



1994-95

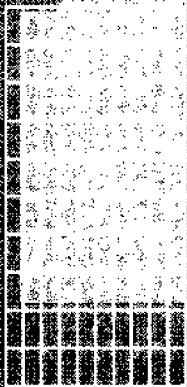
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Research and Experimental Development

All-Sector Summary

Australia

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statistica



NOTES

R&D GUIDELINES

Australian Bureau of Statistics (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 for Higher education may not be strictly comparable with those for previous years due to changes in collection methodology. See paragraph 13 of the Explanatory notes.

SYMBOLS AND OTHER USAGES

FOR	Field of research
GERD	Gross Australian expenditure on R&D
n.p.	not available for separate publication (but included where applicable)
r	revised since previous issue
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For further information about statistics in this publication and the availability of related unpublished statistics, contact Derek Byars on Canberra (06) 252 5627 or any ABS office.

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

W. McLennan
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MAIN FEATURES

EXPENDITURE ON R&D

- Gross expenditure on R&D (GERD) carried out by organisations in Australia during 1994-95 was estimated to be \$7,321m at current prices. This represented an increase of 13% over the two years since 1992-93. At average 1989-90 prices, R&D expenditure was estimated to be \$6,429m, an increase of 9% since 1992-93.
- GERD represented 1.61% of Gross Domestic Product (GDP), up slightly from 1.59% in 1992-93.

HUMAN RESOURCES DEVOTED TO R&D

- Human resources devoted to R&D in Australia was estimated to be 86,162 person years. This represented an increase of 8% over 1992-93.

PURPOSE OF RESEARCH

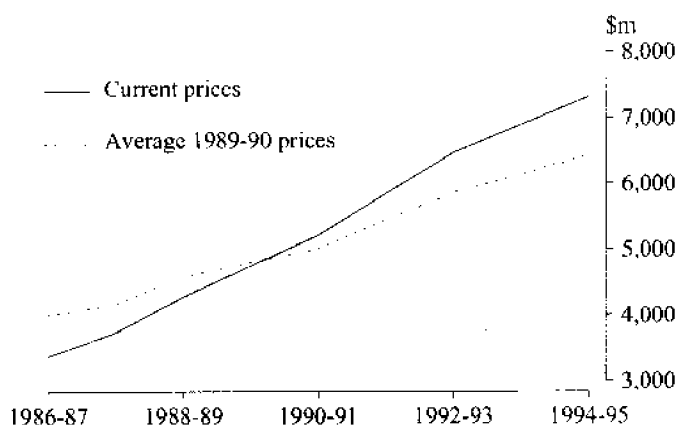
- The majority of expenditure on R&D was directed towards Economic development (\$4,460m or 61%), down slightly from 62% in 1992-93. Expenditure on the Environment increased from 7% in 1992-93 to 8% (\$574m) in 1994-95.

INTRAMURAL R&D

R&D EXPENDITURE

GERD has steadily increased each year since 1986-87 in both current prices and average 1989-90 prices. The average annual rate of growth over that period was 10.2% in current price terms and 6.1% in constant price terms.

In 1994-95, 46% of GERD in current prices was expended in the Business enterprise sector, 27% in the General government sector, 25% in the Higher education sector and 2% in the Private non-profit sector. By comparison, in 1986-87, 38%, 34%, 26% and 1% of GERD was expended in these sectors respectively.



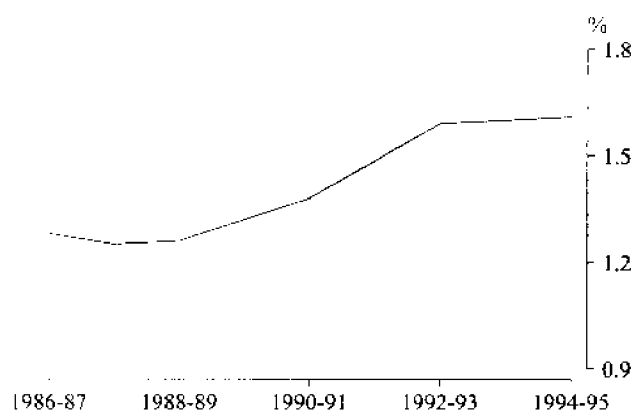
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GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT, AUSTRALIA (\$m)

Sector	1986-87	1987-88	1988-89	1990-91 r	1992-93 r	1994-95
AT CURRENT PRICES						
<i>Business Enterprises</i>						
Private Sector	1,165.1	1,388.2	1,649.1	1,896.1	2,609.8	3,051.3
Public Sector	123.5	117.6	149.2	203.6	244.8	331.8
<i>General Government</i>						
Commonwealth	786.5	797.0	869.6	1,034.0	1,151.1	1,178.4
State	368.4	394.6	482.7	670.0	667.6	786.3
<i>Higher Education</i>	881.7	983.6	1,076.8	1,332.8	1,695.2	1,829.6
<i>Private non-profit</i>	49.1	53.9	53.3	85.4	101.2	143.7
Total	3,374.3	3,734.9	4,280.7	5,221.9	6,469.7	7,321.1
AT AVERAGE 1989-90 PRICES						
<i>Business Enterprises</i>						
Private Sector	1,406.1	1,530.0	1,785.2	1,811.7	2,361.7	2,673.5
Public Sector	141.3	129.6	159.7	190.8	220.5	298.6
<i>General Government</i>						
Commonwealth	919.5	892.4	914.4	989.2	1,001.2	1,000.7
State	433.4	435.5	510.9	630.0	589.6	678.4
<i>Higher Education</i>	1,044.5	1,121.8	1,166.1	1,312.5	1,608.6	1,651.5
<i>Private non-profit</i>	59.6	62.0	57.5	81.2	89.6	126.2
Total	4,004.4	4,171.3	4,593.8	5,015.4	5,871.2	6,428.9

GERD AS A PERCENTAGE
OF GDP

GERD as a percentage of GDP has increased from 1.28% in 1986–87 to 1.61% in 1994–95. The average annual rate of growth over this period has been 2.9%, but has been much less over the last two years.



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

2 GERD/GDP RATIOS OF OECD COUNTRIES

Country	1992-93	1994-95
Japan	3.00	2.90
United States of America	2.78	2.54
France	2.42	2.38
Finland	2.18	2.35
Germany	2.48	2.33
United Kingdom	2.18	2.19
Australia	1.59	1.61
Canada	1.55	1.57
Austria	1.48	1.53
Iceland	1.33	1.40
Italy	1.31	1.19
Spain	0.91	0.93

**HUMAN RESOURCES
DEVOTED TO R&D**

Human resources devoted to R&D have increased steadily each year since 1986-87. The average annual rate of growth over that period was 4.6%.

Of the 86,162 person years devoted to R&D in 1994-95, Higher education organisations accounted for 40,096 (47%), Business enterprises 25,239 (29%), General government 19,134 (22%), and Private non-profit organisations 1,692 (2%). By comparison, in 1986-87, these sectors accounted for 39%, 29%, 31% and 2% of human resources respectively.

From 1992-93 to 1994-95, human resources devoted to R&D by Higher education organisations increased by 4,678 person years (13%), by Business enterprises by 2,355 person years (10%), and by Private non-profit organisations by 322 person years (24%). Over the same period, human resources devoted to R&D by General government organisations decreased by 665 person years (3%).

3

HUMAN RESOURCES DEVOTED TO R&D, AUSTRALIA (person years)

<i>Sector</i>	<i>1986-87</i>	<i>1987-88</i>	<i>1988-89</i>	<i>1990-91 r</i>	<i>1992-93 r</i>	<i>1994-95</i>
<i>Business Enterprises</i>						
Private Sector	16,198	16,952	19,206	19,158	20,665	23,116
Public Sector	1,393	1,527	1,597	1,867	2,219	2,123
<i>General Government</i>						
Commonwealth	11,529	11,491	10,863	10,670	11,020	10,562
State	6,796	7,133	8,335	8,990	8,779	8,572
<i>Higher Education</i>	23,218	24,323	24,902	27,081	35,418	40,096
<i>Private non-profit</i>	945	1,016	1,023	1,282	1,370	1,692
Total	60,079	62,442	65,926	69,048	79,470	86,162

TYPE OF EXPENDITURE

Current expenditure accounted for 88% of gross R&D expenditure, with capital expenditure accounting for the remaining 12%. The major component was labour costs which accounted for 45% of total expenditure.

Other current expenditure was the main component (46%) of expenditure by the Business enterprise sector, up 2% on 1992-93. Labour costs accounted for 42%, down from 43% in 1992-93.

Labour costs continued to be the main component of General government R&D expenditure (46%), down from 50% in 1992-93. Capital expenditure accounted for 14%, up from 11% in 1992-93.

Current expenditure accounted for 91%, up from 85% in 1992-93, of higher education R&D expenditure.

4 GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT, AUSTRALIA, SECTOR BY TYPE OF EXPENDITURE (\$'000)

Sector	Total	Land and buildings	Other capital expenditure	Labour costs(a)	Other current expenditure(b)
<i>1992-93 r</i>					
<i>Business Enterprises</i>					
Private Sector	2,609,759	33,550	328,156	1,080,136	1,167,917
Public Sector	244,771	2,823	22,747	140,069	79,132
<i>General Government</i>					
Commonwealth	1,151,127	47,068	89,889	569,809	444,361
State	667,641	30,485	35,674	341,944	259,539
<i>Higher Education</i>	1,695,209	75,747	180,954	1,079,602 (c)	358,907 (c)
<i>Private non-profit</i>	101,236	1,751	6,870	55,595	37,020
Total	6,469,744	191,424	664,290	3,267,155	2,346,876
<i>1994-95</i>					
<i>Business Enterprises</i>					
Private Sector	3,051,279	n.p.	n.p.	1,274,108	1,419,247
Public Sector	331,846	n.p.	n.p.	135,954	139,610
<i>General Government</i>					
Commonwealth	1,178,394	49,187	89,972	547,352	491,883
State	786,282	73,426	57,445	359,075	296,336
<i>Higher Education</i>	1,829,580	47,933	117,037	913,201 (c)	751,409 (c)
<i>Private non-profit</i>	143,718	16,694	7,213	67,801	52,011
Total	7,321,099	266,051	607,063	3,297,490	3,150,495

(a) Includes wages and salaries, overtime allowances, penalty rates, leave loadings, bonuses, commission payments, all paid leave, employer contributions to superannuation and pension schemes, payroll tax, fringe benefits tax, payments to contract staff on the payroll, severance, termination and redundancy payments and workers compensation insurance. (b) For higher education sector, includes scholarships for research higher degrees. (c) The 1994-95 higher education labour costs figure represents direct labour costs, i.e. the labour costs of staff directly involved with R&D activity. The labour costs of overhead staff whose work indirectly supports R&D are included in other current expenditure. For 1992-93, both direct and indirect labour costs are included in the labour costs figure.

SOURCE OF FUNDS
FOR R&D

The major sources of funds for R&D expenditure in Australia in 1994-95 were Business enterprises \$3,343m (46%), up from 44% in 1992-93, and Commonwealth government \$2,842m (39%), down from 41% in 1992-93. State government (9%), Private non-profit and other Australian (4%) and Overseas (2%) maintained the same proportions as in 1992-93. In 1986-87, the sectors provided 37%, 50%, 10%, 3% and 1% of funding respectively.

5

GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT, AUSTRALIA, SECTOR BY SOURCE OF FUNDS (\$'000)

Sector	Total	Commonwealth government	State government	Business enterprises	Private non-profit and other Australian(a)	Overseas
<i>1992-93 r</i>						
<i>Business Enterprises</i>						
Private Sector	2,609,759	n.p.	n.p.	2,460,985	7,851	85,823
Public Sector	244,771	n.p.	n.p.	229,850	7,479	---
<i>General Government</i>						
Commonwealth	1,151,127	988,008	11,703	74,688	62,757	13,971
State	667,641	56,456	509,303	28,968	69,146	3,768
<i>Higher Education</i>	1,695,209	1,544,754	34,771	41,684	63,488	10,512
<i>Private non-profit</i>	101,236	33,941	12,750	6,930	44,302	3,312
Total	6,469,744	2,677,163	577,065	2,843,105	255,023	117,387
<i>1994-95</i>						
<i>Business Enterprises</i>						
Private Sector	3,051,279	n.p.	n.p.	2,814,094	34,622	109,936
Public Sector	331,846	n.p.	n.p.	321,499	397	---
<i>General Government</i>						
Commonwealth	1,178,394	1,006,787	11,401	85,341	63,044	11,821
State	786,282	68,685	591,057	44,250	78,405	3,885
<i>Higher Education</i>	1,829,580	1,633,713	42,204	63,940	71,224	18,500
<i>Private non-profit</i>	143,718	43,035	22,708	14,034	60,142	3,799
Total	7,321,099	2,842,218	679,949	3,343,158	307,834	147,941

(a) Includes funds provided via government levies.

TYPE OF ACTIVITY

Experimental development remained the predominant activity on which R&D funds were expended, accounting for \$2,720m (37%) of gross expenditure on R&D, down slightly from 38% in 1992-93. Applied research accounted for 35% of gross R&D expenditure, up from 33% in 1992-93. Strategic basic research accounted for 16%, the same as in 1992-93, and Pure basic research accounted for 11%, down from 12%.

In 1994-95, the Higher education sector contributed \$652m (78%) to expenditure on Pure basic research and is the major contributor to this activity. The General government sector contributed \$479m (40%) to Strategic basic research and \$1,095m (43%) to Applied research and is the main contributor to both of these activities. Business enterprises undertook the major portion of Experimental development activity with expenditure of \$2,318m (85%). In 1986-87, the Higher education sector accounted for 80% of expenditure on Pure basic research, the General government sector 46% of Strategic basic research and 47% of Applied research, while Business enterprises undertook 74% of Experimental development activity.

6 GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT, AUSTRALIA, SECTOR BY TYPE OF ACTIVITY(a) (\$'000)

<i>Sector</i>	<i>Total</i>	<i>Pure basic research</i>	<i>Strategic basic research</i>	<i>Applied research</i>	<i>Experimental development</i>
<i>1992-93 r</i>					
<i>Business Enterprises</i>					
Private Sector	2,609,759	21,892	118,834	633,470	1,835,563
Public Sector	244,771	396	21,131	66,649	156,595
<i>General Government</i>					
Commonwealth	1,151,127	35,350	346,633	500,748	268,397
State	667,641	25,848	108,057	416,526	117,210
<i>Higher Education</i>	1,695,209	675,864	401,524	514,177	103,645
Private non-profit	101,236	26,359	53,221	16,315	5,341
Total	6,469,744	785,709	1,049,400	2,147,885	2,486,750
<i>1994-95</i>					
<i>Business Enterprises</i>					
Private Sector	3,051,279	23,089	157,467	726,730	2,143,993
Public Sector	331,846	430	34,696	122,283	174,437
<i>General Government</i>					
Commonwealth	1,178,394	68,032	359,871	604,963	145,528
State	786,282	45,506	119,559	490,181	131,036
<i>Higher Education</i>	1,829,580	652,246	461,147	602,832	113,354
Private non-profit	143,718	45,259	57,424	29,615	11,420
Total	7,321,099	834,562	1,190,165	2,576,604	2,719,769

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

LOCATION OF EXPENDITURE

The leading States in terms of location of gross R&D expenditure in 1994-95 were New South Wales at \$2,312m and Victoria at \$2,160m, accounting for 32% and 30% of total expenditure respectively. Next in order were Queensland (11%), Western Australia (9%), South Australia (8%), the Australian Capital Territory and External Territories (7%), Tasmania (2%) and the Northern Territory (1%). The ranking was the same as in 1992-93 except for New South Wales replacing Victoria as the leading State.

7

GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT, AUSTRALIA, SECTOR BY LOCATION OF EXPENDITURE(a) (\$'000)

Sector	Total	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT and Ext. Terr.	Overseas
<i>1992-93 r</i>										
<i>Business Enterprises</i>										
Private Sector	2,609,759	945,704	967,020	198,663	139,121	293,420	27,548	2,166	20,409	15,707
Public Sector	244,771	108,029	118,934	3,385	9,234	3,711	544	—	908	26
<i>General Government</i>										
Commonwealth	1,151,127	209,802	319,380	86,614	154,378	38,396	56,462	13,628	223,029	49,437
State	667,641	184,814	129,050	151,857	69,837	84,540	22,707	23,596	378	861
<i>Higher Education</i>	1,695,209	503,189	385,695	271,653	118,247	144,574	35,650	5,732	230,471	—
<i>Private non-profit</i>	101,236	25,274	67,341	3,383	1,284	1,755	691	757	572	177
Total	6,469,744	1,976,813	1,987,421	715,556	492,102	566,397	143,602	45,879	475,768	66,207
<i>1994-95</i>										
<i>Business Enterprises</i>										
Private Sector	3,051,279	1,150,214	1,042,611	254,154	199,647	318,156	n.p.	n.p.	n.p.	23,064
Public Sector	331,846	97,068	215,830	3,860	4,763	7,688	n.p.	n.p.	n.p.	257
<i>General Government</i>										
Commonwealth	1,178,394	258,741	294,925	102,549	167,571	47,629	56,982	33,526	208,495	7,976
State	786,282	249,978	134,866	170,283	83,616	94,961	21,810	24,852	3,728	2,188
<i>Higher Education</i>	1,829,580	511,326	393,234	300,551	129,965	167,746	49,198	8,718	268,841	—
<i>Private non-profit</i>	143,718	44,227	78,645	4,852	2,398	10,559	676	832	770	759
Total	7,321,099	2,311,554	2,160,111	836,249	587,961	646,738	164,660	72,061	507,520	34,244

(a) Location of the expenditure. This may not be the location of the organisations head office.

TYPE OF R&D STAFF

Total person years of effort for 1994-95 was 86,162, an increase of 8% over 1992-93. The effort by researchers increased by 8% from 52,124 to 56,520 person years, while that of Technicians and Other supporting staff also increased by 8% from 27,346 to 29,641 person years.

Researchers were the predominant type of employee in total person years for all sectors, accounting for approximately 80% of Higher education person years, 58% of Business enterprise person years, 45% of General government and 55% of Private non-profit person years of effort.

8

HUMAN RESOURCES DEVOTED TO RESEARCH AND EXPERIMENTAL DEVELOPMENT, AUSTRALIA, SECTOR BY TYPE OF EMPLOYEE (person years)

Sector	Total	Researchers	Technicians	Other supporting staff
<i>1992-93 r</i>				
<i>Business Enterprises</i>				
Private Sector	20,665	12,413	5,369	2,883
Public Sector	2,219	1,500	464	255
<i>General Government</i>				
Commonwealth	11,020	5,523	3,266	2,231
State	8,779	4,087	3,410	1,282
<i>Higher Education</i>	35,418	27,914	4,858	2,646
<i>Private non-profit</i>	1,370	688	419	264
Total	79,470	52,124	17,784	9,562
<i>1994-95</i>				
<i>Business Enterprises</i>				
Private Sector	23,116	13,451	6,179	3,486
Public Sector	2,123	1,187	646	290
<i>General Government</i>				
Commonwealth	10,562	4,367	3,554	2,641
State	8,572	4,313	3,226	1,032
<i>Higher Education</i>	40,096	32,272	(a)	7,824 (a)
<i>Private non-profit</i>	1,692	930	528	235
Total	86,162	56,520	14,133 (a)	15,508 (a)

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

EXPENDITURE BY PURPOSE
OF R&D ACTIVITY

In 1994-95, 61% (\$4,460m) of R&D expenditure was directed towards Economic development, 14% (\$1,018m) towards Advancement of knowledge, 12% (\$901m) towards Society, 8% (\$574m) towards Environment and 5% (\$368m) towards Defence.

Economic development accounted for the majority of expenditure on R&D in the Business enterprise sector with \$3,039m (90%), in the Commonwealth government sector, with \$601m (51%), and in the State government sector with \$439m (56%).

The Higher education sector directed \$881m (48%) of total Higher education R&D expenditure towards Advancement of knowledge.

In the Private non-profit sector, Society accounted for \$124m (86%) of total Private non-profit expenditure.

9

GROSS EXPENDITURE ON RESEARCH AND EXPERIMENTAL DEVELOPMENT BY SOCIO-ECONOMIC OBJECTIVE BY SECTOR, AUSTRALIA, 1994-95 (\$'000)

Socio-economic objective	Total	General Government				Private non-profit
		Business Enterprise	Commonwealth	State	Higher Education	
Defence	367,904	139,969	223,099	—	4,836	—
<i>Economic development</i>						
Plant — production and primary products	351,609	28,656	74,610	195,354	52,988	—
Animal — production and primary products	343,588	35,451	95,672	172,283	40,183	—
Mineral resources (excl. energy)	295,872	202,147	61,741	6,308	25,676	—
Energy resources	198,261	126,788	56,533	3,127	11,814	—
Energy supply	162,627	117,470	18,272	8,886	17,698	302
Manufacturing	2,136,903	1,836,290	200,945	22,006	75,442	2,220
Construction	94,040	33,995	24,323	6,785	27,652	1,284
Transport	84,693	61,401	8,143	10,204	4,831	114
Information and communication services	591,258	517,215	31,238	6,031	36,541	234
Commercial services	88,510	69,663	5,346	5,122	8,185	194
Economic framework	112,566	9,851	24,663	3,364	73,013	1,675
Total Economic development	4,459,927	3,038,928	601,486	439,470	374,022	6,022
<i>Society</i>						
Health	681,669	52,583	33,772	175,578	305,748	113,989
Education and training	110,602	5,246	2,064	5,366	89,771	8,155
Social development and community services	109,121	12,906	28,462	12,664	52,976	2,114
Total Society	901,393	70,734	64,297	193,607	448,496	124,258
<i>Environment</i>						
Environmental knowledge	321,143	31,458	133,788	72,710	81,303	1,885
Environmental aspects of economic development	156,864	27,561	87,960	20,449	20,894	—
Environmental management and other aspects	96,356	20,938	26,096	29,117	18,903	1,303
Total environment	574,363	79,957	247,844	122,275	121,099	3,188
<i>Advancement of knowledge</i>						
Natural sciences, technologies and engineering	749,582	53,518	41,012	28,661	616,401	9,989
Social sciences and humanities	267,931	18	657	2,269	264,727	260
Total advancement of knowledge	1,017,513	53,537	41,669	30,930	881,128	10,249
TOTAL	7,321,099	3,383,125	1,178,394	786,282	1,829,580	143,718

HUMAN RESOURCES BY
PURPOSE OF R&D ACTIVITY

In 1994-95, 47% (40,614 person years) of research effort was directed towards Economic development, 25% (21,248 person years) towards Advancement of knowledge, 17% (14,761 person years) towards Society, 8% (6,739 person years) towards Environment and 3% (2,799 person years) towards Defence. This pattern is noticeably different to that for expenditure, reflecting the fact that average R&D expenditure per person year of effort differs across the sectors. In particular, it is considerably lower for the Higher education sector because a major part of the R&D is carried out by postgraduates and the research is generally directed towards less capital intensive objectives.

10 HUMAN RESOURCES DEVOTED TO R&D BY SOCIO-ECONOMIC OBJECTIVE BY SECTOR, AUSTRALIA, 1994-95
(person years)

Socio-economic objective	Total	General Government				Private non-profit
		Business Enterprise	Commonwealth	State	Higher Education	
Defence	2,799	674	2,009	—	115	—
<i>Economic development</i>						
Plant — production and primary products	3,919	275	741	2,009	893	—
Animal — production and primary products	3,691	219	913	1,754	805	—
Mineral resources (excl. energy)	1,825	819	534	54	418	—
Energy resources	1,218	506	474	19	218	—
Energy supply	1,096	466	159	74	394	2
Manufacturing	17,613	13,848	1,827	252	1,659	27
Construction	1,363	352	243	64	685	19
Transport	843	586	76	76	102	2
Information and communication services	6,155	4,931	292	49	882	2
Commercial services	916	660	52	49	154	2
Economic framework	1,975	76	313	27	1,539	20
Total Economic development	40,614	22,740	5,625	4,427	7,749	74
<i>Society</i>						
Health	10,103	471	298	2,322	5,680	1,332
Education and training	2,721	83	19	85	2,458	77
Social development and community services	1,936	152	264	124	1,366	30
Total Society	14,761	706	581	2,531	9,505	1,439
<i>Environment</i>						
Environmental knowledge	3,986	254	976	756	1,966	35
Environmental aspects of economic development	1,663	198	849	192	423	—
Environmental management and other aspects	1,090	150	207	301	408	23
Total environment	6,739	603	2,032	1,249	2,797	58
<i>Advancement of knowledge</i>						
Natural sciences, technologies and engineering	13,481	516	310	331	12,206	117
Social sciences and humanities	7,767	1	6	33	7,724	4
Total advancement of knowledge	21,248	517	316	364	19,930	121
TOTAL	86,162	25,240	10,562	8,572	40,096	1,692

EXPENDITURE BY FIELD OF RESEARCH

Business enterprise data were not classified by Field of research (FOR). The expenditure on R&D activity by the General government, Higher education and Private non-profit sectors in 1994-95 was estimated to be \$3,938m of which \$3,325m (84%) was directed towards Natural sciences, technologies and engineering and \$613m (16%) towards Social sciences and humanities.

The FORs in which most Commonwealth government expenditure occurred were Applied sciences and technologies (\$180m), Information, computers and communication technologies (\$163m) and Earth sciences (\$161m).

State government expenditure on R&D was predominantly expended in Agricultural sciences (\$430m), Medical and health sciences (\$160m) and Biological sciences (\$76m).

The FORs in which most higher education expenditure occurred were Medical and health sciences (\$376m), Biological sciences (\$215m) and Humanities (\$145m).

The majority of the Private non-profit sector's R&D expenditure was in Medical and health sciences (\$94m) and Biological sciences (\$33m).

11 RESOURCES DEVOTED TO R&D BY FIELD OF RESEARCH BY SECTOR, AUSTRALIA, 1994-95(a)

Field of research	Expenditure (\$'000)					Human resources (person years)				
	General Government					General Government				
	Total	Common-wealth	State	Higher Education	Private non-profit	Total	Common-wealth	State	Higher Education	Private non-profit
<i>Natural sciences, technologies and engineering</i>										
Mathematical sciences	68,688	20,888	1,462	46,337	—	1,335	268	23	1,044	—
Physical sciences	182,302	93,772	819	87,463	249	2,243	829	9	1,400	5
Chemical sciences	182,975	76,913	8,132	97,819	111	2,586	697	104	1,784	1
Earth sciences	274,027	160,616	24,935	87,767	709	3,299	1,317	243	1,728	11
Information, computers and communication technologies	279,266	162,718	24,176	92,354	18	3,770	1,442	176	2,152	—
Applied sciences and technologies	257,981	179,518	9,450	67,910	1,104	3,183	1,678	99	1,394	11
General Engineering	244,906	85,279	25,428	132,258	1,941	3,827	773	203	2,823	30
Biological sciences	469,240	144,497	76,375	214,886	33,482	6,913	1,231	863	4,432	387
Agricultural sciences	693,914	153,521	430,287	109,837	269	8,085	1,471	4,370	2,239	5
Medical and health sciences	671,774	42,001	160,067	375,890	93,816	10,720	308	2,190	7,103	1,120
Total natural sciences, technologies and engineering	3,325,073	1,119,723	761,131	1,312,521	131,698	45,961	10,013	8,280	26,098	1,570
<i>Social sciences and humanities</i>										
Accounting and finance	23,811	—	1,064	22,746	—	424	—	5	419	—
Economics	79,383	20,746	3,103	53,741	1,794	1,344	238	28	1,065	13
Political sciences	33,406	2,434	2,144	28,462	365	801	31	20	746	4
Sociology	27,715	6,712	1,592	19,351	60	632	20	25	586	1
Law	33,333	4,562	302	28,210	260	543	27	6	507	3
Psychology	42,993	3,364	995	37,933	701	1,024	33	10	974	7
Education	87,504	151	4,149	76,384	6,820	2,428	2	66	2,300	61
Other social sciences	135,770	20,031	8,873	105,561	1,304	3,194	191	103	2,876	23
Humanities	148,986	671	2,928	144,670	717	4,572	7	30	4,525	10
Total social sciences and humanities	612,901	58,671	25,151	517,060	12,020	14,962	549	292	13,998	123
TOTAL	3,937,974	1,178,394	786,282	1,829,580	143,718	60,922	10,562	8,572	40,096	1,692

(a) Business enterprise data is not classified by Field of Research

HUMAN RESOURCES BY FIELD OF RESEARCH

The total human resource effort for the General government, Higher education and Private non-profit sectors for 1994-95 was estimated to be 60,922 person years. These resources were mainly devoted to Natural sciences, technologies and engineering with 45,961 person years (75%). Social sciences and humanities accounted for 14,962 person years (25%).

The Commonwealth government sector's human resource effort was mainly directed towards Applied sciences and technologies (16%), Agricultural sciences (14%) and Information, computers and communication technologies (14%).

The FORs in which most State government human resource effort occurred were Agricultural sciences (51%) and Medical and health sciences (26%).

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

The majority of the Private non-profit sector's human resources were devoted to Medical and health sciences (66%) and Biological sciences (23%).

BUSINESS ENTERPRISES

Business expenditure on R&D in 1994-95 was estimated to be \$3,383m. Of this expenditure, 57% (\$1,929m) was in Manufacturing industries. The largest other industries were Property and business services (16% of total expenditure) and Mining (7%).

The average expenditure on R&D per person year of R&D effort in 1994-95 for all enterprises which conducted R&D was approximately \$134,000, an increase of approximately \$9,000 (7%) per person year of R&D effort over 1992-93.

The proportion of effort by Researchers to total human resource effort ranged from 68% in Wholesale and retail trade to 38% in Non-metallic mineral product mfg.

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R&D BY BUSINESS ENTERPRISES(a), AUSTRALIA, 1994-95, BY ANZSIC INDUSTRY OF ENTERPRISE

<i>Industry of enterprise</i> ANZSIC Code Description	<i>Enterprises</i> (number)	<i>Expenditure</i> (\$'000)	<i>Human</i> <i>resource effort</i> (person years)	<i>Researcher effort</i> (person years)
B Mining (including services to mining)	92	241,650	825	413
Manufacturing ---				
21 Food, beverage and tobacco	178	141,603	1,131	642
22 Textile, clothing, footwear and leather	60	26,905	197	98
23 Wood and paper product	43	76,524	253	111
24 Printing, publishing and recorded media	44	15,062	174	90
25 Petroleum, coal, chemical and associated product	356	309,835	2,400	1,249
26 Non-metallic mineral product	77	45,260	427	161
27 Metal product	235	309,543	1,970	1,071
281-282 Motor vehicle and part and other transport equipment	145	338,145	2,014	892
283 Photographic and scientific equipment	113	123,003	1,102	704
284-285 Electronic and electrical equipment and appliance	448	450,957	4,108	2,665
286 Industrial machinery and equipment	288	73,456	907	412
29 Other manufacturing	93	18,337	233	107
C Total manufacturing	2,080	1,928,629	14,914	8,202
Other industries ---				
F-G Wholesale and retail trade	263	196,376	1,662	1,136
K Finance and insurance	34	103,409	923	486
77,782-786 Property and business services	651	545,919	4,668	3,122
781 Scientific research	74	114,102	961	594
(b) Other n.e.c.	127	253,041	1,287	686
D-Q Total other industries	1,149	1,212,846	9,500	6,024
TOTAL ALL INDUSTRIES	3,321	3,383,125	25,240	14,638
Private Sector Contribution	3,273	3,051,279	23,116	13,451
Public Sector Contribution	48	331,846	2,123	1,187

(a) Excludes enterprises in ANZSIC Division 'A' (b) ANZSIC codes D,F,H,J,M,Q.

EXTRAMURAL R&D

Details of extramural R&D payments (i.e. payments made to other organisations to conduct R&D on behalf of the organisation) were not collected from the Higher education sector. Extramural payments for R&D by the General government, Business enterprise and Private non-profit sectors in 1994-95 were estimated to be \$1,669m, or equivalent to 23% of GERD. \$1,501m (90%) of these payments were received by organisations within Australia.

The General government sector accounted for \$1,110m (67%) of total extramural payments, the Business enterprise sector \$534m (32%), and the Private non-profit sector \$25m (1%).

13 EXTRAMURAL R&D EXPENDITURE(a), AUSTRALIA, 1994-95(b), BY SECTOR BY COUNTRY OF RECIPIENT (\$'000)

Sector	Total payments	Country of recipient									
		Australia	Africa	Asia	Canada	Europe	New Zealand	Oceania	U.K.	U.S.A.	Other Countries
<i>Business Enterprises</i>											
Private Sector	466,146	314,243	n.p.	16,680	1,569	n.p.	3,163	—	19,957	72,878	7,403
Public Sector	68,000	67,783	—	—	—	n.p.	—	—	—	n.p.	—
<i>General Government</i>											
Commonwealth	1,056,170	1,041,205	991	4,953	5	2,111	2,351	496	640	455	2,963
State	53,514	53,328	—	41	100	25	—	—	—	20	—
Private non-profit	24,682	24,356	—	—	—	—	63	—	10	207	46
Total	1,668,512	1,500,915	n.p.	21,674	1,674	32,504	5,577	496	20,607	n.p.	10,412

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

TECHNICAL KNOW-HOW

PAYMENTS FOR TECHNICAL KNOW-HOW (TKH)

Details on payments for TKH were not collected from the Higher education sector. Payments for TKH by the General government, Business enterprise and Private non-profit sectors in 1994-95 were estimated to be \$640m, of which \$436m (68%) were payments made to overseas. These payments are equivalent to 9% and 6% of GERD respectively.

The Business enterprise sector accounted for \$635m (99%) of the payments.

Patent licence fees and royalties accounted for \$334m (52%) and other technical know-how \$306m (48%).

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PAYMENTS FOR TECHNICAL KNOW-HOW, AUSTRALIA, 1994-95(a), BY SECTOR (\$'000)

Sector	Type of technical know-how			Location of recipient	
	Total	Patent licence fees and royalties	Other technical know-how	Australia	Overseas
<i>Business Enterprises</i>					
Private Sector	606,210	n.p.	n.p.	n.p.	n.p.
Public Sector	29,223	n.p.	n.p.	n.p.	n.p.
<i>General Government</i>					
Commonwealth	2,217	313	1,904	1,938	279
State	2,451	210	2,241	2,424	27
<i>Private non-profit</i>	125	32	93	109	16
Total	640,226	334,048	306,178	204,030	436,196

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

RECEIPTS FOR TKH

Details on receipts for TKH were not collected from the Higher education sector. Receipts for TKH by the General government, Business enterprise and Private non-profit sectors in 1994-95 were estimated to be \$405m, of which \$227m (56%) were received from overseas. These receipts are equivalent to 6% and 3% of GERD respectively.

The Business enterprise sector accounted for \$397m (98%) of total receipts for TKH.

Patent licence fees and royalties accounted for \$154m (38%) and other technical know-how \$251m (62%).

15 RECEIPTS FOR TECHNICAL KNOW-HOW, AUSTRALIA, 1994-95(a), BY SECTOR (\$'000)

<i>Sector</i>	<i>Type of technical know-how</i>			<i>Location of paying organisation</i>	
	<i>Total</i>	<i>Patent licence fees and royalties</i>	<i>Other technical know-how</i>	<i>Australia</i>	<i>Overseas</i>
<i>Business Enterprises</i>					
Private Sector	388,179	n.p.	n.p.	n.p.	n.p.
Public Sector	8,650	n.p.	n.p.	n.p.	n.p.
<i>General Government</i>					
Commonwealth	4,723	1,546	3,177	3,212	1,511
State	1,820	243	1,577	1,671	149
<i>Private non-profit</i>	1,604	210	1,394	1,599	5
Total	404,976	154,203	250,773	177,743	227,233

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

PATENT ACTIVITY

Details of patent activity were not collected from the Higher education sector. Organisations with R&D activity within the General government, Business enterprise and Private non-profit sectors during 1994-95 lodged 1,406 patent applications in Australia and 20,968 overseas, during the period 1 July 1993 to 30 June 1995. The majority of these, 1,171 and 11,285 respectively, were lodged by organisations in the Business enterprise sector.

During the period 1 July 1993 to 30 June 1995, these organisations were granted 965 patents in Australia and 1,870 overseas. The majority, 856 and 1,484 respectively were granted to organisations in the Business enterprise sector.

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PATENT ACTIVITY BY ORGANISATIONS UNDERTAKING R&D, AUSTRALIA(a), BY SECTOR, JULY 1993 TO JUNE 1995 (number)

Sector	Australia		Overseas	
	Patents lodged	Patents granted	Patents lodged (b)	Patents granted
<i>Business Enterprises</i>				
Private Sector	1,119	830	10,783	1,465
Public Sector	52	26	502	19
<i>General Government</i>				
Commonwealth	132	90	8,841	344
State	13	6	512	17
<i>Private non-profit</i>	90	13	330	25
Total	1,406	965	20,968	1,870

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

EXPLANATORY NOTES

INTRODUCTION

1 This publication presents summary statistics of expenditure and human resources devoted to R&D carried out in Australia by enterprises/organisations within the Business enterprise, General government and Private non-profit sectors during 1994–95 and the Higher education sector during the 1994 calendar year.

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

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

DATA SOURCES

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

5 The GDP(I) figures used to derive GERD/GDP ratios are current at the time of manuscript finalisation (*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 GERD/GDP ratios for other OECD countries are current at the time of manuscript finalisation and are sourced from *Main Science and Technology Indicators, 1996–1*, OECD, Paris, 1996.

DEFINITIONS

6 R&D is defined in accordance with the OECD standard as comprising creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

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

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

9 The question relating to lodgement of patent applications overseas specifically asks for the number of countries in which protection was initially sought. For example, if four countries were designated in an application (a Patent Co-operation Treaty application or a European Patent application) then the business, General government organisation or Private non-profit organisation was asked to record the number of patent applications lodged as four. Prior to 1992-93 it is possible that the patent application would have been recorded as only one lodgement.

SCOPE

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

Four sectors are recognised:

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

COVERAGE

11 Exclusions from the survey coverage are:

- Business enterprise sector for the R&D surveys excludes enterprises mainly engaged in agriculture, forestry, and fishing (i.e. industries in Division A of the *Australian and New Zealand Standard Industrial Classification (ANZSIC), 1993 (1292.0)*), partly because of collection difficulties and partly because such enterprises are believed to have very low R&D activity (agricultural R&D activity is generally carried out by specialised research institutes not included in ANZSIC Division A).
- General government sector excludes local government organisations because it is considered that their contribution to total R&D activity would be minimal. Public sector organisations mainly engaged in higher education (e.g. universities) are included in the Higher education sector whilst those mainly engaged in trading or financial activities are included in the Business enterprise sector.
- Higher education sector excludes Technical and Further Education colleges and other post-secondary institutions because it is considered that their contribution to total R&D activity would be minimal.

SOCIO-ECONOMIC OBJECTIVE
AND FIELD OF RESEARCH
CLASSIFICATIONS

12 Statistical information for the General government, Higher education and Private non-profit sectors is classified by both Socio-economic objective (SEO) and Field of research (FOR). Statistical information for the Business enterprise sector is only classified by SEO. For a more detailed description and explanation of SEO and FOR classifications, please see the glossary or the *Australian Standard Research Classification, 1993* (1297.0).

COMPARABILITY WITH
PREVIOUS STATISTICS

13 The statistics for Higher education for 1994 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.

AUSTRALIAN AND NEW
ZEALAND STANDARD
INDUSTRIAL CLASSIFICATION
(ANZSIC)

14 In table 12, R&D by the Business enterprise sector has been classified by the industry of the enterprise in accordance with the 1993 edition of the ANZSIC.

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

CONSTANT PRICE ESTIMATES

16 Estimates of total R&D expenditure are shown at average 1989-90 prices in table 1. In concept, constant price estimates are measures from which direct effects of price change have been eliminated. Although expressed in monetary terms, the constant price measures shown vary only with changes in the underlying quantities of inputs purchased (including labour). In effect, quantities of broadly defined categories of inputs are weighted by their prices in the base year (1989-90). Because the measures relate to input quantities, they do not reflect changes in the efficiency with which labour, capital and other inputs are used.

17 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.

18 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

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

- Many data providers had to make estimates because their accounts do not separately record data on R&D activity, receipts and payments for technical know-how or patent activity.
- The OECD standard definition of R&D used in this survey differs in some respects from what respondents may regard as R&D activity, particularly since the definitions used within the Grants for Industry R&D scheme for the allocation of grants, and the 150% Tax Concession Scheme for tax deductibility for specific R&D activities undertaken within Australia, differ slightly from the R&D survey definition.

UNPUBLISHED STATISTICS

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

RELATED PUBLICATIONS

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

Australian Standard Research Classification (ASRC) 1993 (1297.0)

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)

Research and Experimental Development, Higher Education Organisations, Australia, 1994 (8111.0)

Main Science and Technology Indicators 1996-1, OECD, Paris, 1996

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

22 Current publications issued by the ABS are listed in the *Catalogue of Publications and Products, 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.

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

GLOSSARY

Applied research	Original work undertaken in order to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and predetermined objectives.
Basic research	Experimental and theoretical work undertaken primarily to acquire new knowledge without a specific application in view. It consists of pure basic research and strategic basic research. Pure basic research is carried out without looking for long-term benefits other than the advancement of knowledge. Strategic basic research is directed into specified broad areas in the expectation of useful discoveries. It provides the broad base of knowledge 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.
Current expenditure	Expenditure on labour costs, materials, fuels, rent and leasing, repairs and maintenance, data processing etc. and the proportion of expenditure on general services and overheads which is attributable to R&D activity.
Experimental development	Systematic work, using existing knowledge gained from research or practical experience for the purpose of creating new or improved products/processes.
Extramural R&D	R&D activity funded by an organisation but carried out by other enterprises, organisations, institutions or individuals.
Field of research (FOR)	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.
Gross expenditure on R&D (GERD)	The sum of intramural R&D expenditures incurred by all organisations in the survey.
Human resources devoted to R&D	The effort of researchers, technicians and other staff directly involved with R&D activity. Overhead staff (e.g. administrative and general service employees such as personnel officers, janitors, etc.) whose work indirectly supports R&D, are excluded.
Intramural R&D	R&D carried out by an organisation on its own behalf or on behalf of other organisations, institutions or individuals.
Labour costs	Wages and salaries, overtime allowances, penalty rates, leave loadings, bonuses, commission payments, all paid leave, employer contributions to superannuation and pension schemes, payroll tax, fringe benefits tax, payments to contract staff on the payroll, severance, termination and redundancy payments and workers compensation insurance.

Other current expenditure	Expenditure on materials, fuels, rent and hiring, repairs and maintenance, data processing etc. and proportion of expenditure on general services and overheads.
Other supporting staff	Skilled and unskilled craftpersons, secretarial and clerical staff directly associated with R&D activity.
R&D activity	Systematic investigation or experimentation involving innovation or technical risk, the outcome of which is new knowledge, with or without a specific practical application or new or improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products/processes. R&D activity ceases and pre-production begins when work is no longer experimental.
Researchers	Those involved with the conception and/or development of new knowledge, products, processes, methods and systems, and in the management of the projects concerned.
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.
Technical know-how (TKH)	Specialised technical knowledge required to successfully produce a product or implement a process, etc. (e.g. patent licences; technical data and information; scientific, technical or engineering assistance) that increases technical knowledge and understanding in an organisation. Payments are those made directly to the holders of TKH which is new to a organisation. They exclude non-monetary transfers, and costs incurred by an enterprise in obtaining TKH, such as overseas travel costs.
Technicians	Those performing technical tasks in support of R&D activity, normally under the direction and supervision of a researcher. These tasks include preparation of experiments, taking records, preparation of charts and graphs and coding data.
Type of R&D activity	Comprises basic research, applied research and experimental development.



For more information . . .

The ABS publishes a wide range of statistics and other information on Australia's economic and social conditions. Details of what is available in various publications and other products can be found in the ABS Catalogue of Publications and Products available from all ABS Offices.

ABS Products and Services

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