1998 8111.0

Australian Bureau of Statistics

RESEARCH AND EXPERIMENTAL DEVELOPMENT

AUSTRALIA

HIGHER EDUCATION ORGANISATIONS

EMBARGO: 11.30AM (CANBERRA TIME) WED 26 APR 2000

CONTENTS

■ For further information about these and related statistics, contact the National Information Service on 1300 135 070 or Derek Byars on Canberra 02 6252 5627.

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

COMPARABILITY

The 1998 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.

ABBREVIATIONS

ABS	Australian Bureau of Statistics
FOR	Field of research
GDP	Gross Domestic Product
HERD	Higher education expenditure on R&D
OECD	Organisation for Economic Co-operation and Development
R&D	Research and experimental development
SEO	Socio-economic objective
TOA	Type of R&D activity

W. McLennan
Australian Statistician

MAIN FEATURES

EXPENDITURE ON R&D

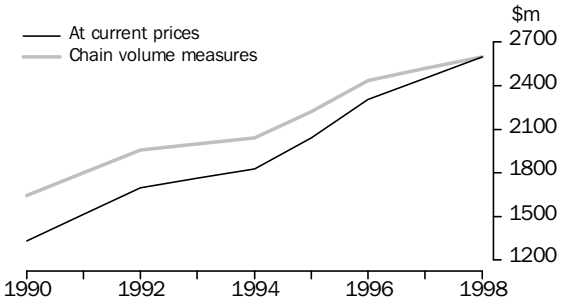
Higher education expenditure on R&D (HERD) in Australia in 1998 was estimated to be $2,600m at current prices. This represented an increase of 13% over 1996.

In volume terms, R&D expenditure increased by 7% compared with 1996.

HERD has steadily increased since 1990. The average annual rate of growth over this period has been 8.7% in current price terms and 5.9% in chain volume measures.

HERD as a percentage of Gross Domestic Product (GDP) has remained steady. It was 0.43% in 1996 and 0.44% in 1998.

EXPENDITURE ON R&D



HUMAN RESOURCES DEVOTED TO R&D

Human resources devoted to R&D in Australia in 1998 by higher education organisations was estimated to be 45,540 person years. This represented an increase of 7% over 1996 and an average annual rate of growth of 6.7% since 1990

.

RESOURCES DEVOTED TO R&D

	1990	*1992*	*1994*	*1995*	*1996*	*1998*
Expenditure						
At current prices *($m)*	1 332.8	1 695.2	1 829.6	2 039.1	2 307.6	2 600.2
Chain volume measures *($m)*	1 647.3	1 957.9	2 042.7	2 220.7	2 435.0	2 600.2
Human resources *(person years)*	27 081	35 418	40 096	na	42 739	45 540

na not available

PURPOSE OF RESEARCH

Most R&D expenditure by higher education organisations was directed towards Advancement of knowledge ($1,087m or 42%) and Society ($710m or 27%).

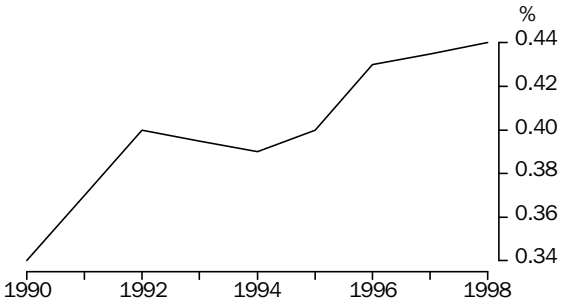
FIELD OF RESEARCH

Medical and health sciences ($591m or 23%), Social sciences ($505m or 19%), Biological sciences ($314m or 12%) and Humanities ($197m or 8%) were the main fields of research by higher education organisations.

HERD AS A PERCENTAGE OF GDP

HERD as a percentage of GDP has risen from 0.34% in 1990 to 0.44% in 1998, an average annual increase of 3.4%.

HERD AS A PERCENTAGE OF GDP



Australia's HERD/GDP ratio for 1998 compares favourably with those available for other OECD countries, being higher than those for Germany, the United States of America, France and Canada.

HERD/GDP RATIOS OF OECD COUNTRIES

	1996	*1998*
	%	%
Netherlands	0.60	na
Finland	0.47	0.56
Iceland	na	0.51
Australia	**0.43**	**0.44**
Japan	0.42	na
Germany	0.42	0.41
Denmark	0.40	0.41
United States of America	0.39	0.39
France	0.39	0.38
United Kingdom	0.38	na
Canada	0.36	0.35
Spain	0.28	0.28
Ireland	0.27	na
Italy	0.27	0.26

na not available

RESOURCES DEVOTED TO R&D

TYPE OF EXPENDITURE

Current expenditure accounted for 93% of higher education R&D expenditure, with capital expenditure accounting for the remaining 7%. The major component was direct labour costs which accounted for 47% 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 1998 with 42% of total expenditure, down from 46% in 1996.

The SEOs within the Society division accounted for 27% of R&D expenditure, up from 25% in 1996. The major subdivision within Society was Health with 19% of total R&D expenditure.

FIELD OF RESEARCH (FOR)

The FORs in which most higher education R&D occurred in 1998 were: Medical and health sciences ($591m); Social sciences ($505m); Biological sciences ($314m) and Humanities ($197m).

These fields of research were also the main four fields in 1996.

TYPE OF ACTIVITY

The proportion of R&D expenditure directed towards each type of R&D activity remained unchanged from 1996, with 35% directed towards Applied research, 33% towards Pure basic research, 25% towards Strategic basic research and 6% towards Experimental development.

SOURCE OF FUNDS

General university funds were the source of funding for 64% ($1,657m) of higher education R&D expenditure in 1998. National Competitive Research Grants provided 17% ($432m), of which $415m came from Commonwealth Schemes. Other funding from the Commonwealth Government provided a further 7% ($191m). State and local government provided 3% ($69m) while Businesses provided 5% ($136m).

Approximately 44% of funding from General university funds was spent on Advancement of knowledge, 27% on Society and 22% on Economic development. There was a similar pattern to spending from National Competitive Research Grants, with 43% spent on Advancement of knowledge, 27% on Society and 23% on Economic development.

The predominant objective on which State and local government funds were spent was Society (47%), while 42% of funds from Business were spent on Economic development.

Medical and health sciences was the predominant FOR in which funds were spent for all of the sources of funds except General university funds and Other Commonwealth Government. General university funds were mainly directed towards Social sciences (24%), Medical and health sciences (20%), Biological sciences (11%) and Humanities (10%), while National Competitive Research Grants were mainly directed towards Medical and health sciences (27%), Biological sciences (15%) and Social sciences (11%).

STATE COMPARISONS

The leading States in terms of location of higher education R&D expenditure in 1998 were New South Wales at $809m and Victoria at $557m, accounting for 31% and 21% of total expenditure respectively. Next in order were Queensland (15%), the Australian Capital Territory (11%), South Australia (9%), Western Australia (9%), Tasmania (2%) and the Northern Territory (1%).

The main SEO division in most State and Territories was Advancement of knowledge. Society was the main SEO division in South Australia, Economic development the main division in Tasmania and Environment the main division in the Northern Territory. The subdivision of Health accounted for 29% of total expenditure in South Australia and 26% in Victoria.

In New South Wales, Victoria, Queensland, South Australia and Western Australia the predominant FORs were Medical and health sciences and Social sciences. In the Australian Capital Territory the predominant FORs were Social sciences and Biological sciences.

TYPE OF R&D STAFF

The percentage distribution by type of R&D employee in 1998 changed slightly when compared to 1996. Researchers increased as a percentage of total employees at the expense of Supporting staff. Researchers increased by 8% compared with a 2% increase in Supporting staff.

There was also a change in the composition of the research effort by Researchers. Academics accounted for 31% of effort by Researchers, a decrease of 1%, while Postgraduates increased to 69% of Researchers' effort.

The Socio-economic objective of Advancement of knowledge accounted for 44% of total research effort (person years) in the higher education sector in 1998. The subdivision of Health accounted for a further 16%.

The major FORs in terms of research effort (person years) in the higher education sector in 1998 were Social sciences (24%), Medical and health sciences (19%), Humanities (12%) and Biological sciences (11%).

1 EXPENDITURE, by Socio-economic Objective, by Type of Expenditure

Socio-economic objective	Total $'000	Land and buildings $'000	Other capital expenditure $'000	Direct labour costs(a) $'000	Scholarships(b) $'000	Other current expenditure $'000
Defence	6 112	30	334	2 876	196	2 676
Economic development						
Plant - production and primary products	95 309	898	4 670	38 565	5 369	45 808
Animal - production and primary products	65 006	536	2 626	27 231	4 107	30 505
Mineral resources (excl. energy)	33 876	290	2 177	13 203	1 975	16 230
Energy resources	16 631	116	1 497	6 895	1 042	7 082
Energy supply	22 310	44	1 309	10 470	1 548	8 940
Manufacturing	116 982	1 788	11 361	49 501	8 805	45 527
Construction	40 658	1 284	2 298	20 195	2 944	13 937
Transport	15 390	186	1 299	7 109	1 104	5 692
Information and communication services	64 361	689	3 042	32 090	3 512	25 028
Commercial services	27 850	681	664	14 903	1 203	10 399
Economic framework	108 666	1 356	2 780	56 829	5 111	42 590
Total economic development	*607 037*	*7 868*	*33 723*	*276 990*	*36 719*	*251 736*
Society						
Health	505 452	4 876	18 270	242 897	20 610	218 799
Education and training	108 531	1 516	2 800	58 130	4 435	41 650
Social development and community services	96 086	1 776	2 926	47 494	3 405	40 485
Total society	*710 068*	*8 168*	*23 996*	*348 521*	*28 449*	*300 935*
Environment						
Environmental knowledge	120 924	2 068	6 982	54 327	6 068	51 479
Environmental aspects of economic development	34 986	549	1 470	16 451	2 304	14 212
Environmental management and other aspects	34 322	460	1 386	15 477	1 875	15 124
Total environment	*190 233*	*3 078*	*9 838*	*86 254*	*10 248*	*80 815*
Advancement of knowledge						
Natural sciences, technologies and engineering	766 315	10 679	66 438	335 111	43 093	310 994
Social sciences and humanities	320 439	4 950	7 903	166 613	22 959	118 014
Total advancement of knowledge	*1 086 754*	*15 629*	*74 341*	*501 725*	*66 052*	*429 008*
TOTAL	**2 600 204**	**34 773**	**142 233**	**1 216 365**	**141 665**	**1 065 169**

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

(b) For research higher degrees.

2 EXPENDITURE, by Field of Research, by Type of Expenditure

Field of research	*Total* $'000	*Land and buildings* $'000	*Other capital expenditure* $'000	*Direct labour costs*(a) $'000	*Scholarships*(b) $'000	*Other current expenditure* $'000
Natural sciences, technologies and engineering						
Mathematical sciences	62 740	247	2 081	31 642	3 193	25 577
Physical sciences	105 985	1 818	9 911	46 022	4 016	44 219
Chemical sciences	120 957	1 682	11 764	50 368	8 637	48 505
Earth sciences	114 017	1 205	8 520	50 717	6 295	47 280
Information, computers and communication technologies	139 279	1 282	10 533	65 765	8 513	53 186
Applied sciences and technologies	98 367	1 295	10 558	42 033	7 595	36 886
General engineering	179 700	2 793	13 793	79 575	13 449	70 090
Biological sciences	314 484	5 465	22 719	135 625	16 792	133 883
Agricultural sciences	171 069	1 455	8 419	70 645	10 877	79 673
Medical and health sciences	591 188	6 146	27 273	277 085	23 473	257 210
Total natural sciences, technologies and engineering	*1 897 785*	*23 386*	*125 571*	*849 477*	*102 840*	*796 511*
Social sciences and humanities						
Social sciences	505 418	8 179	12 472	264 723	22 777	197 267
Humanities	197 002	3 208	4 190	102 165	16 048	71 391
Total social sciences and humanities	*702 419*	*11 386*	*16 662*	*366 888*	*38 825*	*268 658*
TOTAL	**2 600 204**	**34 773**	**142 233**	**1 216 365**	**141 665**	**1 065 169**

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

(b) For research higher degrees.

3 EXPENDITURE, by Socio-economic Objective, by Type of Activity(a)

Socio-economic objective	Total	Pure basic research	Strategic basic research	Applied research	Experimental development
	$'000	$'000	$'000	$'000	$'000
Defence	6 112	437	1 605	3 579	491
Economic development					
Plant - production and primary products	95 309	13 069	26 352	49 569	6 319
Animal - production and primary products	65 006	7 548	17 301	32 589	7 567
Mineral resources (excl. energy)	33 876	4 810	11 388	16 552	1 126
Energy resources	16 631	2 057	3 439	9 445	1 691
Energy supply	22 310	1 951	5 863	9 991	4 506
Manufacturing	116 982	18 817	39 704	45 228	13 233
Construction	40 658	6 074	8 082	23 547	2 955
Transport	15 390	1 363	3 653	8 873	1 502
Information and communication services	64 361	14 338	14 640	26 012	9 372
Commercial services	27 850	3 808	4 955	18 189	898
Economic framework	108 666	19 125	27 189	60 541	1 811
Total economic development	*607 037*	*92 958*	*162 565*	*300 536*	*50 979*
Society					
Health	505 452	94 725	163 488	212 545	34 694
Education and training	108 531	22 021	22 800	55 578	8 130
Social development and community services	96 086	24 866	24 665	41 328	5 226
Total society	*710 068*	*141 613*	*210 953*	*309 452*	*48 051*
Environment					
Environmental knowledge	120 924	31 408	40 577	42 410	6 530
Environmental aspects of economic development	34 986	6 300	10 157	15 711	2 819
Environmental management and other aspects	34 322	5 426	9 057	16 706	3 135
Total environment	*190 233*	*43 133*	*59 790*	*74 826*	*12 483*
Advancement of knowledge					
Natural sciences, technologies and engineering	766 315	387 599	179 251	160 523	38 942
Social sciences and humanities	320 439	204 531	45 472	62 236	8 200
Total advancement of knowledge	*1 086 754*	*592 130*	*224 723*	*222 760*	*47 142*
TOTAL	**2 600 204**	**870 271**	**659 636**	**911 153**	**159 144**

(a) See paragraph 6 of the Explanatory Notes.

4 EXPENDITURE, by Field of Research, by Type of Activity(a)

Field of research	Total	Pure basic research	Strategic basic research	Applied research	Experimental development
	$'000	$'000	$'000	$'000	$'000
Natural sciences, technologies and engineering					
Mathematical sciences	62 740	32 374	12 404	13 344	4 618
Physical sciences	105 985	64 993	16 389	17 894	6 709
Chemical sciences	120 957	51 298	35 084	25 626	8 948
Earth sciences	114 017	35 445	33 548	37 689	7 335
Information, computers and communication technologies	139 279	34 754	32 373	57 107	15 045
Applied sciences and technologies	98 367	15 670	32 681	40 897	9 119
General engineering	179 700	26 248	48 393	86 036	19 024
Biological sciences	314 484	131 107	93 932	76 883	12 561
Agricultural sciences	171 069	26 552	45 919	82 620	15 978
Medical and health sciences	591 188	162 994	171 499	219 792	36 903
Total natural sciences, technologies and engineering	*1 897 785*	*581 436*	*522 221*	*657 889*	*136 238*
Social sciences and humanities					
Social sciences	505 418	151 996	113 280	222 349	17 793
Humanities	197 002	136 838	24 135	30 915	5 113
Total social sciences and humanities	*702 419*	*288 834*	*137 415*	*253 263*	*22 906*
TOTAL	**2 600 204**	**870 271**	**659 636**	**911 153**	**159 144**

(a) See paragraph 6 of the Explanatory Notes.

5 SOURCE OF FUNDS, Socio-economic Objective

Socio-economic objective	Total	NATIONAL COMPETITIVE RESEARCH GRANTS		OTHER					
		Commonwealth schemes	Other schemes	State and local government	Other Commonwealth government	Business enterprise	General university funds (GUF)	Other Australian	Overseas
	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000
Defence	6 112	1 003	1	232	696	380	3 769	23	9
Economic development									
Plant - production and primary products	95 309	26 544	150	3 372	10 481	6 186	43 117	4 779	680
Animal - production and primary products	65 006	16 552	811	2 913	6 520	4 753	31 027	1 704	727
Mineral resources (excl. energy)	33 876	4 303	27	1 185	3 892	7 174	16 066	678	551
Energy resources	16 631	1 448	1 017	492	1 336	1 921	10 213	117	86
Energy supply	22 310	4 268	125	330	1 901	2 545	12 172	510	460
Manufacturing	116 982	19 555	559	2 352	9 128	17 570	64 196	1 373	2 248
Construction	40 658	5 372	246	1 583	3 666	2 430	26 195	1 070	97
Transport	15 390	2 491	70	2 523	1 326	1 138	7 640	99	104
Information and communication services	64 361	7 345	14	1 387	3 206	6 399	43 288	415	2 308
Commercial services	27 850	1 615	29	561	2 404	1 239	21 565	358	79
Economic framework	108 666	8 644	57	1 721	6 734	6 118	81 181	1 004	3 208
Total economic development	*607 037*	*98 136*	*3 103*	*18 421*	*50 594*	*57 472*	*356 658*	*12 106*	*10 548*
Society									
Health	505 452	89 756	6 654	25 056	29 098	26 085	293 230	24 384	11 190
Education and training	108 531	10 099	627	4 308	8 295	2 523	80 017	1 835	826
Social development and community services	96 086	7 844	263	2 777	5 629	1 979	75 777	671	1 146
Total society	*710 068*	*107 699*	*7 544*	*32 140*	*43 022*	*30 587*	*449 024*	*26 890*	*13 162*
Environment									
Environmental knowledge	120 924	16 206	452	3 604	14 064	5 354	75 610	4 681	952
Environmental aspects of economic development	34 986	7 062	402	1 079	2 261	3 756	19 370	710	347
Environmental management and other aspects	34 322	4 991	192	1 813	2 311	4 590	19 379	627	419
Total environment	*190 233*	*28 259*	*1 047*	*6 496*	*18 637*	*13 701*	*114 358*	*6 018*	*1 717*
Advancement of knowledge									
Natural sciences, technologies and engineering	766 315	146 015	4 660	8 204	60 291	30 286	477 871	25 566	13 421
Social sciences and humanities	320 439	33 970	108	3 506	17 889	3 631	255 378	3 710	2 247
Total advancement of knowledge	*1 086 754*	*179 985*	*4 768*	*11 711*	*78 180*	*33 917*	*733 249*	*29 276*	*15 668*
TOTAL	**2 600 204**	**415 083**	**16 463**	**69 000**	**191 129**	**136 056**	**1 657 058**	**74 313**	**41 103**

6 SOURCE OF FUNDS, Field of Research

Field of research	Total	NATIONAL COMPETITIVE RESEARCH GRANTS		OTHER					
		Commonwealth schemes	*Other schemes*	*State and local government*	*Other Commonwealth government*	*Business enterprise*	*General university funds (GUF)*	*Other Australian*	*Overseas*
	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000	$'000
Natural sciences, technologies and engineering									
Mathematical sciences	62 740	10 083	58	859	3 655	1 850	44 988	320	928
Physical sciences	105 985	15 373	135	341	8 020	1 887	74 168	5 248	814
Chemical sciences	120 957	22 212	1 292	1 213	12 352	9 269	72 024	1 595	1 000
Earth sciences	114 017	17 759	806	2 734	12 469	6 466	69 350	2 942	1 492
Information, computers and communication technologies	139 279	17 150	71	2 636	14 821	9 296	90 668	888	3 749
Applied sciences and technologies	98 367	19 621	500	1 414	12 018	9 042	54 065	744	965
General engineering	179 700	31 018	1 614	6 823	12 780	19 330	102 804	3 773	1 559
Biological sciences	314 484	64 731	1 631	5 678	23 025	16 242	189 982	9 617	3 579
Agricultural sciences	171 069	43 753	1 101	6 713	17 792	11 935	81 892	6 628	1 256
Medical and health sciences	591 188	108 319	8 629	26 153	30 402	34 906	330 007	34 401	18 372
Total natural sciences, technologies and engineering	*1 897 785*	*350 017*	*15 836*	*54 563*	*147 332*	*120 222*	*1 109 947*	*66 155*	*33 714*
Social sciences and humanities									
Social sciences	505 418	45 852	440	12 937	30 788	13 440	389 413	6 339	6 207
Humanities	197 002	19 214	186	1 499	13 008	2 394	157 698	1 820	1 182
Total social sciences and humanities	*702 419*	*65 066*	*627*	*14 437*	*43 797*	*15 834*	*547 111*	*8 158*	*7 390*
TOTAL	**2 600 204**	**415 083**	**16 463**	**69 000**	**191 129**	**136 056**	**1 657 058**	**74 313**	**41 103**

7 LOCATION OF EXPENDITURE, by Socio-economic Objective

Socio-economic objective	Aust. $'000	NSW(a) $'000	Vic. $'000	Qld $'000	SA $'000	WA $'000	Tas. $'000	NT $'000	ACT(b) $'000
Defence	6 112	310	1 747	422	1 971	409	2	—	1 251
Economic development									
Plant - production and primary products	95 309	22 271	11 663	14 657	15 466	15 480	7 518	344	7 911
Animal - production and primary products	65 006	18 730	15 724	12 159	4 518	6 251	4 598	262	2 763
Mineral resources (excl. energy)	33 876	2 360	2 342	11 422	4 150	8 646	3 394	112	1 450
Energy resources	16 631	5 786	1 891	2 623	2 113	3 378	98	—	743
Energy supply	22 310	9 243	3 908	1 205	3 533	2 167	371	282	1 601
Manufacturing	116 982	33 985	33 250	26 770	10 726	4 451	1 476	—	6 324
Construction	40 658	14 369	10 986	3 923	3 105	7 256	588	177	254
Transport	15 390	3 356	5 666	2 867	2 608	448	182	—	263
Information and communication services	64 361	20 597	18 128	10 834	8 115	2 073	383	75	4 157
Commercial services	27 850	7 847	9 336	3 348	1 873	1 181	86	73	4 106
Economic framework	108 666	33 648	27 980	12 112	10 176	8 271	2 072	980	13 426
Total economic development	*607 037*	*172 191*	*140 874*	*101 919*	*66 384*	*59 602*	*20 766*	*2 305*	*42 998*
Society									
Health	505 452	125 073	146 843	69 759	70 063	40 608	5 288	920	46 899
Education and training	108 531	37 755	30 077	15 491	7 429	11 259	2 537	2 014	1 968
Social development and community services	96 086	22 546	14 566	16 197	12 152	4 605	2 218	885	22 918
Total society	*710 068*	*185 374*	*191 485*	*101 447*	*89 644*	*56 472*	*10 042*	*3 820*	*71 785*
Environment									
Environmental knowledge	120 924	31 221	17 229	21 815	9 810	10 887	8 687	2 548	18 729
Environmental aspects of economic development	34 986	14 793	4 233	4 510	2 374	3 691	979	1 147	3 260
Environmental management and other aspects	34 322	13 322	2 982	6 742	4 587	2 940	833	633	2 283
Total environment	*190 233*	*59 336*	*24 443*	*33 066*	*16 770*	*17 518*	*10 500*	*4 328*	*24 271*
Advancement of knowledge									
Natural sciences, technologies and engineering	766 315	268 635	132 481	115 058	49 922	68 175	11 571	3 054	117 421
Social sciences and humanities	320 439	122 923	66 097	43 230	16 100	23 371	6 537	1 104	41 077
Total advancement of knowledge	*1 086 754*	*391 558*	*198 578*	*158 287*	*66 022*	*91 546*	*18 108*	*4 158*	*158 498*
TOTAL	**2 600 204**	**808 768**	**557 127**	**395 142**	**240 791**	**225 547**	**59 417**	**14 611**	**298 803**

— nil or rounded to zero (including null cells)

(a) Includes Australian Catholic University.

(b) Includes Australian Defence Force Academy.

8 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	62 740	19 713	15 776	6 506	7 289	2 163	251	121	10 921
Physical sciences	105 985	31 768	13 680	8 025	6 438	7 109	2 115	449	36 401
Chemical sciences	120 957	33 032	23 395	19 936	13 175	8 492	2 171	674	20 082
Earth sciences	114 017	27 157	14 774	18 472	7 597	11 728	10 425	144	23 721
Information, computers and communication technologies	139 279	40 159	34 206	17 623	16 181	12 632	1 070	636	16 772
Applied sciences and technologies	98 367	33 397	25 312	14 173	6 324	8 267	289	630	9 975
General engineering	179 700	70 213	33 913	37 877	14 253	18 516	1 637	893	2 398
Biological sciences	314 484	78 156	50 221	67 567	29 776	29 345	6 384	2 187	50 848
Agricultural sciences	171 069	48 316	31 529	26 539	19 236	23 206	13 184	1 942	7 117
Medical and health sciences	591 188	189 060	159 962	82 992	68 656	52 164	6 334	743	31 277
Total natural sciences, technologies and engineering	*1 897 785*	*570 971*	*402 769*	*299 711*	*188 924*	*173 622*	*43 858*	*8 419*	*209 512*
Social sciences and humanities									
Social sciences	505 418	171 641	108 256	71 011	37 787	39 486	10 929	5 269	61 038
Humanities	197 002	66 156	46 102	24 420	14 080	12 439	4 629	923	28 253
Total social sciences and humanities	*702 419*	*237 797*	*154 358*	*95 432*	*51 867*	*51 925*	*15 558*	*6 192*	*89 291*
TOTAL	**2 600 204**	**808 768**	**557 127**	**395 142**	**240 791**	**225 547**	**59 417**	**14 611**	**298 803**

(a) Includes Australian Catholic University.

(b) Includes Australian Defence Force Academy.

9 HUMAN RESOURCES DEVOTED TO R&D, by Socio-economic Objective, by Type of Employee

Socio-economic objective	Total	RESEARCHERS		Supporting staff
		Academics	*Postgraduates*	
	person years	person years	person years	person years
Defence	91	25	44	23
Economic development				
Plant - production and primary products	1 419	322	759	338
Animal - production and primary products	1 017	256	513	247
Mineral resources (excl. energy)	444	139	213	92
Energy resources	315	108	167	41
Energy supply	338	98	164	76
Manufacturing	1 861	463	1 015	384
Construction	697	170	417	111
Transport	269	72	146	51
Information and communication services	1 110	290	601	219
Commercial services	454	136	261	57
Economic framework	2 172	659	1 224	288
Total economic development	*10 094*	*2 713*	*5 478*	*1 903*
Society				
Health	7 338	2 274	3 558	1 507
Education and training	2 623	625	1 769	229
Social development and community services	1 846	499	1 102	244
Total society	*11 806*	*3 398*	*6 429*	*1 979*
Environment				
Environmental knowledge	2 129	508	1 209	411
Environmental aspects of economic development	629	171	372	87
Environmental management and other aspects	588	144	334	110
Total environment	*3 346*	*823*	*1 916*	*608*
Advancement of knowledge				
Natural sciences, technologies and engineering	11 776	3 173	6 311	2 292
Social sciences and humanities	8 426	1 877	5 961	588
Total advancement of knowledge	*20 202*	*5 050*	*12 271*	*2 880*
TOTAL	**45 540**	**12 009**	**26 137**	**7 394**

10 HUMAN RESOURCES DEVOTED TO R&D, by Field of Research, by 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	994	370	534	90
Physical sciences	1 350	398	587	366
Chemical sciences	1 891	519	1 023	348
Earth sciences	1 894	490	1 029	376
Information, computers and communication technologies	2 339	616	1 299	423
Applied sciences and technologies	1 715	406	1 025	285
General engineering	2 813	676	1 591	546
Biological sciences	4 887	1 242	2 531	1 114
Agricultural sciences	2 667	624	1 470	573
Medical and health sciences	8 466	2 615	4 075	1 776
Total natural sciences, technologies and engineering	*29 015*	*7 957*	*15 162*	*5 896*
Social sciences and humanities				
Social sciences	10 958	2 899	6 905	1 153
Humanities	5 567	1 152	4 070	345
Total social sciences and humanities	*16 524*	*4 051*	*10 975*	*1 498*
TOTAL	**45 540**	**12 009**	**26 137**	**7 394**

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 1998.

2 For details of R&D statistics available for the Business enterprise and General government and Private non-profit sectors see paragraph 23.

DATA SOURCES

3 The 1998 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 1998.

4 The GDP 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 1999* (Cat. no. 5206.0)) and, at current prices, are as follows: $397,057m (1990-91); $427,281m (1992–93); $474,546m (1994–95); $508,113m (1995-96); $533,632m (1996-97); and $593,727m (1998–99). 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, 1999–2*, OECD, Paris, 1999.

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 1998 statistics presented in this publication may not be strictly comparable with those for previous years due to changes in collection methodology. The 1994, 1995, 1996 and 1998 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 1998 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.

CHAIN VOLUME MEASURES

15 Constant price estimates have been replaced with chain volume estimates from this issue.

16 Chain volume measures have been introduced because they provide a better measure of growth in volume than existing constant price estimates. To understand this it is necessary to briefly explain how constant price estimates are derived.

17 While current price estimates of research and development expenditure reflect both price and volume changes, constant price estimates eliminate the direct effect of price changes and therefore only reflect volume changes. Although expressed in monetary terms, the constant price measures 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. Because the measures relate to input quantities, they do not reflect changes in the efficiency with which labour, capital and other inputs are used.

18 Changes in price relativities adversely affect the usefulness of constant price estimates, particularly for periods distant from the base year, and consequently the base year used to derive constant price estimates needs to be changed from time to time. It has been ABS practice to change the base year every five years, but it has been found that better estimates of growth in volume can be obtained by rebasing every year and linking the resulting indexes to form annually reweighted chain volume measures.

19 The impact of the change from constant price estimates to chain volume measures largely depends on the extent of differences in growth rates between the prices and volumes of the components of particular series. In the case of research and development expenditure, the introduction of chain volume measures has had little effect on growth rates over time.

20 The chain volume measures appearing in this publication are annually reweighted chain Laspeyres indexes referenced to the current price values in a chosen reference year (currently 1998). They can be thought of as current price values re-expressed in (i.e. based on) the prices of the previous year and linked together to form continuous time series. They are formed in a multi-stage process of which the major steps are described in Section 15 of the information paper, *Introduction of Chain Volume Measures in the Australian National Accounts* (Cat. no. 5248.0).

RELIABILITY OF STATISTICS

21 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

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

RELATED PUBLICATIONS

23 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 1999-2, OECD, Paris, 1999
Research and Experimental Development, All Sector Summary, Australia, 1996-97 (Cat. no. 8112.0)
Research and Experimental Development, Business Enterprises, Australia, 1997-98 (Cat. no. 8104.0).
Research and Experimental Development, General Government and Private Non-profit Organisations, Australia, 1996-97 (Cat. no. 8109.0)
The Measurement of Scientific and Technological Activities ('Frascati Manual' 1993) OECD, Paris, 1994

24 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.

25 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.
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.
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.
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.
Type of R&D activity	Comprises basic research, applied research and experimental development.

FOR MORE INFORMATION...

INTERNET	**www.abs.gov.au** the ABS web site is the best place to start for access to summary data from our latest publications, information about the ABS, advice about upcoming releases, our catalogue, and Australia Now—a statistical profile.
LIBRARY	A range of ABS publications is available from public and tertiary libraries Australia-wide. Contact your nearest library to determine whether it has the ABS statistics you require, or visit our web site for a list of libraries.
CPI INFOLINE	For current and historical Consumer Price Index data, call 1902 981 074 (call cost 75c per minute).
DIAL-A-STATISTIC	For the latest figures for National Accounts, Balance of Payments, Labour Force, Average Weekly Earnings, Estimated Resident Population and the Consumer Price Index call 1900 986 400 (call cost 75c per minute).

INFORMATION SERVICE

Data which have been published and can be provided within five minutes are free of charge. Our information consultants can also help you to access the full range of ABS information—ABS user pays services can be tailored to your needs, time frame and budget. Publications may be purchased. Specialists are on hand to help you with analytical or methodological advice.

PHONE	**1300 135 070**
EMAIL	**client.services@abs.gov.au**
FAX	1300 135 211
POST	Client Services, ABS, GPO Box 796, Sydney 1041

WHY NOT SUBSCRIBE?

ABS subscription services provide regular, convenient and prompt deliveries of ABS publications and products as they are released. Email delivery of monthly and quarterly publications is available.

PHONE	1300 366 323
EMAIL	subscriptions@abs.gov.au
FAX	03 9615 7848
POST	Subscription Services, ABS, GPO Box 2796Y, Melbourne 3001

2811100001983
ISSN 0729-171X

RRP $17.00

Produced by the Australian Bureau of Statistics