



1994

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Research and Experimental Development

Higher Education Organisations

Australia

Statistics ■

NOTES

R&D GUIDELINES

ABS surveys of research and development (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 human resources devoted to R&D should be restricted to the effort of researchers, technicians and other staff directly involved with R&D activity, whereas the expenditure on R&D should include both direct expenditure and an estimate for indirect (overhead) expenditure in support of R&D.

COMPARABILITY

The 1994 statistics presented in this publication may not be strictly comparable with those for previous years due to changes in collection methodology. See paragraph 11 of the Explanatory notes.

SYMBOLS AND OTHER USAGES

FOR	Field of research
HERD	higher education expenditure on R&D
SEO	Socio-economic objective
—	nil or rounded to zero

INQUIRIES

For further information about statistics in this publication and the availability of related unpublished statistics, contact Derek Byars on Canberra (06) 252 5627 or any Australian Bureau of Statistics (ABS) office.

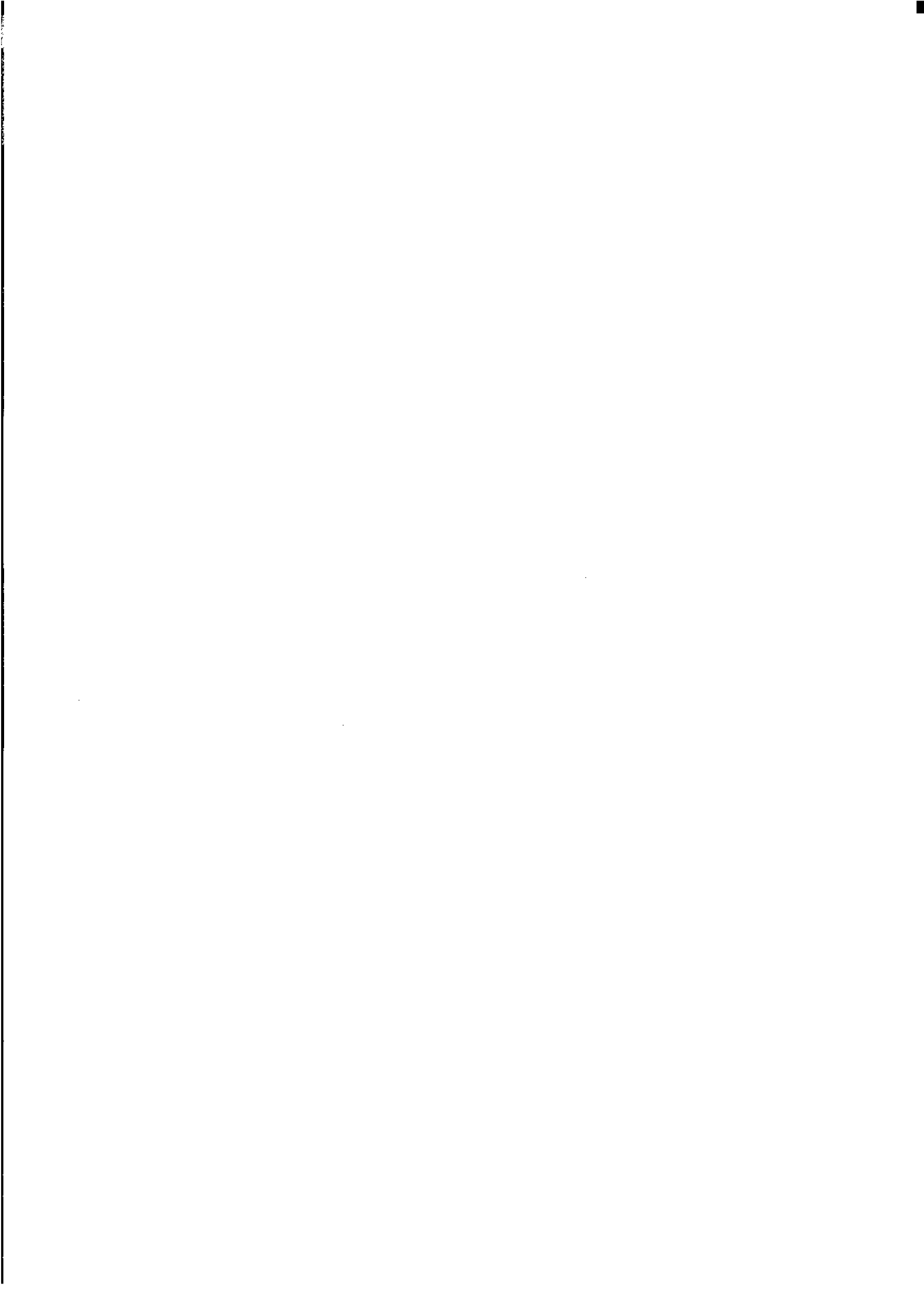
For further information about constant price estimates, contact Paul Curran on Canberra (06) 252 6801.

For information about other ABS statistics and services, please refer to the back of this publication.

Dennis Trewin
Acting Australian Statistician

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MAIN FEATURES

EXPENDITURE ON R&D

- Higher education expenditure on R&D (HERD) in Australia in 1994 was estimated to be \$1,830m at current prices. This represented an increase of 8% over the two years since 1992. At average 1989-90 prices, R&D expenditure was estimated to be \$1,652m, an increase of 3% compared with 1992.
- After remaining stable between 1986 and 1988, HERD as a percentage of Gross Domestic Product (GDP) increased significantly reaching 0.42% in 1992, before falling slightly to 0.40% in 1994.

HUMAN RESOURCES DEVOTED TO R&D

- Human resources devoted to R&D in Australia in 1994 by higher education organisations was estimated to be 40,096 person years. This represented an increase of 13% over 1992. This compared with an increase of 31% between 1990 and 1992.

PURPOSE OF RESEARCH

- Most R&D expenditure by higher education organisations was directed towards Advancement of knowledge (\$881m or 48%) and Society (\$448m or 25%).

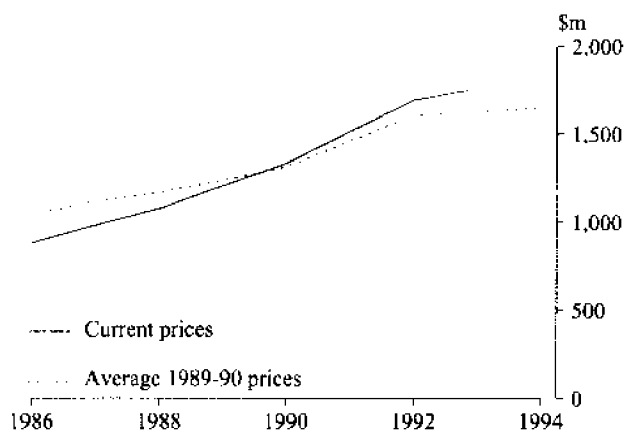
FIELD OF RESEARCH

- Medical and health sciences (\$376m or 21%), Biological sciences (\$215m or 12%), Humanities (\$145m or 8%) and General engineering (\$132m or 7%) were the main fields of research by higher education organisations.

R&D BY HIGHER EDUCATION ORGANISATIONS

EXPENDITURE ON R&D

HERD has steadily increased every year since 1986 in both current prices and average 1989-90 prices. The average annual rate of growth over that period has been 9.6% in current price terms and 5.9% in constant price terms.



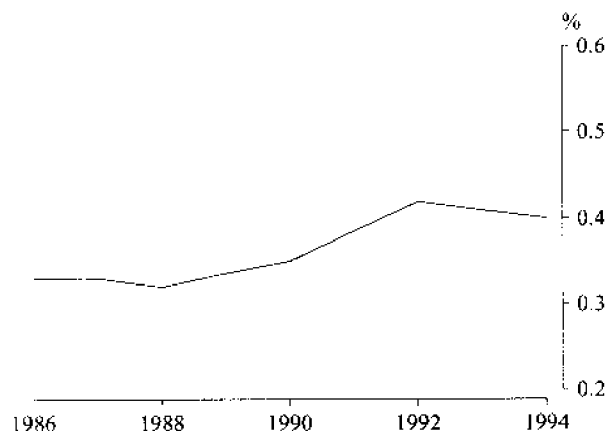
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EXPENDITURE ON R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA (\$m)

	1986	1987	1988	1990	1992	1994
AT CURRENT PRICES						
Higher education organisations	881.7	983.6	1,076.8	1,332.8	1,695.2	1,829.6
AT AVERAGE 1989-90 PRICES						
Higher education organisations	1,044.5	1,121.8	1,166.1	1,312.5	1,608.6	1,651.5

HERD AS A PERCENTAGE OF GDP

Following a significant increase between 1988 and 1992, HERD as a percentage of GDP stood at 0.40% in 1994.



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

2 HERD/GDP RATIOS OF OECD COUNTRIES

Country	1992	1994
Switzerland	0.67	0.66
Japan	0.56	0.59
Finland	0.48	0.44
Germany	0.43	0.44
Australia	0.42	0.40
Canada	0.40	0.39
United States	0.40	0.38
France	0.37	0.38
United Kingdom	0.36	0.38
Iceland	0.41	0.34
Spain	0.26	0.27
Ireland	0.24	0.27
Italy	0.27	0.25

HUMAN RESOURCES DEVOTED TO R&D

Human resources devoted to research by higher education organisations increased by 13% over 1992.

3 HUMAN RESOURCES DEVOTED TO R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA (person years)

	1986	1987	1988	1990	1992	1994
Higher education organisations	23,218	24,323	24,902	27,081	35,418	40,096

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 1994 with 48% of total expenditure, up from 41% in 1992.

The SEOs within the Society division accounted for 25% of R&D expenditure, down from 27% in 1992. The major subdivision within Society was Health with approximately 17% of R&D expenditure.

TYPE OF EXPENDITURE

Current expenditure accounted for 91% of higher education R&D expenditure, with capital expenditure accounting for the remaining 9%. The major component was direct labour costs which accounted for 50% of total expenditure.

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R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY SOCIO-ECONOMIC OBJECTIVE, BY TYPE OF EXPENDITURE AND TYPE OF ACTIVITY, 1994 (\$'000)

Socio-economic objective	Type of expenditure					Type of activity(a)				
	Land and Total buildings	Other capital expend- iture	Direct labour costs(b)	Scholar ships(c)	Other current expend- iture	Pure basic research	Strategic basic research	Applied research	Experi- mental develop- ment	
Defence	4,836	114	797	2,096	285	1,544	564	1,673	1,758	841
<i>Economic development</i>										
Plant --- production and primary products	52,988	5,185	3,500	22,089	2,253	19,962	7,747	21,246	21,709	2,285
Animal --- production and primary products	40,183	4,566	1,721	15,984	2,098	15,813	2,385	13,300	19,272	5,226
Mineral resources (excl. energy)	25,676	1,091	2,323	8,846	1,529	11,887	2,955	8,001	13,553	1,168
Energy resources	11,814	742	1,050	4,080	877	5,065	1,210	2,798	5,782	2,024
Energy supply	17,698	439	2,292	7,326	847	6,794	1,475	6,137	7,196	2,891
Manufacturing	75,442	2,534	9,080	32,935	3,728	27,165	9,908	19,602	34,602	11,330
Construction	27,652	536	2,350	13,583	1,348	9,836	4,643	7,367	13,485	2,158
Transport	4,831	71	410	2,205	262	1,882	340	576	3,359	556
Information and communication services	36,541	404	3,327	18,433	911	13,465	5,367	6,409	13,126	11,638
Commercial services	8,185	369	340	4,518	283	2,675	1,372	1,450	4,906	457
Economic framework	73,013	1,534	2,419	39,921	1,440	27,699	11,966	17,032	42,085	1,930
Total Economic development	374,022	17,471	28,812	169,919	15,577	142,242	49,369	103,916	179,074	41,663
<i>Society</i>										
Health	305,748	3,566	14,343	159,630	9,781	118,427	46,219	98,929	138,535	22,064
Education and training	89,771	2,512	2,851	49,882	1,463	33,063	14,171	18,072	48,106	9,423
Social development and community services	52,976	504	2,052	29,727	1,329	19,365	13,529	10,090	24,244	5,113
Total Society	448,496	6,582	19,247	239,238	12,574	170,855	73,919	127,091	210,886	36,601
<i>Environment</i>										
Environmental knowledge	81,303	1,419	5,954	38,819	2,843	32,268	18,798	32,139	25,556	4,809
Environmental aspects of economic development	20,894	950	1,137	10,005	842	7,960	4,686	4,578	9,840	1,790
Environmental management and other aspects	18,903	523	1,845	8,024	947	7,564	2,679	5,235	10,021	968
Total environment	121,099	2,892	8,936	56,847	4,632	47,792	26,164	41,952	45,417	7,566
<i>Advancement of knowledge</i>										
Natural sciences, technologies and engineering	616,401	15,500	51,007	296,843	26,146	226,904	315,686	156,246	121,559	22,909
Social sciences and humanities	264,727	5,374	8,237	148,257	7,940	94,919	186,545	30,269	44,139	3,774
Total advancement of knowledge	881,128	20,874	59,245	445,100	34,087	321,822	502,231	186,515	165,699	26,683
TOTAL	1,829,580	47,933	117,037	913,201	67,154	684,255	652,246	461,147	602,832	113,354

(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 6 of the Explanatory Notes. (b) 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 pay, long service leave payments, sick pay, employer contributions to superannuation and pension schemes. (c) For research higher degrees.

FIELD OF RESEARCH (FOR)

The FORs in which most higher education R&D expenditure occurred in 1994 were: Medical and health sciences (\$376m); Biological sciences (\$215m); Humanities (\$145m); and General engineering (\$132m).

These fields of research were also the main four fields in 1992.

TYPE OF ACTIVITY

Approximately 36% of the higher education R&D expenditure was directed towards Pure basic research, down from 40% in 1992. Strategic basic research increased to 25% in 1994 from 24% in 1992. Applied research increased from 30% in 1992 to 33% in 1994. Experimental development remained steady on approximately 6%.

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R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY FIELD OF RESEARCH, BY TYPE OF EXPENDITURE AND TYPE OF ACTIVITY, 1994 (\$'000)

Field of research	Type of expenditure					Type of activity(a)				
	Land and Total buildings	Other capital expend- iture	Direct labour costs(b)	Scholar- ships(c)	Other current expend- iture	Pure basic research	Strategic basic research	Applied research	Experi- mental develop- ment	
<i>Natural sciences, technologies and engineering</i>										
Mathematical sciences	46,337	479	2,750	25,145	1,514	16,450	27,984	6,695	8,340	3,318
Physical sciences	87,463	1,243	9,594	41,792	2,591	32,243	56,445	14,048	12,590	4,379
Chemical sciences	97,819	3,685	9,289	43,368	5,076	36,401	49,490	25,708	19,102	3,520
Earth sciences	87,767	1,726	7,386	37,762	3,788	37,105	35,263	27,668	21,331	3,506
Information, computers and communication technologies	92,354	3,433	10,570	43,927	3,294	31,130	23,006	22,264	31,057	16,027
Applied sciences and technologies	67,910	2,362	8,987	28,091	3,969	24,502	10,803	21,169	28,849	7,088
General Engineering	132,258	5,435	13,708	55,716	8,195	49,203	21,331	34,819	59,994	16,114
Biological sciences	214,886	4,891	13,725	102,798	8,530	84,941	90,377	71,279	47,164	6,066
Agricultural sciences	109,837	10,247	5,893	45,241	5,521	42,935	17,989	34,734	48,747	8,367
Medical and health sciences	375,890	4,045	18,020	201,565	11,400	140,861	85,153	118,088	150,090	22,559
Total natural sciences, technologies and engineering	1,312,521	37,546	99,921	625,405	53,878	495,770	417,841	376,473	427,263	90,944
<i>Social sciences and humanities</i>										
Accounting and finance	22,746	352	705	13,631	102	7,956	6,028	3,551	12,715	452
Economics	53,741	1,081	1,443	28,611	1,317	21,290	16,473	8,148	28,246	874
Political sciences	28,462	388	914	14,612	907	11,642	13,686	7,546	6,673	558
Sociology	19,351	307	696	11,126	665	6,557	10,039	3,838	4,923	551
Law	28,210	164	749	16,568	167	10,563	14,280	5,688	7,682	560
Psychology	37,933	529	1,452	22,496	970	12,487	14,914	10,251	11,074	1,694
Education	76,384	2,250	2,376	43,150	1,493	27,114	16,201	15,551	38,892	5,740
Other social sciences	105,561	2,232	3,969	56,507	3,235	39,618	34,918	21,468	45,413	3,763
Humanities	144,670	3,085	4,812	81,095	4,420	51,258	107,867	8,634	19,951	8,218
Total social sciences and humanities	517,060	10,387	17,116	287,796	13,276	188,484	234,406	84,674	175,569	22,410
TOTAL	1,829,580	47,933	117,037	913,201	67,154	684,255	652,246	461,147	602,832	113,354

(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 6 of the Explanatory Notes. (b) 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 pay, long service leave payments, sick pay, employer contributions to superannuation and pension schemes. (c) For research higher degrees.

SOURCE OF FUNDS FOR R&D

General university funds were the source of funding for 64% (\$1,166m) of higher education R&D expenditure in 1994. National Competitive Research Grants provided 19% (\$343m), of which \$330m came from Commonwealth Schemes. Other funding from the Commonwealth Government provided a further 8% (\$138m). State and local government provided 2% (\$42m) while Business enterprises provided 3% (\$64m).

SOCIO-ECONOMIC OBJECTIVES

Approximately 52% of funding from General university funds was spent on Advancement of knowledge, 23% on Society and 19% on Economic development. There was a similar pattern to spending from National Competitive Research Grants, with 50% spent on Advancement of knowledge, 22% on Society and 22% on Economic development.

Other funding from the Commonwealth Government was spent mainly on Society, 34%, Advancement of knowledge, 31%, and Economic development, 24%.

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SOURCE OF FUNDS FOR R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY SOCIO-ECONOMIC OBJECTIVE, 1994 (\$'000)

Socio-economic objective	Source of funds								
	Total	National Competitive Research Grants			Other Commonwealth Gov't	Business enterprise	General university funds (GUF)	Other Australian	Overseas
		Commonwealth schemes	Non Commonwealth schemes	State and local Gov't					
Defence	4,836	780	47	9	1,252	104	2,475	26	142
<i>Economic development</i>									
Plant — production and primary products	52,988	14,993	397	1,548	7,011	1,539	26,590	712	199
Animal — production and primary products	40,183	11,672	267	1,144	1,836	1,170	22,412	887	794
Mineral resources (excl. energy)	25,676	4,457	1	588	4,099	4,042	11,648	774	67
Energy resources	11,814	2,761	557	663	134	1,985	5,535	172	5
Energy supply	17,698	3,407	408	798	1,642	915	10,131	192	204
Manufacturing	75,442	15,209	414	1,396	8,054	6,596	41,466	1,702	606
Construction	27,652	4,685	65	580	1,029	1,237	19,092	918	45
Transport	4,831	788	7	381	457	250	2,904	37	7
Information and communication services	36,541	4,036	344	1,136	2,569	1,946	24,264	314	1,930
Commercial services	8,185	512	52	141	181	183	6,927	167	22
Economic framework	73,013	9,748	362	779	6,097	2,141	51,645	1,610	632
Total Economic development	374,022	72,269	2,875	9,154	33,109	22,005	222,615	7,484	4,511
<i>Society</i>									
Health	305,748	58,152	3,421	15,393	35,446	11,128	156,699	20,748	4,760
Education and training	89,771	7,808	464	1,910	7,425	1,365	68,834	1,762	204
Social development and community services	52,976	4,069	199	1,675	4,212	827	40,016	1,011	967
Total Society	448,496	70,028	4,085	18,978	47,082	13,321	265,549	23,520	5,932
<i>Environment</i>									
Environmental knowledge	81,303	14,285	546	2,723	11,367	1,990	46,916	3,026	449
Environmental aspects of economic development	20,894	3,299	327	831	827	845	14,007	710	47
Environmental management and other aspects	18,903	2,490	54	1,280	2,033	1,394	9,919	838	894
Total environment	121,099	20,075	927	4,834	14,227	4,229	70,842	4,575	1,391
<i>Advancement of knowledge</i>									
Natural sciences, technologies and engineering	616,401	142,355	4,530	7,060	30,485	22,106	386,156	19,163	4,547
Social sciences and humanities	264,727	24,307	411	2,170	11,961	2,176	218,145	3,580	1,977
Total advancement of knowledge	881,128	166,663	4,941	9,229	42,446	24,282	604,301	22,743	6,524
TOTAL	1,829,580	329,814	12,876	42,204	138,116	63,940	1,165,783	58,348	18,500

FIELDS OF RESEARCH

Medical and health sciences was the predominant FOR in which funds were spent for all of the sources of funds. General university funds were mainly directed towards Medical and health sciences (17%), Biological sciences (11%) and Humanities (10%), while National Competitive Research Grants were mainly directed towards Medical and health sciences (27%), Biological sciences (15%) and Agricultural sciences (9%).

7 SOURCE OF FUNDS FOR R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY FIELD OF RESEARCH, 1994 (\$'000)

Field of research	Source of funds								
	National Competitive Research Grants					General university funds (GUF)			
	Total	Common-wealth schemes	Non Common-wealth schemes	State and local Gov't	Other Common-wealth Gov't	Business enterprise	Australian	Other	Overseas
<i>Natural sciences, technologies and engineering</i>									
Mathematical sciences	46,337	8,051	51	166	2,295	358	34,161	1,082	174
Physical sciences	87,463	19,529	93	149	3,133	1,654	61,312	1,041	551
Chemical sciences	97,819	18,392	394	2,087	4,403	8,087	62,862	1,265	330
Earth sciences	87,767	15,008	310	2,255	11,004	3,612	52,276	2,395	909
Information, computers and communication technologies	92,354	13,935	732	1,541	8,805	3,652	60,312	1,158	2,217
Applied sciences and technologies	67,910	16,003	202	601	8,085	4,882	37,015	879	243
General Engineering	132,258	23,219	1,538	3,702	11,082	10,652	73,371	7,122	1,571
Biological sciences	214,886	49,504	2,378	3,899	22,043	6,381	123,427	5,076	2,177
Agricultural sciences	109,837	31,563	380	3,839	7,453	3,770	59,012	2,759	1,060
Medical and health sciences	375,890	86,540	5,376	16,898	27,991	14,097	192,789	26,827	5,371
Total natural sciences, technologies and engineering	1,312,521	281,745	11,455	35,137	106,295	57,145	756,537	49,603	14,604
<i>Social sciences and humanities</i>									
Accounting and finance	22,746	1,098	6	57	480	179	20,475	323	129
Economics	53,741	5,450	389	786	5,261	1,241	38,667	1,402	545
Political sciences	28,462	1,948	—	353	2,560	218	22,534	631	218
Sociology	19,351	1,795	11	755	778	537	14,979	296	200
Law	28,210	909	35	671	1,715	176	23,827	724	153
Psychology	37,933	7,218	49	708	943	343	27,895	719	57
Education	76,384	4,582	446	1,527	4,844	744	62,686	1,421	133
Other social sciences	105,561	10,242	217	1,623	7,020	2,294	80,459	1,791	1,915
Humanities	144,670	14,827	267	587	8,220	1,062	117,724	1,438	545
Total social sciences and humanities	517,060	48,069	1,421	7,067	31,821	6,795	409,246	8,745	3,896
TOTAL	1,829,580	329,814	12,876	42,204	138,116	63,940	1,165,783	58,348	18,500

STATE COMPARISONS

The leading States in terms of location of higher education R&D expenditure in 1994 were New South Wales at \$511m and Victoria at \$393m, accounting for 28% and 21% of total expenditure respectively. Next in order were Queensland (16%), the Australian Capital Territory (15%), Western Australia (9%), South Australia (7%), Tasmania (3%) and the Northern Territory (0.5%). The ranking was the same as in 1992.

SOCIO-ECONOMIC OBJECTIVES

The main SEO division in all States and Territories was Advancement of knowledge. Society was the second largest SEO division in all States other than South Australia and Western Australia. In Victoria the subdivision of Health accounted for 25% of total expenditure.

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LOCATION OF R&D EXPENDITURE BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY SOCIO-ECONOMIC OBJECTIVE, 1994 (\$'000)

Socio-economic objective	Location of expenditure								
	Total	NSW(a)	Vic.	Qld	SA	WA	Tas.	NT	ACT(b)
Defence	4,836	102	1,508	858	715	26	—	—	1,627
<i>Economic development</i>									
Plant — production and primary products	52,988	4,139	6,624	13,698	7,141	11,890	2,476	—	7,021
Animal — production and primary products	40,183	6,028	15,012	7,835	1,384	8,823	760	12	330
Mineral resources (excl. energy)	25,676	3,725	3,743	6,563	1,641	8,250	790	—	964
Energy resources	11,814	3,775	255	4,492	1,006	2,208	—	—	77
Energy supply	17,698	9,889	2,114	1,502	1,327	1,418	240	—	1,208
Manufacturing	75,442	26,572	20,568	10,191	6,118	5,678	912	—	5,404
Construction	27,652	11,204	6,203	3,945	1,388	3,286	838	—	788
Transport	4,831	339	1,175	1,448	1,183	175	—	—	510
Information and communication services	36,541	12,316	6,900	7,945	3,157	1,114	237	—	4,872
Commercial services	8,185	3,344	2,263	1,231	361	776	—	44	166
Economic framework	73,013	26,370	13,973	10,867	4,133	5,738	1,565	168	10,200
Total Economic development	374,022	107,699	78,831	69,716	28,839	49,355	7,818	223	31,541
<i>Society</i>									
Health	305,748	76,592	99,474	45,951	14,276	25,690	4,695	71	39,000
Education and training	89,771	25,150	22,527	22,092	6,090	6,745	4,561	1,506	1,100
Social development and community services	52,976	14,608	10,778	10,693	3,748	3,329	2,457	748	6,615
Total Society	448,496	116,351	132,779	78,736	24,113	35,764	11,713	2,325	46,715
<i>Environment</i>									
Environmental knowledge	81,303	15,212	14,845	15,546	6,669	7,331	7,620	286	13,793
Environmental aspects of economic development	20,894	5,668	2,242	3,506	3,803	2,619	171	48	2,837
Environmental management and other aspects	18,903	4,848	4,146	4,521	1,142	1,417	412	102	2,315
Total environment	121,099	25,728	21,234	23,573	11,614	11,367	8,203	436	18,944
<i>Advancement of knowledge</i>									
Natural sciences, technologies and engineering	616,401	186,355	110,181	89,341	52,250	49,982	16,601	3,230	108,460
Social sciences and humanities	264,727	75,092	48,700	38,326	12,435	21,253	4,863	2,504	61,555
Total advancement of knowledge	881,128	261,447	158,881	127,667	64,685	71,235	21,464	5,734	170,015
TOTAL	1,829,580	511,326	393,234	300,551	129,965	167,746	49,198	8,718	268,841

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

FIELDS OF RESEARCH

In New South Wales, Victoria, Queensland and South Australia the predominant FORs were Medical and health sciences (23%, 27%, 18% and 26% respectively) and Biological sciences (9%, 10%, 15% and 11% respectively). In Western Australia the predominant FORs were Medical and health sciences (20%) and Agricultural sciences (13%), while in the Australian Capital Territory the predominant FORs were Biological sciences (17%) and Physical sciences (13%).

9

LOCATION OF R&D EXPENDITURE BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY FIELD OF RESEARCH, 1994 (\$'000)

Field of research	Location of expenditure								
	Total	NSW(a)	Vic.	Qld	SA	WA	Tas.	NT	ACT(b)
<i>Natural sciences, technologies and engineering</i>									
Mathematical sciences	46,337	18,161	9,413	4,990	3,677	2,422	616	—	7,058
Physical sciences	87,463	20,532	14,390	6,607	4,152	4,164	1,386	288	35,943
Chemical sciences	97,819	20,199	23,203	17,535	8,280	5,759	2,513	402	19,929
Earth sciences	87,767	21,505	9,618	9,182	6,180	9,921	9,298	66	21,997
Information, computers and communication technologies	92,354	20,307	20,089	21,389	6,488	9,482	1,991	184	12,425
Applied sciences and technologies	67,910	24,033	17,771	8,748	4,133	6,617	67	30	6,509
General Engineering	132,258	44,959	28,263	25,937	8,315	17,168	1,848	342	5,426
Biological sciences	214,886	45,457	39,892	45,244	13,731	17,664	4,849	1,654	46,394
Agricultural sciences	109,837	26,449	20,696	20,826	11,890	21,219	5,161	543	3,053
Medical and health sciences	375,890	116,737	105,481	54,277	33,640	33,974	7,045	128	24,608
Total natural sciences, technologies and engineering	1,312,521	358,339	288,816	214,735	100,486	128,391	34,773	3,636	183,344
<i>Social sciences and humanities</i>									
Accounting and finance	22,746	11,230	4,043	3,333	419	2,287	612	—	823
Economics	53,741	14,201	10,745	5,476	2,144	4,385	1,018	44	15,728
Political sciences	28,462	4,556	3,767	1,878	1,054	2,221	844	88	14,054
Sociology	19,351	5,629	6,672	2,492	921	393	652	177	2,415
Law	28,210	8,185	4,652	4,146	3,068	2,554	735	599	4,272
Psychology	37,933	11,887	9,170	8,571	2,270	3,933	890	120	1,092
Education	76,384	24,909	16,726	20,217	4,200	6,138	1,663	1,329	1,201
Other social sciences	105,561	30,926	16,666	19,817	7,559	7,168	3,058	1,195	19,173
Humanities	144,670	41,464	31,976	19,886	7,845	10,277	4,953	1,529	26,739
Total social sciences and humanities	517,060	152,987	104,418	85,816	29,479	39,355	14,425	5,082	85,497
TOTAL	1,829,580	511,326	393,234	300,551	129,965	167,746	49,198	8,718	268,841

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

TYPE OF R&D STAFF

The percentage distribution by type of employee in 1994 changed slightly when compared to 1992. Researchers increased as a percentage of total employees at the expense of Supporting staff. The increase in Researchers was 16% compared with 4% for Supporting staff.

There was also a change in the composition of the research effort by Researchers. Academics accounted for 32% of effort by Researchers, a fall of 4%, while Post graduates increased to 68% of Researchers' effort.

SOCIO-ECONOMIC OBJECTIVE

The Socio-economic objective of Advancement of knowledge accounted for 50% of total research effort (person years) in the Higher education sector in 1994. The subdivision of Health accounted for a further 14%.

10

HUMAN RESOURCES DEVOTED TO R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY SOCIO-ECONOMIC OBJECTIVE, 1994 (person years)

Socio-economic objective	Type of employee			
	Total	Researchers		Supporting staff
		Academics	Postgraduates	
Defence	115	20	75	20
<i>Economic development</i>				
Plant — production and primary products	893	187	452	254
Animal — production and primary products	805	183	419	202
Mineral resources (excl. energy)	418	107	231	80
Energy resources	218	57	130	32
Energy supply	394	74	233	87
Manufacturing	1,659	350	970	338
Construction	685	151	431	103
Transport	102	25	53	24
Information and communication services	882	232	456	194
Commercial services	154	60	71	23
Economic framework	1,539	574	749	216
Total Economic development	7,749	2,001	4,196	1,553
<i>Society</i>				
Health	5,680	1,674	2,371	1,635
Education and training	2,458	674	1,493	291
Social development and community services	1,366	412	781	173
Total Society	9,505	2,760	4,646	2,099
<i>Environment</i>				
Environmental knowledge	1,966	409	1,201	356
Environmental aspects of economic development	423	103	226	94
Environmental management and other aspects	408	96	240	72
Total environment	2,797	609	1,667	521
<i>Advancement of knowledge</i>				
Natural sciences, technologies and engineering	12,206	2,934	6,389	2,883
Social sciences and humanities	7,724	1,906	5,070	748
Total advancement of knowledge	19,930	4,840	11,459	3,631
TOTAL	40,096	10,230	22,042	7,824

FIELDS OF RESEARCH

The major FORs in terms of research effort (person years) in the Higher education sector in 1994 were Medical and health sciences (18%), Humanities (11%) and Biological sciences (11%).

11

HUMAN RESOURCES DEVOTED TO R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, BY FIELD OF RESEARCH, 1994 (person years)

Field of research	Type of employee			
	Total	Researchers		Supporting staff
		Academics	Postgraduates	
<i>Natural sciences, technologies and engineering</i>				
Mathematical sciences	1,044	404	528	111
Physical sciences	1,400	398	610	391
Chemical sciences	1,784	436	960	388
Earth sciences	1,728	395	1,010	323
Information, computers and communication technologies	2,152	515	1,223	414
Applied sciences and technologies	1,394	296	789	309
General Engineering	2,823	527	1,720	575
Biological sciences	4,432	999	2,318	1,115
Agricultural sciences	2,239	412	1,237	589
Medical and health sciences	7,103	2,025	2,965	2,114
Total natural sciences, technologies and engineering	26,098	6,409	13,361	6,328
<i>Social sciences and humanities</i>				
Accounting and finance	419	211	158	49
Economics	1,065	381	497	187
Political sciences	746	171	486	90
Sociology	586	153	375	58
Law	507	209	238	60
Psychology	974	234	590	150
Education	2,300	578	1,493	229
Other social sciences	2,876	758	1,797	321
Humanities	4,525	1,126	3,047	352
Total social sciences and humanities	13,998	3,822	8,681	1,495
TOTAL	40,096	10,230	22,042	7,824

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 1994.
- 2 Comparable R&D statistics are produced for the Business enterprise and General government and Private non-profit sectors (see paragraph 20).

DATA SOURCES

- 3 The 1994 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 1994.
- 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, June Quarter 1996*, (5206.0)), and, at current prices, are as follows: \$264,007m (1986–87); \$298,395m (1987–88); \$339,068m (1988–89); \$378,964m (1990–91); \$405,764m (1992–93); and \$455,616m (1994–95). 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, 1996–1*, OECD, Paris, 1996.

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. 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* (1297.0).

COMPARABILITY WITH
PREVIOUS STATISTICS

11 The 1994 statistics presented in this publication may not be strictly comparable with those for previous years due to changes in collection methodology. The 1994 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 1994 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 The estimate of the labour costs component was obtained by multiplying each broad category of labour used in each period by the relevant average labour costs in the base year (1989–90). The non-labour costs components were estimated by deflating each by a composite price index of relevant materials or capital expenditure items. In revaluing R&D non-labour expenditure, extensive use has been made of price series used in deriving constant price national accounts estimates.

17 For a more comprehensive description of constant price concepts and estimation procedures see *Australian National Accounts: Concepts, Sources and Methods* (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 (1297.0)

Research and Experimental Development, All Sector Summary, Australia, 1994–95 (8112.0) (to be released later this year)

Research and Experimental Development, Business Enterprises, Australia, 1994–95 (8104.0)

Research and Experimental Development, General Government and Private Non-profit Organisations, Australia, 1994–95 (8109.0)

Main Science and Technology Indicators 1996–I, OECD, Paris, 1996

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, Australia* (1101.0). The ABS also issues, on Tuesdays and Fridays, a *Release Advice* (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 necessary 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.
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.

Socio-economic objective (SEO)	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.



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