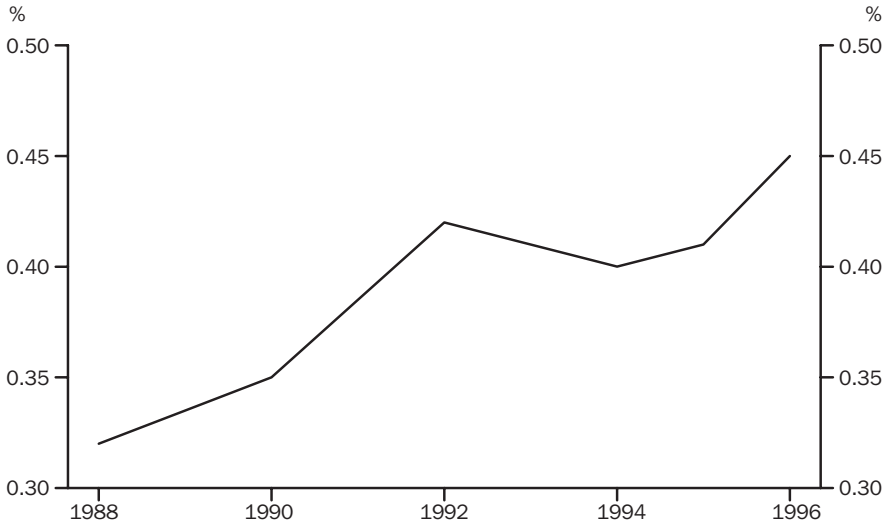
	1988	*1990*	*1992*	*1994*	*1995*	*1996*
	$m	*$m*	*$m*	*$m*	*$m*	*$m*
At current prices	1 076.8	1 332.8	1 695.2	1 829.6	2 039.1	2 307.6
At average 1989–90 prices	1 159.6	1 291.6	1 531.5	1 587.0	1 718.3	1 909.7

COMPARISON WITH GDP

HERD AS A PERCENTAGE OF GDP

HERD as a percentage of GDP has risen from 0.32 in 1988 to 0.45 in 1996, an average annual increase of 4.3%.

HERD AS A PERCENTAGE OF GDP



Australia's HERD/GDP ratio for 1996 compares favourably with those available for other OECD countries, being higher than those for Germany, the United States of America, France and Canada. However, data are not available for 1996 for a number of countries which had higher HERD/GDP ratios in 1995.

2 HERD/GDP RATIOS OF OECD COUNTRIES

Country	*1995*	*1996*
Sweden	0.79	n.a.
Japan	0.62	n.a.
Netherlands	0.60	n.a.
Denmark	0.47	n.a.
Finland	0.46	n.a.
Norway	0.45	n.a.
Australia	**0.41**	**0.45**
Belgium	0.44	n.a.
Germany	0.43	0.43
France	0.39	0.39
United States	0.39	0.38
United Kingdom	0.39	n.a.
Iceland	0.42	0.36
Canada	0.37	0.36
New Zealand	0.30	n.a.
Ireland	0.27	n.a.
Italy	0.26	0.25

RESOURCES DEVOTED TO R&D

HUMAN RESOURCES

Human resources devoted to research by higher education organisations increased by 7% over 1994.

3 HUMAN RESOURCES DEVOTED TO R&D

Year	*person years*
1988	24 902
1990	27 081
1992	35 418
1994	40 096
1995	n.a.
1996	42 739

TYPE OF EXPENDITURE

Current expenditure accounted for 92% of higher education R&D expenditure, with capital expenditure accounting for the remaining 8%. The major component was direct labour costs which accounted for 45% of total expenditure.

Purpose of research

The Socio-economic objectives (SEOs) within the Advancement of knowledge division accounted for the majority of expenditure on higher education R&D in 1996 with 46% of total expenditure, down slightly from 48% in 1995.

The SEOs within the Society division accounted for 25% of R&D expenditure, the same as in 1995. The major subdivision within Society was Health with 18% of total R&D expenditure.

4 EXPENDITURE BY SOCIO-ECONOMIC OBJECTIVE, TYPE OF EXPENDITURE

Socio-economic objective	*Total* $'000	*Land and buildings* $'000	*Other capital expend-iture* $'000	*Direct labour costs(a)* $'000	*Scholar-ships(b)* $'000	*Other current expend-iture* $'000
Defence	7 190	12	491	3 194	296	3 196
Economic development						
Plant — production and primary products	70 381	1 671	3 927	28 857	3 432	32 494
Animal — production and primary products	49 906	1 065	2 429	20 346	2 516	23 550
Mineral resources (excl. energy)	36 741	320	2 360	12 373	2 500	19 188
Energy resources	16 971	171	1 190	6 844	795	7 971
Energy supply	22 902	123	1 708	9 967	1 280	9 825
Manufacturing	100 358	1 884	7 522	38 996	6 721	45 235
Construction	32 254	2 249	1 890	14 796	2 169	11 151
Transport	10 651	160	466	5 410	582	4 033
Information and communication services	46 160	199	3 022	21 698	2 437	18 804
Commercial services	14 397	600	702	7 097	542	5 456
Economic framework	84 481	655	2 708	42 972	4 126	34 019
Total economic development	485 203	9 097	27 924	209 356	27 099	211 727
Society						
Health	413 458	5 101	18 170	199 082	15 493	175 613
Education and training	105 326	1 091	4 918	52 034	4 322	42 962
Social development and community services	63 317	306	2 847	30 224	2 512	27 428
Total society	582 101	6 498	25 934	281 340	22 326	246 003
Environment						
Environmental knowledge	116 738	2 980	7 171	49 183	6 369	51 035
Environmental aspects of economic development	28 301	177	1 589	12 480	1 590	12 465
Environmental management and other aspects	25 713	457	1 412	10 764	1 391	11 689
Total environment	170 753	3 615	10 172	72 427	9 351	75 188
Advancement of knowledge						
Natural sciences, technologies and engineering	726 471	23 933	57 053	312 465	39 118	293 902
Social sciences and humanities	335 861	4 250	9 393	170 360	21 757	130 100
Total advancement of knowledge	1 062 332	28 183	66 446	482 825	60 875	424 002
Total	**2 307 578**	**47 404**	**130 967**	**1 049 143**	**119 948**	**960 116**

(a) Includes wages and salaries, payroll tax, payments to contract staff on the payroll, fringe benefits tax and workers compensation insurance, overtime earnings, shift allowances, penalty rates, bonuses, commission payments, holiday and sick pay, long service leave payments, employer contributions to superannuation and pension schemes.

(b) For research higher degrees.

Field of research (FOR)

The FORs in which most higher education R&D occurred in 1996 were: Medical and health sciences ($491m); Biological sciences ($286m); Humanities ($184m); and General engineering ($163m).

These fields of research were also the main four fields in 1995.

5 EXPENDITURE BY FIELD OF RESEARCH, TYPE OF EXPENDITURE

Field of research	*Total* $'000	*Land and buildings* $'000	*Other capital expend-iture* $'000	*Direct labour costs(a)* $'000	*Scholar-ships(b)* $'000	*Other current expend-iture* $'000
Natural sciences, technologies and engineering						
Mathematical sciences	55 667	406	2 273	27 355	3 445	22 187
Physical sciences	102 301	1 099	8 602	46 516	4 743	41 340
Chemical sciences	109 816	1 990	11 309	46 274	8 604	41 640
Earth sciences	110 021	709	8 681	44 611	5 663	50 357
Information, computers and communication technologies	139 265	11 802	9 438	57 274	6 809	53 942
Applied sciences and technologies	92 179	2 378	8 544	36 637	6 301	38 319
General engineering	163 313	5 377	12 824	66 646	11 072	67 394
Biological sciences	286 265	5 668	20 799	122 585	14 505	122 708
Agricultural sciences	127 834	3 601	6 710	52 044	7 764	57 715
Medical and health sciences	491 378	5 969	22 812	232 433	18 350	211 814
Total natural sciences, technologies and engineering	1 678 037	39 000	111 991	732 375	87 254	707 417
Social sciences and humanities						
Accounting and finance	20 125	18	606	11 231	404	7 867
Economics	59 745	239	2 035	30 490	2 572	24 409
Political sciences	31 324	126	903	14 936	1 634	13 727
Sociology	27 244	245	533	13 869	1 657	10 940
Law	37 211	51	884	20 834	993	14 450
Psychology	52 111	2 660	2 041	25 678	2 365	19 367
Education	88 457	1 267	2 796	45 403	2 833	36 157
Other social sciences	129 730	2 754	3 732	61 179	6 316	55 749
Humanities	183 593	1 044	5 446	93 149	13 920	70 032
Total social sciences and humanities	629 541	8 404	18 976	316 768	32 694	252 699
Total	**2 307 578**	**47 404**	**130 967**	**1 049 143**	**119 948**	**960 116**

(a) Includes wages and salaries, payroll tax, payments to contract staff on the payroll, fringe benefits tax and workers compensation insurance, overtime earnings, shift allowances, penalty rates, bonuses, commission payments, holiday and sick pay, long service leave payments, employer contributions to superannuation and pension schemes.

(b) For research higher degrees.

TYPE OF ACTIVITY

Approximately 34% of the higher education R&D expenditure was directed towards Pure basic research, down from 37% in 1995. Strategic basic research was steady at 25%. Applied research increased from 32% in 1995 to 35% in 1996. Experimental development remained steady at 6%.

6 EXPENDITURE BY SOCIO-ECONOMIC OBJECTIVE, TYPE OF ACTIVITY(a)

	Total	*Pure basic research*	*Strategic basic research*	*Applied research*	*Experimental development*
Socio-economic objective	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Defence	7 190	1 570	1 618	3 308	693
Economic development					
Plant — production and primary products	70 381	9 102	26 374	28 808	6 097
Animal — production and primary products	49 906	5 147	18 915	20 057	5 787
Mineral resources (excl. energy)	36 741	3 974	15 616	15 295	1 856
Energy resources	16 971	1 853	3 689	8 921	2 508
Energy supply	22 902	2 185	7 466	8 830	4 421
Manufacturing	100 358	12 293	33 450	44 693	9 922
Construction	32 254	4 451	7 280	16 906	3 617
Transport	10 651	666	2 328	6 526	1 132
Information and communication services	46 160	6 125	9 902	22 354	7 778
Commercial services	14 397	1 815	2 350	9 559	673
Economic framework	84 481	15 125	20 174	47 687	1 495
Total economic development	485 203	62 737	147 544	229 635	45 287
Society					
Health	413 458	62 524	122 034	199 757	29 142
Education and training	105 326	14 630	20 838	61 214	8 645
Social development and community services	63 317	18 615	10 474	32 127	2 100
Total society	582 101	95 770	153 346	293 098	39 887
Environment					
Environmental knowledge	116 738	29 149	38 044	41 094	8 452
Environmental aspects of economic development	28 301	4 814	6 621	14 280	2 586
Environmental management and other aspects	25 713	4 610	6 905	12 211	1 987
Total environment	170 753	38 573	51 570	67 585	13 025
Advancement of knowledge					
Natural sciences, technologies and engineering	726 471	353 920	182 722	151 938	37 892
Social sciences and humanities	335 861	234 369	39 629	55 116	6 746
Total advancement of knowledge	1 062 332	588 289	222 350	207 055	44 639
Total	**2 307 578**	**786 938**	**576 429**	**800 680**	**143 530**

(a) See paragraph 6 of the Explanatory Notes.

7 EXPENDITURE BY FIELD OF RESEARCH, TYPE OF ACTIVITY(a)

Field of research	Total $'000	Pure basic research $'000	Strategic basic research $'000	Applied research $'000	Experimental development $'000
Natural sciences, technologies and engineering					
Mathematical sciences	55 667	30 334	9 109	12 290	3 933
Physical sciences	102 301	64 797	15 847	14 476	7 181
Chemical sciences	109 816	48 819	30 047	24 048	6 903
Earth sciences	110 021	35 304	34 220	34 356	6 141
Information, computers and communication technologies	139 265	34 321	35 594	50 903	18 447
Applied sciences and technologies	92 179	15 077	29 676	40 557	6 869
General engineering	163 313	25 463	45 539	73 223	19 088
Biological sciences	286 265	112 493	92 178	69 798	11 797
Agricultural sciences	127 834	13 873	45 329	55 248	13 383
Medical and health sciences	491 378	113 524	138 944	207 525	31 386
Total natural sciences, technologies and engineering	1 678 037	494 005	476 481	582 424	125 127
Social sciences and humanities					
Accounting and finance	20 125	5 636	2 461	11 432	597
Economics	59 745	15 628	9 766	33 466	886
Political sciences	31 324	17 143	6 368	6 984	830
Sociology	27 244	14 280	5 400	7 112	453
Law	37 211	16 722	9 254	10 446	790
Psychology	52 111	20 889	11 609	16 898	2 715
Education	88 457	14 620	17 697	50 715	5 425
Other social sciences	129 730	44 203	22 208	59 946	3 373
Humanities	183 593	143 813	15 186	21 259	3 335
Total social sciences and humanities	629 541	292 933	99 948	218 257	18 403
Total	**2 307 578**	**786 938**	**576 429**	**800 680**	**143 530**

(a) See paragraph 6 of the Explanatory Notes.

SOURCE OF FUNDS

General university funds were the source of funding for 65% ($1,508m) of higher education R&D expenditure in 1996. National Competitive Research Grants provided 16% ($376m), of which $363m came from Commonwealth Schemes. Other funding from the Commonwealth Government provided a further 7% ($161m). State and local government provided 2% ($51m) while Business enterprises provided 5% ($121m).

BY SOCIO-ECONOMIC OBJECTIVE

Approximately 50% of funding from General university funds was spent on Advancement of knowledge, 24% on Society and 18% on Economic development. There was a similar pattern to spending from National Competitive Research Grants, with 45% spent on Advancement of knowledge, 26% on Society and 21% on Economic development.

Other funding from the Commonwealth government was spent mainly on Advancement of knowledge, 39%; Economic development, 32%; and Society, 17%.

BY FIELD OF RESEARCH

Medical and health sciences was the predominant FOR in which funds were spent for all of the sources of funds except Other Commonwealth Government. General university funds were mainly directed towards Medical and health sciences (19%), Biological sciences (12%) and Humanities (10%), while National Competitive Research Grants were mainly directed towards Medical and health sciences (26%), Biological sciences (17%) and Agricultural sciences (9%).

8 SOURCE OF FUNDS BY SOCIO-ECONOMIC OBJECTIVE

		NATIONAL COMPETITIVE RESEARCH GRANTS	
	Total	*Common-wealth schemes*	*Other schemes*
Socio-economic objective	*$'000*	*$'000*	*$'000*
Defence	7 190	815	18
Economic development			
Plant — production and primary products	70 381	17 494	59
Animal — production and primary products	49 906	12 875	292
Mineral resources (excl. energy)	36 741	3 546	89
Energy resources	16 971	1 598	558
Energy supply	22 902	3 451	286
Manufacturing	100 358	17 768	346
Construction	32 254	4 345	147
Transport	10 651	1 545	30
Information and communication services	46 160	5 197	166
Commercial services	14 397	962	88
Economic framework	84 481	6 874	198
Total economic development	485 203	75 655	2 258
Society			
Health	413 458	75 900	3 662
Education and training	105 326	12 229	1 209
Social development and community services	63 317	4 256	184
Total society	582 101	92 385	5 054
Environment			
Environmental knowledge	116 738	19 085	922
Environmental aspects of economic development	28 301	5 454	315
Environmental management and other aspects	25 713	4 040	125
Total environment	170 753	28 579	1 362
Advancement of knowledge			
Natural sciences, technologies and engineering	726 471	134 781	3 806
Social sciences and humanities	335 861	31 216	483
Total advancement of knowledge	1 062 332	165 997	4 290
Total	**2 307 578**	**363 430**	**12 983**

8 SOURCE OF FUNDS BY SOCIO-ECONOMIC OBJECTIVE — *continued*

					OTHER	
	State and local government	*Other Commonwealth*	*Business enterprise*	*General university funds (GUF)*	*Other Australian*	*Overseas*
Socio-economic objective	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Defence	48	1 769	713	3 574	36	216
Economic development						
Plant — production and primary products	1 473	11 680	4 665	33 751	997	263
Animal — production and primary products	1 082	5 167	3 929	24 713	1 691	157
Mineral resources (excl. energy)	949	7 474	7 531	15 452	1 259	442
Energy resources	640	1 853	2 379	9 295	225	424
Energy supply	648	1 955	2 505	13 489	320	249
Manufacturing	1 118	7 482	18 076	52 801	1 572	1 195
Construction	937	3 240	2 913	19 496	1 131	45
Transport	1 704	1 416	814	4 964	151	28
Information and communication services	751	4 074	4 702	28 815	700	1 754
Commercial services	351	567	570	11 553	223	84
Economic framework	1 113	6 182	3 686	63 837	1 482	1 109
Total economic development	10 766	51 090	51 769	278 166	9 750	5 750
Society						
Health	20 981	16 417	21 286	242 224	24 835	8 153
Education and training	3 355	6 564	3 183	76 454	1 997	336
Social development and community services	1 641	5 101	809	49 997	854	475
Total society	25 977	28 082	25 278	368 675	27 686	8 964
Environment						
Environmental knowledge	3 194	12 496	5 678	70 398	3 962	1 003
Environmental aspects of economic development	734	2 253	2 309	15 756	1 312	168
Environmental management and other aspects	923	2 279	2 986	14 076	886	400
Total environment	4 850	17 029	10 973	100 230	6 159	1 570
Advancement of knowledge						
Natural sciences, technologies and engineering	5 614	50 251	28 548	480 976	16 169	6 325
Social sciences and humanities	3 722	13 172	3 394	276 661	5 403	1 810
Total advancement of knowledge	9 336	63 423	31 942	757 637	21 572	8 135
Total	**50 977**	**161 393**	**120 674**	**1 508 282**	**65 203**	**24 637**

9 SOURCE OF FUNDS BY FIELD OF RESEARCH

		NATIONAL COMPETITIVE RESEARCH GRANTS	
	Total	*Commonwealth schemes*	*Other schemes*
Field of research	*$'000*	*$'000*	*$'000*
Natural sciences, technologies and engineering			
Mathematical sciences	55 667	8 601	60
Physical sciences	102 301	18 547	225
Chemical sciences	109 816	20 765	1 404
Earth sciences	110 021	15 533	607
Information, computers and communication technologies	139 265	17 870	548
Applied sciences and technologies	92 179	17 262	105
General engineering	163 313	24 187	1 796
Biological sciences	286 265	60 636	1 826
Agricultural sciences	127 834	31 804	447
Medical and health sciences	491 378	93 002	4 427
Total natural sciences, technologies and engineering	1 678 037	308 207	11 448
Social sciences and humanities			
Accounting and finance	20 125	954	14
Economics	59 745	5 176	424
Political sciences	31 324	3 445	11
Sociology	27 244	2 322	12
Law	37 211	1 408	2
Psychology	52 111	7 382	152
Education	88 457	7 585	346
Other social sciences	129 730	11 294	306
Humanities	183 593	15 656	267
Total social sciences and humanities	629 541	55 223	1 535
Total	**2 307 578**	**363 430**	**12 983**

9 SOURCE OF FUNDS BY FIELD OF RESEARCH — *continued*

						OTHER
Field of research	*State and local government* $'000	*Other Commonwealth* $'000	*Business enterprise* $'000	*General university funds (GUF)* $'000	*Other Australian* $'000	*Overseas* $'000
Natural sciences, technologies and engineering						
Mathematical sciences	698	2 895	1 622	40 724	732	335
Physical sciences	136	4 793	2 098	74 029	1 064	1 407
Chemical sciences	592	5 483	9 001	69 725	1 836	1 010
Earth sciences	2 066	14 313	9 185	64 698	2 276	1 342
Information, computers and communication technologies	1 103	18 555	7 844	89 511	1 466	2 368
Applied sciences and technologies	1 170	9 594	7 481	54 460	1 762	346
General engineering	4 349	17 764	17 319	92 996	3 695	1 206
Biological sciences	5 504	21 110	11 592	175 692	7 300	2 605
Agricultural sciences	2 923	14 522	8 847	65 069	3 802	420
Medical and health sciences	21 800	18 382	33 731	279 785	31 056	9 195
Total natural sciences, technologies and engineering	40 340	127 411	108 719	1 006 689	54 989	20 234
Social sciences and humanities						
Accounting and finance	18	368	385	17 953	261	172
Economics	1 158	5 126	3 383	43 261	526	692
Political sciences	294	2 635	312	24 034	306	288
Sociology	641	1 916	206	21 342	494	311
Law	640	3 044	328	30 748	792	248
Psychology	1 123	1 790	746	39 643	933	342
Education	2 771	5 021	855	70 487	1 147	244
Other social sciences	2 904	6 135	4 023	100 243	3 628	1 197
Humanities	1 088	7 947	1 716	153 883	2 128	908
Total social sciences and humanities	10 637	33 982	11 955	501 593	10 214	4 402
Total	**50 977**	**161 393**	**120 674**	**1 508 282**	**65 203**	**24 637**

LOCATION OF R&D EXPENDITURE

STATE COMPARISONS

The leading States in terms of location of higher education R&D expenditure in 1996 were New South Wales at $661m and Victoria at $485m, accounting for 29% and 21% of total expenditure respectively. Next in order were Queensland (17%), the Australian Capital Territory (13%), Western Australia (10%), South Australia (8%), Tasmania (2%) and the Northern Territory (1%). The ranking was the same in 1995.

BY SOCIO-ECONOMIC OBJECTIVE

The main SEO division in all State and Territories except South Australia was Advancement of knowledge. Society was the main SEO division in South Australia. In both Victoria and South Australia the subdivision of Health accounted for 25% of total expenditure.

10 LOCATION OF EXPENDITURE BY SOCIO-ECONOMIC OBJECTIVE

	Aust.	*NSW(a)*	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT(b)*
Socio-economic objective	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*	*$'000*
Defence	7 190	418	1 281	521	2 102	179	—	—	2 689
Economic development									
Plant — production and primary products	70 381	9 859	8 389	15 021	8 822	12 633	4 251	757	10 649
Animal — production and primary products	49 906	16 036	10 668	11 009	4 364	5 785	1 062	832	150
Mineral resources (excl. energy)	36 741	3 431	4 479	10 540	2 767	11 408	2 712	—	1 405
Energy resources	16 971	5 650	882	2 789	3 561	3 933	156	—	—
Energy supply	22 902	10 477	3 778	2 568	3 224	721	70	815	1 250
Manufacturing	100 358	36 641	23 057	23 112	9 165	4 032	713	4	3 634
Construction	32 254	9 156	12 818	4 192	1 302	2 848	680	—	1 257
Transport	10 651	1 658	4 370	1 475	1 265	841	40	—	1 002
Information and communication services	46 160	13 620	10 792	9 799	5 754	1 293	161	40	4 701
Commercial services	14 397	5 421	3 541	3 022	913	1 046	39	52	363
Economic framework	84 481	26 378	20 423	12 313	5 259	8 485	1 804	267	9 552
Total economic development	485 203	138 328	103 196	95 840	46 396	53 025	11 687	2 768	33 964
Society									
Health	413 458	104 728	120 722	54 934	46 527	41 057	5 494	401	39 596
Education and training	105 326	29 883	30 486	16 052	10 321	12 378	2 979	1 984	1 243
Social development and community services	63 317	17 786	9 413	10 926	5 125	4 102	2 465	823	12 677
Total society	582 101	152 397	160 621	81 912	61 972	57 537	10 937	3 209	53 515
Environment									
Environmental knowledge	116 738	28 779	17 110	18 791	11 767	11 633	4 688	3 025	20 946
Environmental aspects of economic development	28 301	8 684	5 103	5 308	3 520	3 143	1 000	265	1 277
Environmental management and other aspects	25 713	7 557	3 774	6 407	2 390	2 439	829	299	2 018
Total environment	170 753	45 020	25 987	30 506	17 677	17 214	6 517	3 590	24 241
Advancement of knowledge									
Natural sciences, technologies and engineering	726 471	223 534	128 394	122 884	39 745	73 729	17 393	2 495	118 298
Social sciences and humanities	335 861	101 409	65 901	53 970	20 269	24 386	4 992	3 110	61 824
Total advancement of knowledge	1 062 332	324 943	194 294	176 855	60 014	98 114	22 385	5 605	180 122
Total	**2 307 578**	**661 105**	**485 379**	**385 634**	**188 161**	**226 069**	**51 527**	**15 172**	**294 531**

(a) Includes Australian Catholic University.
(b) Includes Australian Defence Force Academy.

BY FIELD OF RESEARCH

In New South Wales, Victoria, Queensland, South Australia and Western Australia the predominant FORs were Medical and health sciences (23%, 26%, 20%, 27% and 23% respectively) and Biological sciences (9%, 10%, 17%, 13% and 12% respectively). In the Australian Capital Territory the predominant FORs were Biological sciences (18%) and Physical sciences (14%).

11 LOCATION OF EXPENDITURE BY FIELD OF RESEARCH

Field of research	*Aust.* *$'000*	*NSW(a)* *$'000*	*Vic.* *$'000*	*Qld* *$'000*	*SA* *$'000*	*WA* *$'000*	*Tas.* *$'000*	*NT* *$'000*	*ACT(b)* *$'000*
Natural sciences, technologies and engineering									
Mathematical sciences	55 667	18 627	14 297	6 323	5 370	2 945	518	226	7 362
Physical sciences	102 301	23 432	15 145	10 237	5 796	5 452	1 715	638	39 884
Chemical sciences	109 816	29 500	23 351	19 857	9 070	6 199	2 160	802	18 877
Earth sciences	110 021	22 933	12 932	18 030	8 708	12 405	9 707	43	25 262
Information, computers and communication technologies	139 265	31 704	29 041	24 112	11 392	23 311	1 259	348	18 098
Applied sciences and technologies	92 179	31 588	24 425	12 464	4 425	8 656	223	559	9 838
General engineering	163 313	58 444	35 055	32 739	12 665	15 397	1 077	708	7 227
Biological sciences	286 265	61 119	46 817	65 104	25 289	26 147	6 200	4 034	51 555
Agricultural sciences	127 834	37 781	22 466	22 934	15 186	19 314	7 381	1 213	1 559
Medical and health sciences	491 378	153 809	127 050	76 936	50 439	51 353	7 591	331	23 870
Total natural sciences, technologies and engineering	1 678 037	468 937	350 578	288 736	148 341	171 179	37 832	8 902	203 532
Social sciences and humanities									
Accounting and finance	20 125	9 228	3 729	1 600	901	3 102	572	31	963
Economics	59 745	15 450	13 465	4 849	2 688	5 244	1 040	190	16 819
Political sciences	31 324	7 021	3 694	2 604	2 965	3 420	807	305	10 508
Sociology	27 244	9 205	5 867	3 488	2 022	686	884	190	4 901
Law	37 211	12 864	7 765	3 894	1 745	3 240	1 198	593	5 914
Psychology	52 111	17 071	12 964	12 293	1 895	5 584	712	186	1 407
Education	88 457	28 965	21 064	18 606	5 241	9 237	2 539	1 588	1 218
Other social sciences	129 730	37 046	24 530	29 156	10 357	10 246	1 101	1 452	15 842
Humanities	183 593	55 318	41 725	20 408	12 007	14 130	4 843	1 734	33 428
Total social sciences and humanities	629 541	192 167	134 801	96 899	39 820	54 890	13 695	6 270	90 999
Total	**2 307 578**	**661 105**	**485 379**	**385 634**	**188 161**	**226 069**	**51 527**	**15 172**	**294 531**

(a) Includes Australian Catholic University.

(b) Includes Australian Defence Force Academy.

HUMAN RESOURCES DEVOTED TO R&D

TYPE OF R&D STAFF

The percentage distribution by type of R&D employee in 1996 changed slightly when compared to 1994. Researchers increased as a percentage of total employees at the expense of Supporting staff. Researchers increased by 10% compared with a 7% decrease in Supporting staff.

There was also a change in the composition of the research effort by Researchers. Academics accounted for 33% of effort by Researchers, an increase of 1%, while Postgraduates decreased to 67% of Researchers' effort.

BY SOCIO-ECONOMIC OBJECTIVE

The Socio-economic objective of Advancement of knowledge accounted for 48% of total research effort (person years) in the higher education sector in 1996. The subdivision of Health accounted for a further 15%.

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

		Type of employee		
		Researchers		
	Total	Academics	Postgraduates	Supporting staff
Socio-economic objective	person years	person years	person years	person years
Defence	118	35	56	26
Economic development				
Plant — production and primary products	1 170	259	645	266
Animal — production and primary products	762	172	384	206
Mineral resources (excl. energy)	446	146	231	69
Energy resources	296	87	164	45
Energy supply	356	108	185	64
Manufacturing	1 716	396	1 018	302
Construction	648	165	382	101
Transport	176	60	74	42
Information and communication services	897	330	435	132
Commercial services	273	98	151	24
Economic framework	1 748	563	1 005	181
Total economic development	8 489	2 385	4 671	1 433
Society				
Health	6 487	2 055	2 860	1 571
Education and training	2 690	643	1 725	322
Social development and community services	1 282	361	767	155
Total society	10 459	3 059	5 352	2 048
Environment				
Environmental knowledge	2 062	512	1 129	421
Environmental aspects of economic development	527	145	279	102
Environmental management and other aspects	465	108	270	88
Total environment	3 054	765	1 679	611
Advancement of knowledge				
Natural sciences, technologies and engineering	12 113	3 419	6 280	2 414
Social sciences and humanities	8 506	2 013	5 759	734
Total advancement of knowledge	20 619	5 432	12 039	3 148
Total	**42 739**	**11 675**	**23 797**	**7 266**

The major FORs in terms of research effort (person years) in the higher education sector in 1996 were Medical and health sciences (18%), Humanities (12%) and Biological sciences (11%).

13 HUMAN RESOURCES DEVOTED TO R&D BY FIELD OF RESEARCH

		Type of employee		
		Researchers		
	Total	Academics	Postgraduates	Supporting staff
Field of research	person years	person years	person years	person years
Natural sciences, technologies and engineering				
Mathematical sciences	1 017	360	559	98
Physical sciences	1 495	530	630	335
Chemical sciences	1 997	598	1 037	362
Earth sciences	1 739	458	931	350
Information, computers and communication technologies	2 418	684	1 295	440
Applied sciences and technologies	1 604	387	962	254
General engineering	2 838	692	1 640	507
Biological sciences	4 773	1 246	2 411	1 116
Agricultural sciences	2 227	461	1 252	514
Medical and health sciences	7 575	2 405	3 353	1 817
Total natural sciences, technologies and engineering	27 684	7 821	14 069	5 793
Social sciences and humanities				
Accounting and finance	344	155	161	28
Economics	1 082	384	549	149
Political sciences	698	162	457	79
Sociology	597	155	370	72
Law	665	265	330	71
Psychology	1 106	303	644	160
Education	2 446	567	1 636	244
Other social sciences	3 025	738	1 960	327
Humanities	5 091	1 126	3 622	343
Total social sciences and humanities	15 055	3 854	9 728	1 473
Total	**42 739**	**11 675**	**23 797**	**7 266**

EXPLANATORY NOTES

INTRODUCTION

1 This publication presents estimates of expenditure and human resources devoted to R&D carried out by organisations in the Higher education sector during 1996.

2 For details of R&D statistics available for the Business enterprise and General government and Private non-profit sectors see paragraph 20.

DATA SOURCES

3 The 1996 statistics presented in this publication have been compiled from data collected from universities in the ABS Survey of Research and Experimental Development in respect of the year ended 31 December 1996.

4 The GDP(I) figures used to derive higher education expenditure on R&D/GDP ratios are current at the time of manuscript finalisation (National Income, Expenditure and Product, December Quarter 1997, (5206.0)), and, at current prices, are as follows: $339,881m (1988–89); $380,762m (1990–91); $407,951m (1992–93); $460,292m (1994–95); $492,113m (1995–96; and $516,306m (1996–97). The available higher education expenditure on R&D/GDP ratios for other OECD countries are current at time of manuscript finalisation and are sourced from Main Science and Technology Indicators, 1997–2, OECD, Paris, 1997.

DEFINITIONS

5 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.

6 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.

7 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.

SCOPE AND COVERAGE

8 The Higher education sector is defined by OECD as including all universities and other institutions of post-secondary education whatever their source of finance or legal status.

9 For the ABS R&D surveys of this sector, only universities are surveyed. The universities are asked to include R&D carried out by them as participants in unincorporated Cooperative Research Centres (CRCs), but to exclude any R&D for incorporated CRCs as they are included in the Business enterprise sector. Other institutions (e.g. Technical and Further Education colleges) 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

10 The statistics in this publication are classified by 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

11 The 1996 statistics presented in this publication may not be strictly comparable with those for previous years 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.

METHODOLOGY FOR DERIVING UNIVERSITY R&D EXPENDITURE ESTIMATES

12 Universities were asked to provide the ABS with the following data:

- direct staff inputs into R&D; i.e. personnel resources expended in undertaking R&D projects;
- other staff resources directly supporting R&D by providing direct services to the researchers but not undertaking research in their own right; and
- direct expenditure on R&D; i.e. the expenses directly attributable to research projects.

13 An estimate for indirect (overhead) expenditure was then added to the direct expenditure on R&D to obtain an estimate of the total cost of the R&D undertaken.

14 The following approach to estimating overhead R&D expenditure was adopted in the 1996 data collection:

- in cases where an allowance for overheads had already been included in the data reported by a university, no adjustments were made to the data; and
- where an allowance had not been included, either:
  - the university identified overhead costs and estimated the R&D part to be apportioned across relevant projects, etc.; or
  - the ABS applied agreed factors to the reported data.

CONSTANT PRICE ESTIMATES

15 Estimates of total R&D expenditure are shown at average 1989–90 prices in Table 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.

16 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.

17 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

18 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.
- The OECD standard definition of R&D used in this survey differs in some respects from what data providers may regard as R&D activity.
- Some data providers had difficulties describing their R&D programs in terms of SEO, FOR and TOA. The data presented under these classifications therefore reflect a degree of subjectivity.
- The estimation of overhead R&D expenditure was subjective and varied across universities.

UNPUBLISHED STATISTICS

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

RELATED PUBLICATIONS

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

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

Main Science and Technology Indicators 1997–2, OECD, Paris, 1997

Research and Experimental Development, All Sector Summary, Australia, 1994–95 (Cat. no. 8112.0)

Research and Experimental Development, Business Enterprises, Australia, 1995–96 (Cat. no. 8104.0).

Research and Experimental Development, General Government and Private Non-profit Organisations, Australia, 1994–95 (Cat. no. 8109.0)

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

21 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.

22 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.

Direct 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.

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

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.

HERD Higher education expenditure on R&D.

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.

OECD Organisation for Economic Co-operation and Development.

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

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.

Supporting staff Technicians, skilled and unskilled craftpersons, secretarial and clerical staff directly associated with R&D activity.

TOA Type of R&D activity.

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

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2811100001969
ISSN 0729-171X

RRP $16.00

Produced by the Australian Bureau of Statistics