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**RESEARCH AND  
EXPERIMENTAL DEVELOPMENT**

**Higher Education Organisations  
Australia**

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**RESEARCH AND EXPERIMENTAL DEVELOPMENT  
HIGHER EDUCATION ORGANISATIONS  
AUSTRALIA  
1992**

**W. McLennan  
Australian Statistician**

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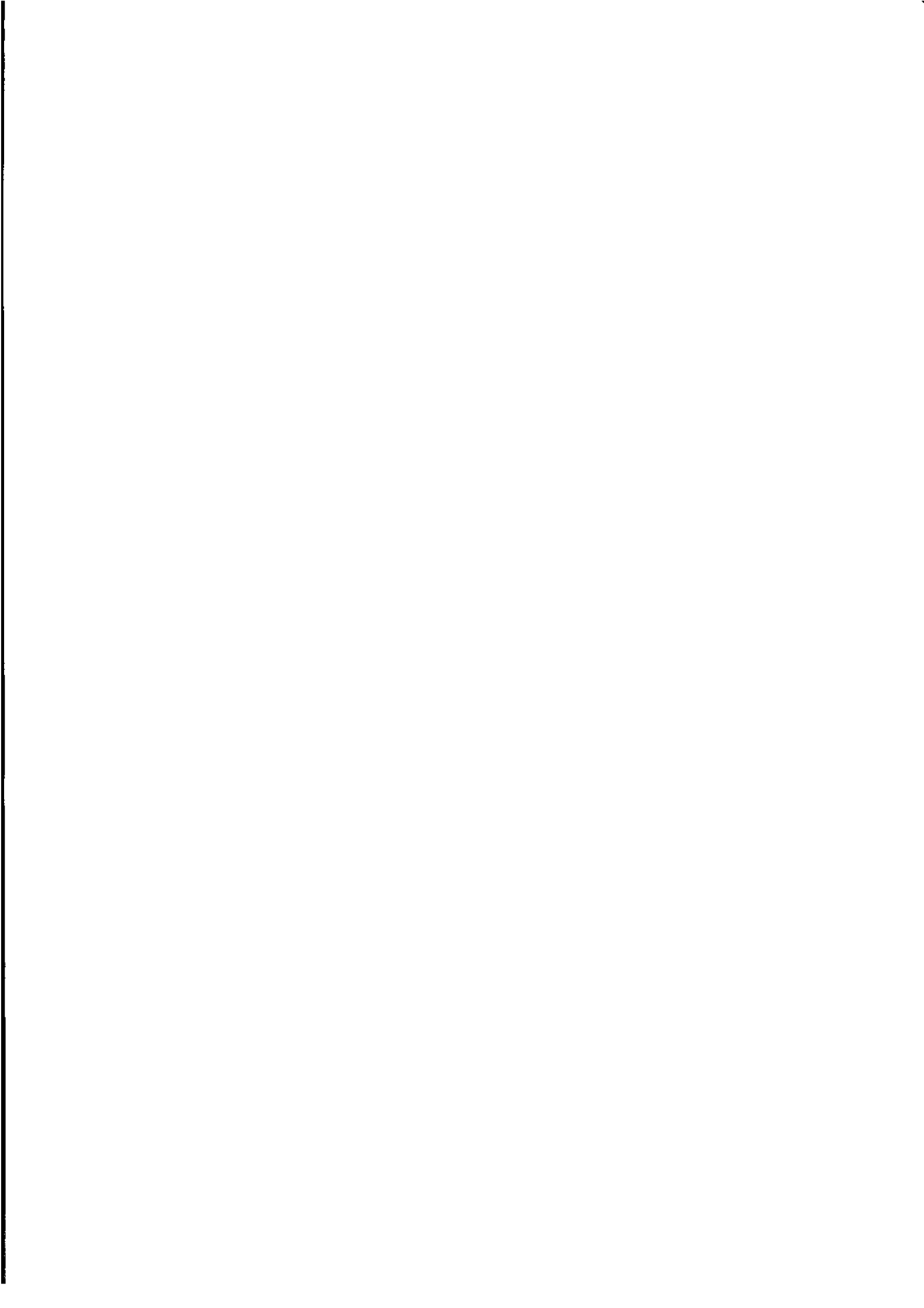
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### INQUIRIES

- *for further information about statistics in this publication and the availability of related unpublished statistics, contact Derek Byars on Canberra (06) 252 5627 or any ABS office.*
  - *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 page of this publication.*
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## SUMMARY OF FINDINGS

### Higher Education Expenditure on R&D (HERD)

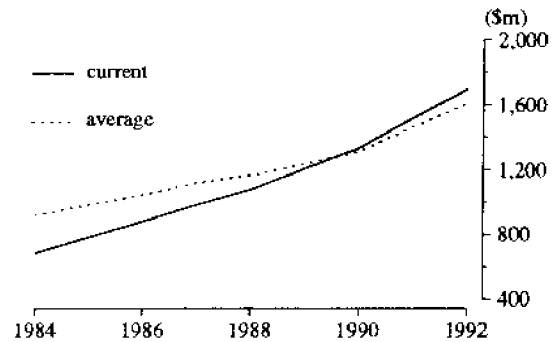
Higher education expenditure on R&D (HERD) carried out in Australia in 1992 is estimated to be \$1,695 million at current prices. This represents an increase of 27 per cent over the two years since 1990. At average 1989-90 prices, R&D expenditure is estimated to be \$1,608 million. This represents an increase of 23 per cent when compared with 1990, or an average annual growth rate of 11 per cent. This compares with an average annual increase in total R&D expenditure of approximately 6 per cent for the period 1984 to 1990.

Higher education expenditure on R&D (HERD) represents .42 per cent of Gross Domestic Product (GDP). This represents an increase of .07 per cent over 1990.

Australia's HERD/GDP ratio, compared with other OECD countries, is shown in the table below.

Japan	.55
Finland	.48
USA	.46
Germany	.42
<b>AUSTRALIA</b>	<b>.42</b>
Iceland	.42
Canada	.40
France	.38
UK	.36
Italy	.28
Ireland	.25
Spain	.21

R&D EXPENDITURE AT CURRENT AND AVERAGE 1989-90 PRICES



HIGHER EDUCATION R&D AS A PERCENTAGE OF GDP

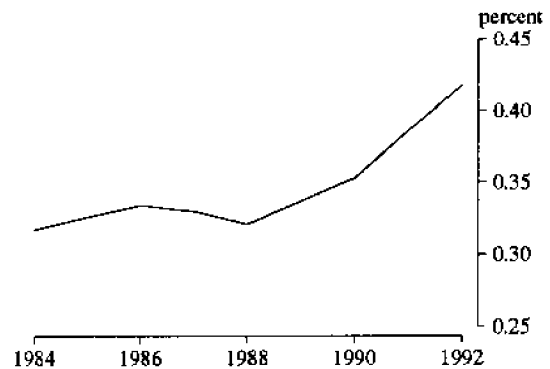


TABLE 1. RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA  
R & D EXPENDITURE AT CURRENT AND AVERAGE 1989-90 PRICES  
(\$m)

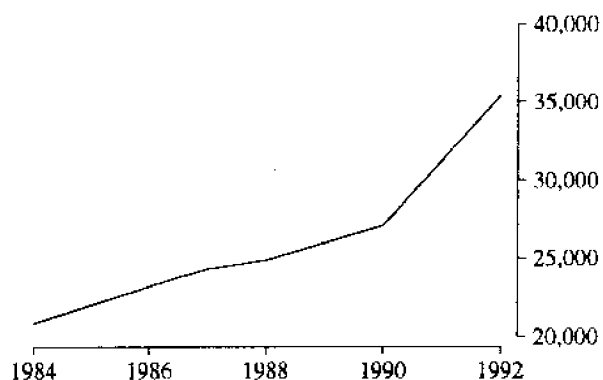
	1984	1986	1987	1988	1990 r	1992
AT CURRENT PRICES						
Higher education organisations	685.7	881.7	983.6	1,076.8	1,332.8	1,695.2
AT AVERAGE 1989-90 PRICES						
Higher education organisations	925.3	1,043.7	1,120.8	1,165.7	1,312.5	1,608.5

### Human resources devoted to R&D

Human resources devoted to R&D carried out in Australia in 1992 by Higher Education organisations is estimated to be 35,418 person years. This represents an increase of 31 per cent over 1990, or an average annual rate of 14.5 per cent between 1990 and 1992. This compares with an annual increase of 4.5 per cent for the period of 1984 to 1990.

The increase in the annual rate of growth for human resources devoted to R&D over the past 2 years parallels that of total expenditure on R&D which has also increased its annual rate of growth over the same period.

### HIGHER EDUCATION ORGANISATIONS HUMAN RESOURCES DEVOTED TO R&D



**TABLE 2. RESEARCH AND EXPERIMENTAL DEVELOPMENT CARRIED OUT  
BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA  
HUMAN RESOURCES DEVOTED TO R & D  
(person years)**

	1984	1986	1987	1988	1990	1992
Higher education organisations	20,844	23,218	24,323	24,902	27,081	35,418



### Type of expenditure

Labour costs continue to be the major component of higher education R&D expenditure (64%). Labour costs, as a percentage of total expenditure fell for a number of years (71 per cent in 1986 to 63 per cent in 1990) but has increased over the period 1990 to 1992. The other components of expenditure were expenditure on land and buildings, accounting for 4 per cent, other capital expenditure, 11 per cent, and other current expenditure, 21 per cent.

### Purpose of research

The socio-economic objectives (SEO's) within the Advancement of knowledge division accounted for the majority of expenditure on higher education R&D with 41 per cent of total expenditure. The major subdivision within the Advancement of knowledge division was Natural sciences, technologies and engineering which accounted for approximately 25 per cent of total R&D expenditure.

The SEO's within the Society division accounted for 27 per cent of R&D expenditure. The major subdivision within Society was Health with approximately 19 per cent of R&D expenditure.

The Economic development division accounted for approximately 24 per cent of total R&D expenditure and the Environment division accounted for approximately 8 per cent.

TYPE OF R&D EXPENDITURE

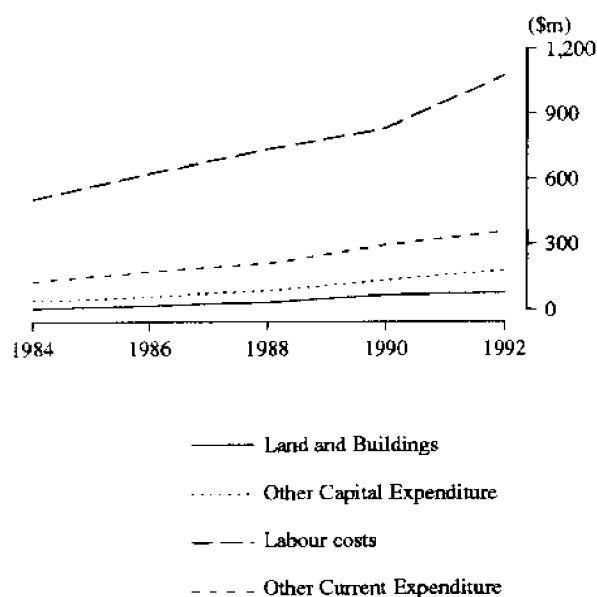


TABLE 3. R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992 BY SOCIO-ECONOMIC OBJECTIVE BY TYPE OF EXPENDITURE AND TYPE OF ACTIVITY (\$'000)

Socio-economic objective	Type of expenditure				Type of activity(a)				
	Total	Land and buildings	Other capital expenditure	Labour costs(b)	Other current expenditure	Pure basic research	Strategic basic research	Applied research	Experimental development
<b>Defence</b>	<b>2,926</b>	<b>79</b>	<b>452</b>	<b>1,721</b>	<b>675</b>	<b>814</b>	<b>1,162</b>	<b>685</b>	<b>265</b>
<b>Economic development</b>	<b>58,537</b>	<b>2,270</b>	<b>5,275</b>	<b>36,532</b>	<b>14,459</b>	<b>9,029</b>	<b>25,729</b>	<b>19,643</b>	<b>4,135</b>
Plant — production and primary products	42,239	1,965	4,009	25,658	10,607	4,243	14,368	18,320	5,308
Animal — production and primary products	21,900	891	2,308	12,954	5,747	3,218	8,405	6,143	4,134
Mineral resources (excl. energy)	9,170	355	1,315	4,968	2,532	1,832	3,509	2,836	993
Energy resources	30,882	545	4,674	17,858	7,806	5,136	8,165	14,037	3,544
Energy supply	75,018	2,402	13,285	42,056	17,274	8,814	25,489	32,419	8,296
Manufacturing	38,513	1,199	5,280	22,519	9,515	4,144	8,561	19,537	6,271
Construction	4,536	188	572	2,771	1,005	218	697	3,089	532
Transport	34,607	1,606	5,438	20,111	7,451	4,807	11,398	15,829	2,573
Information and communication services	14,232	640	1,217	9,223	3,152	1,607	3,231	8,535	859
Commercial services	76,339	3,551	5,842	50,412	16,533	21,476	18,605	34,027	2,231
Economic framework	<b>405,971</b>	<b>15,613</b>	<b>49,216</b>	<b>245,062</b>	<b>96,081</b>	<b>64,525</b>	<b>128,156</b>	<b>174,417</b>	<b>38,874</b>
<b>Society</b>	<b>318,975</b>	<b>9,331</b>	<b>28,783</b>	<b>215,397</b>	<b>65,464</b>	<b>66,162</b>	<b>102,948</b>	<b>122,138</b>	<b>27,726</b>
Health	81,286	4,955	6,028	53,731	16,573	16,856	12,413	44,531	7,486
Education and training	53,731	3,045	3,928	35,385	11,373	16,701	10,329	24,302	2,400
Social development and community services	<b>453,992</b>	<b>17,331</b>	<b>38,739</b>	<b>304,513</b>	<b>93,409</b>	<b>99,718</b>	<b>125,690</b>	<b>190,972</b>	<b>37,611</b>
<b>Environment</b>	<b>84,780</b>	<b>4,625</b>	<b>8,970</b>	<b>51,607</b>	<b>19,578</b>	<b>30,369</b>	<b>25,317</b>	<b>23,825</b>	<b>5,269</b>
Environmental knowledge	35,800	1,635	3,142	23,337	7,685	12,396	6,339	14,236	2,828
Environmental aspects of economic development	9,959	492	1,170	5,765	2,532	1,939	2,983	4,780	256
Environmental management and other aspects	<b>130,539</b>	<b>6,752</b>	<b>13,282</b>	<b>80,710</b>	<b>29,795</b>	<b>44,704</b>	<b>34,639</b>	<b>42,842</b>	<b>8,354</b>
<b>Advancement of knowledge</b>	<b>422,316</b>	<b>18,329</b>	<b>56,915</b>	<b>261,108</b>	<b>85,964</b>	<b>250,640</b>	<b>89,386</b>	<b>70,184</b>	<b>12,106</b>
Natural sciences, technologies and engineering	279,466	17,644	22,351	186,488	52,983	215,463	22,490	35,077	6,435
Social sciences and humanities	<b>701,782</b>	<b>35,973</b>	<b>79,266</b>	<b>447,596</b>	<b>138,947</b>	<b>466,103</b>	<b>111,876</b>	<b>105,261</b>	<b>18,541</b>
<b>TOTAL</b>	<b>1,695,209</b>	<b>75,747</b>	<b>180,954</b>	<b>1,079,602</b>	<b>358,907</b>	<b>675,864</b>	<b>401,524</b>	<b>514,177</b>	<b>103,645</b>

(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 8 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.

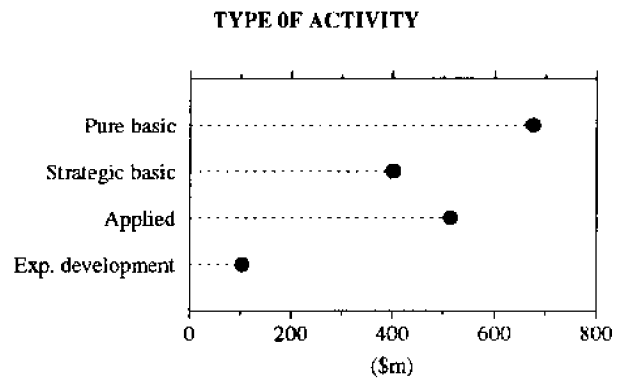
### Type of activity

Approximately 40 per cent of the higher education R&D expenditure is directed towards Pure basic research, down from 41 per cent in 1990. Strategic basic research has increased to 24 per cent in 1992 from 22 per cent in 1990. Applied research has decreased from 31 per cent in 1990 to 30 per cent in 1992. Experimental development remained steady on approximately 6 per cent.

### Field of research

The fields of research in which most higher education R&D expenditure occurred in 1992 were: Medical and health sciences (\$314m), Biological sciences (\$194m), Humanities (\$163m) and General engineering (\$116m).

These fields of research were also the main four fields in 1990.



**TABLE 4. R&D BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992 BY FIELD OF RESEARCH BY TYPE OF EXPENDITURE AND TYPE OF ACTIVITY (\$'000)**

Field of research	Type of expenditure				Type of activity(a)				
	Total	Land and buildings	Other capital expenditure	Labour costs(b)	Other current expenditure	Pure basic research	Strategic basic research	Applied research	Experimental development
<i>Natural sciences, technologies and engineering</i>									
Mathematical sciences	45,091	1,806	4,711	30,362	8,212	29,699	4,183	9,827	1,382
Physical sciences	80,214	3,089	13,319	48,768	15,038	58,019	10,349	9,483	2,364
Chemical sciences	92,364	3,920	14,068	55,800	18,577	47,928	22,820	17,081	4,535
Earth sciences	76,265	3,987	10,004	44,101	18,172	33,639	20,945	18,350	3,332
Information, computers and communication technologies	74,876	2,870	12,577	44,006	15,423	17,764	24,770	27,588	4,754
Applied sciences and technologies	71,030	2,216	13,321	38,656	16,836	13,830	24,924	25,812	6,463
General Engineering	115,787	3,361	15,514	69,099	27,813	17,289	32,230	48,967	17,302
Biological sciences	194,370	8,996	20,998	120,186	44,190	89,607	62,390	34,893	7,480
Agricultural sciences	97,151	4,042	8,983	58,987	25,138	9,970	34,723	43,846	8,612
Medical and health sciences	314,309	9,557	26,599	213,476	64,676	68,631	95,233	123,433	27,013
<b>Total natural sciences, technologies and engineering</b>	<b>1,161,457</b>	<b>43,844</b>	<b>140,095</b>	<b>723,443</b>	<b>254,075</b>	<b>386,374</b>	<b>332,565</b>	<b>359,279</b>	<b>83,238</b>
<i>Social sciences and humanities</i>									
Accounting and finance	21,697	1,035	1,506	15,892	3,263	5,014	4,867	10,736	1,079
Economics	52,567	2,404	3,940	36,238	9,985	20,736	11,353	19,438	1,041
Political sciences	33,512	2,357	2,452	21,772	6,930	19,408	7,559	5,858	687
Sociology	19,125	1,191	1,287	13,289	3,358	13,219	1,961	3,656	289
Law	26,969	1,386	1,633	19,009	4,940	14,095	5,710	6,171	993
Psychology	36,326	1,934	3,270	25,018	6,105	19,944	6,086	8,766	1,529
Education	73,594	4,990	5,409	48,131	15,065	17,225	11,154	38,492	6,724
Other social sciences	106,717	6,559	8,684	68,341	23,132	43,916	15,361	43,654	3,786
Humanities	163,247	10,048	12,677	108,469	32,054	135,932	4,908	18,127	4,280
<b>Total social sciences and humanities</b>	<b>533,753</b>	<b>31,903</b>	<b>40,859</b>	<b>356,159</b>	<b>104,832</b>	<b>289,489</b>	<b>68,958</b>	<b>154,898</b>	<b>20,407</b>
<b>TOTAL</b>	<b>1,695,209</b>	<b>75,747</b>	<b>180,954</b>	<b>1,079,602</b>	<b>358,907</b>	<b>675,864</b>	<b>401,524</b>	<b>514,177</b>	<b>103,645</b>

(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 8 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.

### Source of funds for R&D

Most of the funding for higher education R&D expenditure in 1992 came from the Commonwealth government (91 per cent or \$1,545m). As a percentage of total funds, this represents an increase of 2 per cent over 1990. Private non-profit and Other Australian sources decreased as a percentage of total funds, from 6 per cent (\$73m) in 1990 to 4 per cent (\$63m) in 1992. Both State and local government and Business enterprises contributed approximately 2 per cent of total funding, with Overseas sources contributing less than 1 per cent.

### Funding for Socio-economic objectives

Approximately 43 per cent of total funding by the Commonwealth government was spent on Advancement of knowledge, 26 per cent on Society, 23 per cent on Economic development, 8 per cent on Environment and only 0.2 per cent on Defence. Health was the major subdivision within the Society division making up 17 per cent of total Commonwealth government funding. Economic framework and Manufacturing were the main subdivisions within Economic development with 5 per cent and 4 per cent respectively of total Commonwealth government funding.

The majority of State and local government funding was spent in the Society division (35%), with the main subdivision being Health with 28 per cent of total expenditure.

### SOURCE OF FUNDS

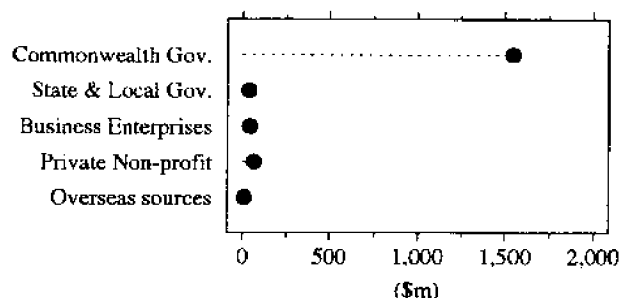


TABLE 5. SOURCE OF FUNDS BY SOCIO-ECONOMIC OBJECTIVE FOR HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992 (\$'000)

Socio-economic objective	Total	Source of funds				
		Commonwealth government	State and local government	Business enterprises	Private non-profit and other Australian	Overseas
<b>Defence</b>	<b>2,926</b>	<b>2,780</b>	<b>77</b>	<b>44</b>	<b>21</b>	<b>3</b>
<i>Economic development</i>						
Plant — production and primary products	58,537	53,307	2,055	1,312	1,697	166
Animal — production and primary products	42,239	38,244	812	1,048	1,870	265
Mineral resources (excl. energy)	21,900	15,598	417	3,607	2,236	42
Energy resources	9,170	7,676	865	388	200	42
Energy supply	30,882	26,952	1,983	705	704	538
Manufacturing	75,018	66,045	1,418	4,316	2,735	503
Construction	38,513	31,935	688	1,600	4,245	45
Transport	4,536	4,081	168	86	191	10
Information and communication services	34,607	31,714	1,348	757	502	286
Commercial services	14,232	13,293	210	443	274	11
Economic framework	76,339	71,953	1,030	905	1,865	585
<b>Total Economic development</b>	<b>405,971</b>	<b>360,798</b>	<b>10,994</b>	<b>15,167</b>	<b>16,518</b>	<b>2,494</b>
<i>Society</i>						
Health	318,975	270,038	9,753	7,908	27,543	3,732
Education and training	81,286	78,212	1,412	301	1,201	159
Social development and community services	53,731	51,151	980	458	857	285
<b>Total Society</b>	<b>453,992</b>	<b>399,402</b>	<b>12,145</b>	<b>8,667</b>	<b>29,601</b>	<b>4,177</b>
<i>Environment</i>						
Environmental knowledge	84,780	78,203	2,031	2,239	1,920	387
Environmental aspects of economic development	35,800	33,034	845	948	876	97
Environmental management and other aspects	9,959	8,465	642	446	387	18
<b>Total environment</b>	<b>130,539</b>	<b>119,703</b>	<b>3,517</b>	<b>3,634</b>	<b>3,183</b>	<b>502</b>
<i>Advancement of knowledge</i>						
Natural sciences, technologies and engineering	422,316	392,190	5,582	12,376	9,836	2,332
Social sciences and humanities	279,466	269,883	2,454	1,796	4,328	1,004
<b>Total advancement of knowledge</b>	<b>701,782</b>	<b>662,073</b>	<b>8,037</b>	<b>14,172</b>	<b>14,164</b>	<b>3,336</b>
<b>TOTAL</b>	<b>1,695,209</b>	<b>1,544,754</b>	<b>34,771</b>	<b>41,684</b>	<b>63,488</b>	<b>10,512</b>

*Funding for SEO's (cont.)*

Approximately 36 per cent of total funding by Business enterprises was spent on Economic development, 34 per cent on Advancement of knowledge and 21 per cent on Society. The Manufacturing and Mineral resources (excl. energy) subdivisions were the main areas of expenditure within the Economic development division, with 10 per cent and 9 per cent respectively of total Business enterprise funding.

The main SEO division of expenditure of Private non-profit and other Australian funds was Society with 47 per cent of total expenditure. The main subdivision within Society was Health with 43 per cent of total expenditure. The Economic development division accounted for 26 per cent of total expenditure with the Construction subdivision accounting for 7 per cent of total expenditure. The Advancement of knowledge division accounted for 22 per cent of total expenditure from Private non-profit and other Australian funding.

Funds received from Overseas sources were mainly spent on Society and Advancement of knowledge with 40 per cent and 32 per cent respectively of total expenditure. The Economic development division accounted for 24 per cent of total expenditure.

*Funding for Fields of research*

The predominant fields of research in which funds were spent varied greatly for the different sources of funds. The main FOR's to which Commonwealth government funds were directed were Medical and health sciences, Biological sciences and Humanities. For State and local government funding, the main FOR's were Medical and health sciences, General engineering and Biological sciences. Business enterprise funding was mainly directed to the FOR's of Medical and health sciences, General engineering and Information, computers and communication technologies whilst funding from Private non-profit organisations and Other Australian sources was directed to Medical and health sciences, Biological sciences and General engineering. Funding from Overseas sources was mainly directed to the FOR's of Medical and health sciences, Biological sciences and Economics.

TABLE 6. SOURCE OF FUNDS BY FIELD OF RESEARCH FOR HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992  
(\$'000)

Field of research	Total	Source of funds				Overseas
		Commonwealth government	State and local government	Business enterprises	Private non-profit and other Australian	
<i>Natural sciences, technologies and engineering</i>						
Mathematical sciences	45,091	44,034	326	296	219	215
Physical sciences	80,214	77,046	217	1,657	983	311
Chemical sciences	92,364	85,912	711	3,733	1,349	660
Earth sciences	76,265	70,201	1,143	2,682	1,605	633
Information, computers and communication technologies	74,876	66,594	2,738	4,310	837	397
Applied sciences and technologies	71,030	61,326	1,029	3,589	4,652	434
General Engineering	115,787	97,878	4,786	7,111	5,331	681
Biological sciences	194,370	179,077	3,513	3,963	6,886	930
Agricultural sciences	97,151	87,625	3,378	2,491	3,255	402
Medical and health sciences	314,309	263,011	10,548	7,852	29,112	3,787
<b>Total natural sciences, technologies and engineering</b>	<b>1,161,457</b>	<b>1,032,706</b>	<b>28,389</b>	<b>37,684</b>	<b>54,228</b>	<b>8,450</b>
<i>Social sciences and humanities</i>						
Accounting and finance	21,697	21,356	56	225	57	3
Economics	52,567	48,246	578	1,078	1,824	841
Political sciences	33,512	31,885	478	140	721	288
Sociology	19,125	18,092	268	233	428	105
Law	26,969	25,859	416	76	577	42
Psychology	36,326	34,944	399	326	606	51
Education	73,594	70,413	1,898	254	896	134
Other social sciences	106,717	102,052	1,129	1,044	2,062	429
Humanities	163,247	159,200	1,162	625	2,090	170
<b>Total social sciences and humanities</b>	<b>533,753</b>	<b>512,048</b>	<b>6,382</b>	<b>4,000</b>	<b>9,260</b>	<b>2,062</b>
<b>TOTAL</b>	<b>1,695,209</b>	<b>1,544,754</b>	<b>34,771</b>	<b>41,684</b>	<b>63,488</b>	<b>10,512</b>

### State comparisons

The leading States in terms of location of higher education R&D expenditure in 1992 are New South Wales at \$503m and Victoria at \$386m, accounting for 30 per cent and 23 per cent of total expenditure respectively. Next in order are Queensland (16%), the ACT (14%), Western Australia (9%), South Australia (7%), Tasmania (2%) and the Northern Territory (0.3%). This ranking is similar to 1990, only Queensland and the ACT reversing positions.

The main SEO division in New South Wales, Victoria, Queensland, Western Australia, Northern Territory and the ACT was Advancement of knowledge with 37 per cent, 45 per cent, 37 per cent, 48 per cent, 66 per cent and 61 per cent respectively of total expenditure within those states. South Australia and Tasmania recorded the most expenditure in the SEO division of Economic development with 31 per cent and 44 per cent of state total expenditure.

Society was the second largest SEO division in all states other than Tasmania and the Northern Territory. In both Victoria and South Australia, the subdivision of Health accounted for 23 per cent of total expenditure.

### R&D EXPENDITURE BY STATE

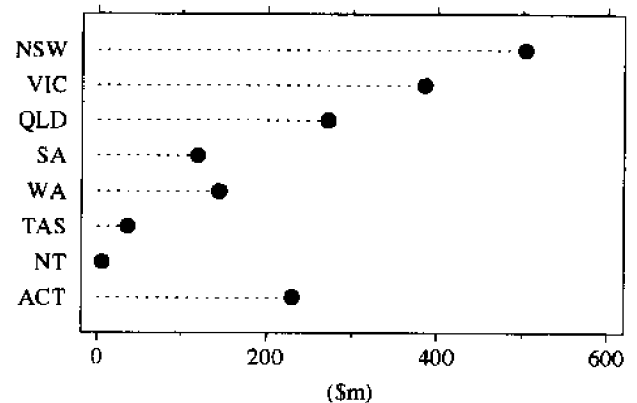


TABLE 7. LOCATION OF R&D EXPENDITURE BY SOCIO-ECONOMIC OBJECTIVE BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992 (\$'000)

Socio-economic objective	Location of expenditure								
	Total	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT
<b>Defence</b>	<b>2,926</b>	<b>1,279</b>	<b>191</b>	<b>532</b>	<b>665</b>	<b>119</b>	—	—	<b>139</b>
<i>Economic development</i>									
Plant — production and primary products	58,537	8,269	7,119	7,567	13,459	7,401	3,806	89	10,826
Animal — production and primary products	42,239	9,099	12,140	12,750	1,088	5,029	2,001	49	84
Mineral resources (excl. energy)	21,900	1,758	5,616	7,490	1,750	3,489	130	—	1,666
Energy resources	9,170	4,311	861	474	265	1,625	394	—	1,240
Energy supply	30,882	20,750	2,986	2,464	3,023	1,163	438	18	42
Manufacturing	75,018	30,538	15,288	10,159	5,228	1,645	2,967	—	9,173
Construction	38,513	19,508	5,102	2,280	4,948	5,080	1,550	—	46
Transport	4,536	1,264	1,266	508	619	829	50	—	—
Information and communication services	34,607	11,876	11,262	5,209	2,396	866	238	6	2,753
Commercial services	14,232	3,886	2,002	4,071	1,459	1,020	314	—	1,481
Economic framework	76,339	28,200	15,689	11,844	2,012	3,801	3,717	—	11,075
<b>Total Economic development</b>	<b>405,971</b>	<b>139,479</b>	<b>79,332</b>	<b>64,816</b>	<b>36,245</b>	<b>31,946</b>	<b>15,605</b>	<b>162</b>	<b>38,386</b>
<i>Society</i>									
Health	318,975	104,086	87,417	42,533	27,485	22,738	3,580	55	31,081
Education and training	81,286	24,477	19,787	20,078	3,949	7,004	2,743	128	3,119
Social development and community services	53,731	14,366	9,520	15,999	3,647	2,579	1,328	59	6,233
<b>Total Society</b>	<b>453,992</b>	<b>142,929</b>	<b>116,724</b>	<b>78,610</b>	<b>35,082</b>	<b>32,321</b>	<b>7,652</b>	<b>242</b>	<b>40,432</b>
<i>Environment</i>									
Environmental knowledge	84,780	20,384	10,991	17,169	12,117	6,696	6,407	1,533	9,483
Environmental aspects of economic development	35,800	9,476	4,678	5,014	8,076	3,351	3,514	—	1,691
Environmental management and other aspects	9,959	2,814	1,471	4,259	183	816	241	—	174
<b>Total environment</b>	<b>130,539</b>	<b>32,674</b>	<b>17,141</b>	<b>26,442</b>	<b>20,376</b>	<b>10,863</b>	<b>10,162</b>	<b>1,533</b>	<b>11,349</b>
<i>Advancement of knowledge</i>									
Natural sciences, technologies and engineering	422,316	95,845	106,804	66,943	19,604	45,625	2,032	316	85,147
Social sciences and humanities	279,466	90,984	65,501	34,310	6,275	23,699	199	3,479	55,017
<b>Total advancement of knowledge</b>	<b>701,782</b>	<b>186,829</b>	<b>172,306</b>	<b>101,253</b>	<b>25,879</b>	<b>69,324</b>	<b>2,231</b>	<b>3,795</b>	<b>140,164</b>
<b>TOTAL</b>	<b>1,695,209</b>	<b>503,189</b>	<b>385,695</b>	<b>271,653</b>	<b>118,247</b>	<b>144,574</b>	<b>35,650</b>	<b>5,732</b>	<b>230,471</b>

*State comparison (cont.)*

In New South Wales the predominant fields of research (FOR) are Medical and health sciences and Humanities, accounting for 19 per cent and 11 per cent respectively of total state expenditure. In Victoria, Queensland, South Australia and Western Australia the predominant FOR's are Medical and health sciences (24%, 15%, 24% and 20% respectively) and Biological sciences (10%, 15%, 14% and 11% respectively). In the ACT the predominant FOR's are Biological sciences (17%) and Physical sciences (13%).

TABLE 8. LOCATION OF R&D EXPENDITURE BY FIELD OF RESEARCH BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992 (\$'000)

Field of research	Location of expenditure								
	Total	NSW	Vic.	Qld	SA	WA	Tas.	NT	ACT
<i>Natural sciences, technologies and engineering</i>									
Mathematical sciences	45,091	14,993	11,036	3,920	3,951	2,606	665	52	7,868
Physical sciences	80,214	23,424	10,725	5,148	6,349	4,121	1,379	98	28,970
Chemical sciences	92,364	24,294	20,922	16,037	5,559	6,599	2,069	231	16,654
Earth sciences	76,265	19,247	7,883	9,425	6,626	7,521	5,598	52	19,915
Information, computers and communication technologies	74,876	17,929	22,805	16,438	5,150	6,398	1,354	31	4,771
Applied sciences and technologies	71,030	26,288	20,222	11,360	2,802	6,708	278	3	3,369
General Engineering	115,787	49,276	22,121	21,341	8,161	10,191	1,119	27	3,552
Biological sciences	194,370	37,587	38,043	41,740	17,130	15,649	3,858	1,406	38,955
Agricultural sciences	97,151	24,916	19,603	18,257	11,229	12,888	4,686	—	5,571
Medical and health sciences	314,309	94,710	93,349	40,007	28,951	29,293	4,306	144	23,551
<b>Total natural sciences, technologies and engineering</b>	<b>1,161,457</b>	<b>332,664</b>	<b>266,708</b>	<b>183,672</b>	<b>95,907</b>	<b>101,974</b>	<b>25,313</b>	<b>2,042</b>	<b>153,176</b>
<i>Social sciences and humanities</i>									
Accounting and finance	21,697	8,523	4,905	4,431	172	1,823	254	—	1,590
Economics	52,567	16,728	10,403	4,562	1,327	3,309	821	19	15,399
Political sciences	33,512	6,314	6,044	2,563	1,814	3,614	726	1,166	11,271
Sociology	19,125	5,238	5,905	3,401	956	885	403	77	2,259
Law	26,969	8,566	6,098	3,812	1,475	2,846	843	40	3,289
Psychology	36,326	13,052	8,423	7,333	2,019	3,393	768	281	1,057
Education	73,594	24,563	18,751	16,421	3,072	6,306	2,713	128	1,641
Other social sciences	106,717	29,748	20,750	23,161	4,621	7,574	780	570	19,513
Humanities	163,247	57,794	37,707	22,298	6,883	12,850	3,030	1,408	21,277
<b>Total social sciences and humanities</b>	<b>533,753</b>	<b>170,525</b>	<b>118,987</b>	<b>87,981</b>	<b>22,339</b>	<b>42,599</b>	<b>10,337</b>	<b>3,689</b>	<b>77,295</b>
<b>TOTAL</b>	<b>1,695,209</b>	<b>503,189</b>	<b>385,695</b>	<b>271,653</b>	<b>118,247</b>	<b>144,574</b>	<b>35,650</b>	<b>5,732</b>	<b>230,471</b>

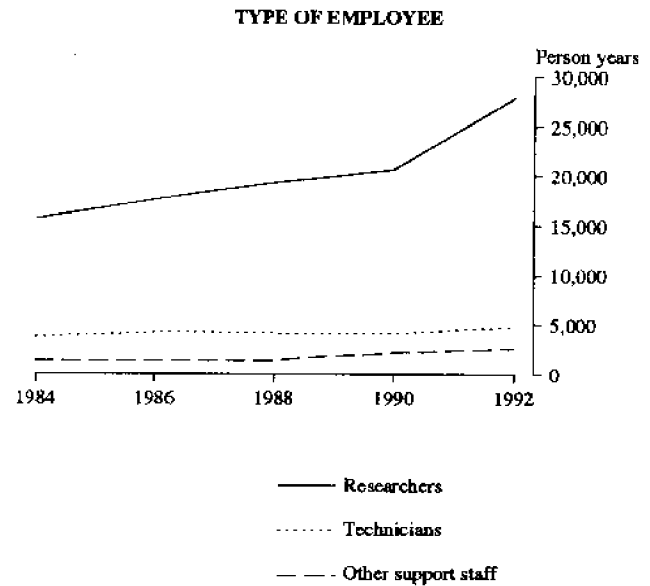
### Type of R&D staff

The percentage distribution by type of employee in 1992 has changed slightly when compared to 1990. Researchers have increased as a percentage of total employees at the expense of Technical and Other supporting staff. The percentage increase in Researchers (35%), was approximately double that of Technicians (17%) and Other supporting staff (18%).

There has also been a change in the composition of the research effort by Researchers. Academics now account for 36 per cent of effort by Researchers, a fall of 2 per cent, while Post graduates have increased by 2 per cent and now account for 64 per cent of Researcher effort.

### Research effort by socio-economic objective

The socio-economic objective of Advancement of knowledge accounted for 39 per cent of total research effort (person years) in the higher education sector in 1992. The subdivision of Health accounted for a further 17 per cent.



**TABLE 9. TYPE OF EMPLOYEE BY SOCIO-ECONOMIC OBJECTIVE BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992 (person years)**

Socio-economic objective	Type of employee				
	Total	Type of researcher			Other supporting staff
		Academic	Post Graduates	Technicians	
<b>Defence</b>	<b>78</b>	<b>13</b>	<b>48</b>	<b>14</b>	<b>4</b>
<i>Economic development</i>					
Plant — production and primary products	1,204	246	621	274	63
Animal — production and primary products	939	207	442	216	75
Mineral resources (excl. energy)	431	101	240	61	29
Energy resources	225	50	113	44	19
Energy supply	567	128	318	83	38
Manufacturing	1,794	395	983	314	103
Construction	808	169	514	87	38
Transport	124	24	70	19	11
Information and communication services	941	238	554	81	68
Commercial services	350	135	162	31	22
Economic framework	1,439	601	624	104	110
<b>Total Economic development</b>	<b>8,823</b>	<b>2,294</b>	<b>4,641</b>	<b>1,314</b>	<b>575</b>
<i>Society</i>					
Health	6,187	1,807	2,397	1,411	572
Education and training	2,402	833	1,246	147	177
Social development and community services	1,531	554	771	119	88
<b>Total Society</b>	<b>10,120</b>	<b>3,194</b>	<b>4,413</b>	<b>1,677</b>	<b>837</b>
<i>Environment</i>					
Environmental knowledge	1,770	427	949	250	144
Environmental aspects of economic development	731	192	433	63	43
Environmental management and other aspects	234	52	138	30	14
<b>Total environment</b>	<b>2,734</b>	<b>671</b>	<b>1,519</b>	<b>343</b>	<b>201</b>
<i>Advancement of knowledge</i>					
Natural sciences, technologies and engineering	7,936	2,204	3,900	1,274	558
Social sciences and humanities	5,726	1,684	3,334	236	471
<b>Total advancement of knowledge</b>	<b>13,662</b>	<b>3,889</b>	<b>7,234</b>	<b>1,510</b>	<b>1,030</b>
<b>TOTAL</b>	<b>35,418</b>	<b>10,059</b>	<b>17,855</b>	<b>4,858</b>	<b>2,646</b>

*Research effort by field of research*

The major fields of research in terms of research effort (person years) in the higher education sector in 1992 were Medical and health sciences (17%), Humanities (11%) and Biological sciences (10%).

TABLE 10. TYPE OF EMPLOYEE BY FIELD OF RESEARCH BY HIGHER EDUCATION ORGANISATIONS, AUSTRALIA, 1992  
(person years)

Field of research	Type of employee				
	Total	Type of researcher			Other supporting staff
		Academic	Post Graduates	Technicians	
<i>Natural sciences, technologies and engineering</i>					
Mathematical sciences	747	303	355	44	45
Physical sciences	1,454	384	635	296	140
Chemical sciences	1,859	517	950	259	133
Earth sciences	1,400	373	707	221	99
Information, computers and communication technologies	1,795	478	1,013	198	106
Applied sciences and technologies	1,548	348	875	244	81
General Engineering	2,441	459	1,404	423	155
Biological sciences	3,717	937	1,734	761	284
Agricultural sciences	1,946	409	1,015	390	131
Medical and health sciences	6,196	1,830	2,444	1,364	558
<b>Total natural sciences, technologies and engineering</b>	<b>23,103</b>	<b>6,039</b>	<b>11,132</b>	<b>4,200</b>	<b>1,732</b>
<i>Social sciences and humanities</i>					
Accounting and finance	429	219	168	28	15
Economics	923	374	365	69	115
Political sciences	678	202	390	24	62
Sociology	431	127	260	12	33
Law	575	266	226	28	55
Psychology	861	233	441	106	81
Education	2,059	691	1,105	126	137
Other social sciences	2,530	761	1,479	117	173
Humanities	3,828	1,149	2,289	148	242
<b>Total social sciences and humanities</b>	<b>12,315</b>	<b>4,021</b>	<b>6,723</b>	<b>658</b>	<b>914</b>
<b>TOTAL</b>	<b>35,418</b>	<b>10,059</b>	<b>17,855</b>	<b>4,858</b>	<b>2,646</b>



## EXPLANATORY NOTES

### Introduction

This publication presents estimates of expenditure and human resources devoted to Research and Development (R&D) carried out by Higher Education organisations in Australia during 1992.

2. Comparable R&D statistics are also produced for the Business Enterprise and General Government and Private Non-Profit sectors (Paragraph 19 lists relevant R&D related publications to which you may also wish to refer.).

### Data sources

3. The 1992 statistics presented in this publication have been compiled from data collected biennially from universities by the Department of Employment, Education and Training (DEET) in the Finance and Research Data collections.

4. Limited additional detailed R&D statistics will be available at a charge from the ABS when compiled. Revised details for previous R&D Surveys are also available.

5. The GDP(E) figures used to derive Higher Education expenditure on R&D / GDP ratios quoted in the Summary of Findings are current at time of manuscript finalisation (National Income, Expenditure and Product, September Quarter, 1994, Catalogue No 5206.0), and at current prices, are as follows: \$216,249m (1984-85); \$264,316m (1986-87); \$297,735m (1987-88); \$335,234m (1988-89); \$377,591m (1990-91) and \$405,794m (1992-93). 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, 1994-1", OECD, Paris 1994.

### Definitions

6. *Research and Experimental Development* is defined in accordance with the Organisation for Economic Co-operation and Development (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. For a more comprehensive interpretation of the definition of R&D, contact the ABS or refer to the OECD publication, "The Measurement of Scientific and Technological Activities ("Frascati Manual" 1993)" OECD, Paris 1994.

8. 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. 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.

### Scope and Coverage

9. 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.

10. 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

11. The statistics in this publication are classified by Socio-Economic Objective (SEO) and Field Of Research (FOR). For a more detailed description and explanation of SEO and FOR classifications see the Australian Standard Research Classification, 1993 (1297.0) or contact the ABS.

### Comparability with previous statistics

12. The 1992 statistics presented in this publication may not be strictly comparable with those for previous years, for the following reasons:

- (a) There was a change in the collection methodology, with both the 1990 and 1992 statistics being compiled from data collected biennially from universities by the Department of Employment, Education and Training (DEET), whereas statistics for earlier years were derived from ABS Research and Development Surveys in conjunction with general expenditure estimates obtained from DEET.
- (b) Both the SEO and FOR classifications have been revised. Extensive revisions were made prior to the 1990 survey, with further slight revisions before the 1992 survey. The revisions were prior to the release of the Australian Standard Research Classification (ASRC) in April 1993.

### Methodology for deriving university R&D expenditure estimates

13. The ABS obtained 1992 university R&D expenditure estimates by using data from the DEET Finance and Research Data collections.

14. In broad terms, the estimation of university R&D expenditure was carried out in the following manner:

- (a) *Direct Major Field of Research R&D expenditure.* Expenditure on research-only and the research component of Teaching and Research by Major Field of Research are extracted directly from DEET statistics.
- (b) *Direct Minor Field of Research R&D expenditure* is then derived by multiplying Major Field of Research R&D expenditure in (a) by the ratio of

Minor Field of Research R&D person years to Major Field of Research R&D person years. The ratio is calculated from reported data.

- (c) *Overhead R&D expenditure* is then derived by calculating the ratio of Minor Field of Research R&D person years to total university R&D person years. This ratio is then applied to university level overhead expenditure, the result being overhead R&D expenditure estimates at Minor Field of Research level.
- (d) *The sum of R&D expenditure* data derived at (b) and (c) forms the basis for expenditure estimates in this publication.

#### 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 must be interpreted with caution for the following reasons:

- (a) Many respondents had to make estimates because their accounts do not separately record data on R&D activity.
- (b) The OECD standard definition of R&D differs in some respects from what respondents may regard as R&D activity.
- (c) Some respondents have difficulties describing their R&D programs in terms of SEO, FOR and TOA. The data presented under these classifications will therefore reflect a degree of subjectivity.

#### Related publications

19. Users may also wish to refer to the following publications:

*Research and Experimental Development, Business Enterprises, Australia, 1992-93* (8104.0)

*Research and Experimental Development, General Government and Private Non-profit Organisations, Australia, 1992-93* (8109.0)

*Research and Experimental Development, All Sector Summary, Australia, 1992-93* (8112.0) (to be released shortly)

*Main Science and Technology Indicators 1994:1*, OECD, Paris, 1994

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

*The Australian Standard Research Classification (ASRC) 1993* (1297.0)

20. Current publications issued by the ABS are listed in the *Catalogue of Publications, Australia* (1101.0). The ABS also issues, on Tuesdays and Fridays, a *Publications Advice* (1105.0) which lists publications to be released in the next few days. The *Catalogue* and *Publications Advice* are available from any ABS office.

#### Symbols and other usages

- nil or rounded to zero
- r revised since previous issue

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

## GLOSSARY

*Applied research* is 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 pre-determined objectives.

*Basic research* is 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* is expenditure on the acquisition (less disposals) of fixed tangible assets such as land, buildings, vehicles, plant, machinery and equipment attributable to R&D activity.

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

*Field of Research* refers to the field in which the R&D activity was performed rather than the fields used in the research program. The FOR classification is primarily structured around disciplines or activities. It describes 'what' research is being performed.

*Human resources* devoted to R&D measures 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.

*Labour costs* include wages and salaries, payroll tax, payments to contract staff on the payroll, fringe benefit tax and workers compensation payments, sick pay, and

employer contributions to superannuation and pension schemes.

*Other current expenditure* is expenditure on materials, fuel, rent and hiring, repairs and maintenance, data processing, payments for the use of specialised testing facilities, commission and sub-contract work and the proportion of expenditure on general services and overheads which is attributable to R&D activity.

*Other supporting staff* are those skilled and unskilled craftspersons, secretarial and clerical staff directly associated with R&D activity.

*R&D activity* is systematic investigation or experimentation involving innovation or technical risk, the outcome of which is *new knowledge*, with or without 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* are those involved with the conception and/or development of new products/processes e.g. executives and directors involved in the planning or management of scientific and technical aspects of R&D projects, and software developers/programmers.

*Socio-Economic Objective (SEO)* refers to the *area of expected national benefit* rather than to 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 'why' the research is being performed.

*Technicians* are 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 computer programs.

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



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