Australian Bureau of Statistics

30 June 1994

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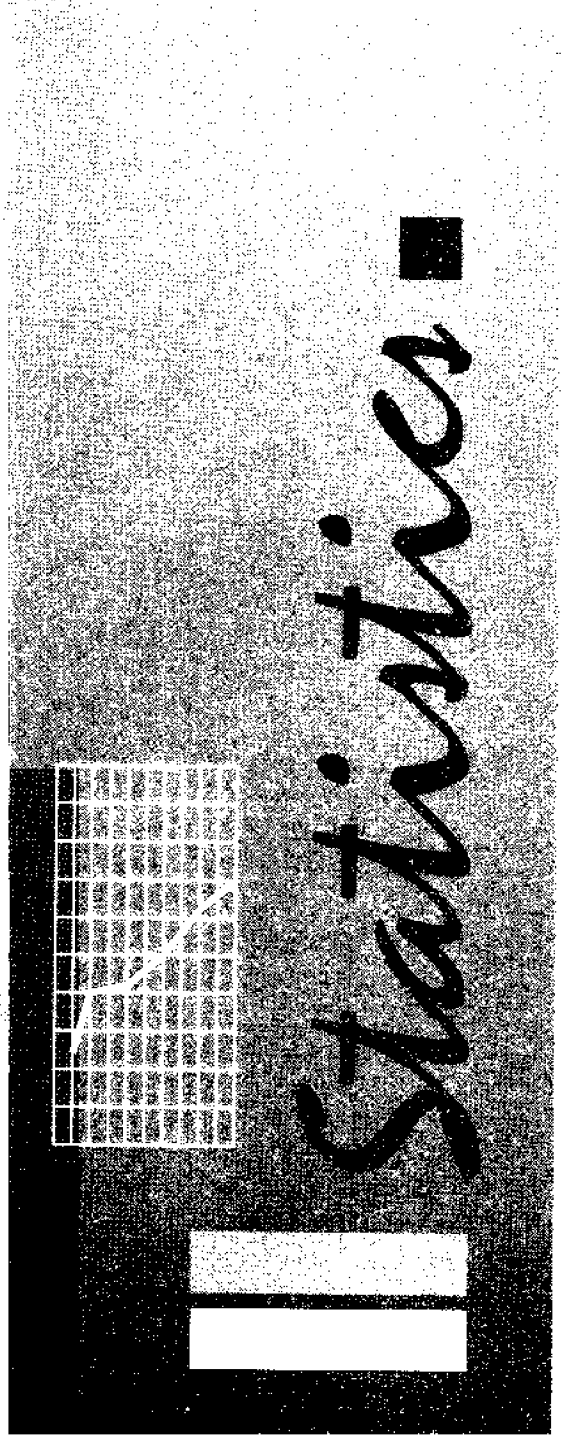
Mining Technology Statistics

Australia



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MINING TECHNOLOGY STATISTICS, AUSTRALIA
30 JUNE 1994

W. McLennan
Australian Statistician

AUSTRALIAN BUREAU OF STATISTICS

CATALOGUE NO. 8413.0

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INQUIRIES

- *for more information about statistics in this publication and the availability of related unpublished statistics,* contact Andrew Middleton on Adelaide (08) 8237 7539 or any ABS State Office.
- *for information about other ABS statistics and services,* please refer to the back of this publication.

INTRODUCTION

This publication presents information on mining technology for the period ending 30 June 1994. The previous issue of this publication related to the reference period ended 30 June 1991.

The 1993–94 survey of mining technology included an expanded coverage from the 1990–91 collection. In addition to data being collected from establishments with 10 or more employees classified to ANZSIC subdivisions 11 to 13 (Coal mining, oil and gas extraction and metal ore mining), details were collected from all establishments with 10 or more employees classified to ANZSIC subdivision 14 (Other mining) and ANZSIC subdivision 15 (Services to Mining). In 1990–91, the survey was ASIC based. Only establishments with 10 or more employees classified to ASIC subdivisions 11 to 13, and ASIC classes 1401 (Sand and Gravel) and 1505 (Non–metallic minerals n.e.c.) were in scope. Care should therefore be taken when comparing data for the 'Other mining' and 'Services to Mining' categories between 1990–91 and 1993–94.

The range of technologies collected has also been modified. Sources within the industry advised that diamond drilling, non-core drilling, shovel/excavator load monitoring and conveyor monitoring were no longer technologies relevant to mining; they have been excluded from the 1993–94 survey. Computer modelling and simulation systems have been added to the list of technologies covered in the 1993–94 survey. The 1990–91 survey data was revised in this publication by removing from aggregates those technologies that had been deleted in 1993–94. Hence direct comparisons of 1990–91 data in this issue and that released for 1990–91 on 8 June 1993 will reveal some differences. Newly included technologies for 1993–94 are shown as n.c. (not collected) in 1990–91.

MAIN FEATURES

USE OF TECHNOLOGY	Of the 559 mining establishments with 10 or more employees included in the survey, 80% had acquired one or more of the advanced technologies at 30 June 1994. Almost all (98%) coal mining establishments had acquired one or more advanced technologies by 30 June 1994.
PLANNED EXPENDITURE	The number of mining establishments planning no expenditure during the next five years on advanced technologies was 23% at 30 June 1994, compared with 41% at 30 June 1991. Establishments in the oil and gas extraction industry planning to spend over $10 million during the next five years on advanced technologies, increased from 6% in 1990–91 to 18% in 1993–94.
USE BY STATE	Establishments located in Western Australia reported the highest proportion of technology acquisition with 86% having acquired at least one advanced technology prior to June 1994. This compares with 74% prior to June 1991.
MOST COMMONLY ACQUIRED	The most commonly acquired broad level technology type was environmental technologies with 64% of establishments having these technologies. Rehabilitation design was the most commonly acquired specific technology with 55% of mining establishments in Australia having this technology at 30 June 1994.
SOURCE OF TECHNOLOGY	Australia continued to be the main source for technologies with at least 71% of each technology being acquired locally.
OVERSEAS OWNERSHIP	In the oil and gas extraction industry 30% of establishments with technology were overseas owned, while in the coal mining industry 29% of establishments with technology were overseas owned.
STAFF SKILL ISSUES	A total of 83% of mining establishments using at least one of the technologies reported no difficulty getting staff with the required skills necessary to ensure the normal operation, maintenance or programming associated with those surveyed technologies.
REASONS FOR INTRODUCTION	Primary reasons for introducing advanced mining technologies were to improve efficiency (72%) and increase output (63%). These were also rated as the most important reasons in 1990–91. Major reasons for introducing environmental monitoring and pollution abatement and control techniques were legislative requirements (79%) and concern for the environment (68%).
EFFECT ON PRODUCTION	Over half (52%) of the mining establishments in the survey reported an increase in output as a result of the introduction of the technology. A similar proportion (54%) reported an improvement in product quality as a result of the introduction of technology.
ENVIRONMENTAL TECHNIQUES	Techniques being used by a large proportion of establishments included silencers and protective equipment for the control of noise levels for employees and/or concern for the environment and revegetation and rehabilitation of sites.

SUMMARY OF FINDINGS

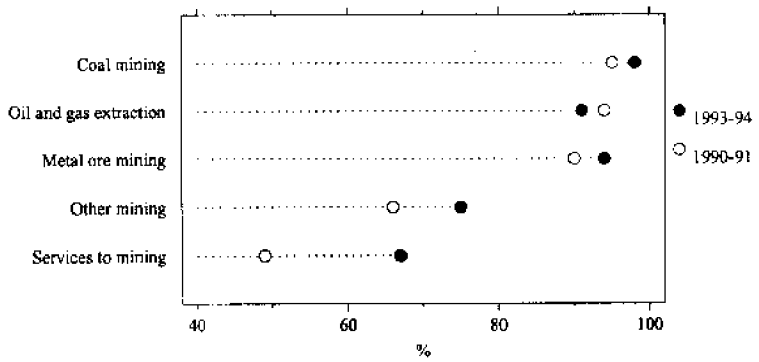
PROPORTION USING TECHNOLOGY

Of the 559 mining establishments with 10 or more employees included in the survey, 80% had acquired one or more advanced technologies at 30 June 1994. This compares with 72% of the 486 mining establishments that had acquired one or more advanced technologies at 30 June 1991.

The coal industry continued to show a very high proportion of establishments acquiring one or more advanced technologies with 98% at 30 June 1994 compared with 95% at 30 June 1991. The metal ore mining and oil and gas industries also have a high level of adoption of technology with 94% and 91% of establishments, respectively. The only industry in which a decline in use of technology was reported was oil and gas extraction, falling from 94% in 1990–91 to 91% in 1993–94.

Data reported in this survey does not include technologies (use or acquisition) by companies that are contracted to surveyed units. Increasing use of contractors is a possible contributing factor to differences that appear in the data of successive surveys.

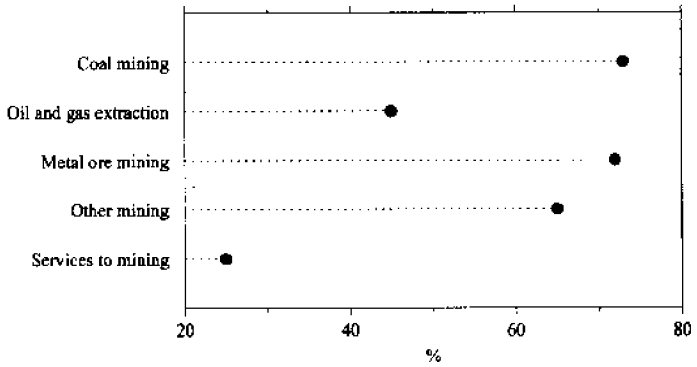
ESTABLISHMENTS USING TECHNOLOGY



COMMON TECHNOLOGIES

Of the surveyed technologies, 'rehabilitation design' was the most common, having been acquired by 55% of mining establishments in Australia at 30 June 1994. This technology was highly applied in the coal mining industry (73%) and the metal ore mining industry (72%). The next most commonly acquired technologies were 'aerial photography' and 'water quality monitoring' with 46% of mining establishments having acquired these technologies.

ESTABLISHMENTS USING REHABILITATION DESIGN, 30 JUNE 1994



The technology showing the largest increase in acquisition was 'aerial photography', increasing from 33% at 30 June 1991 to 46% at 30 June 1994. Acquisition of 'waste disposal design' technology decreased acquisition from 39% at 30 June 1991 to 27% at 30 June 1994.

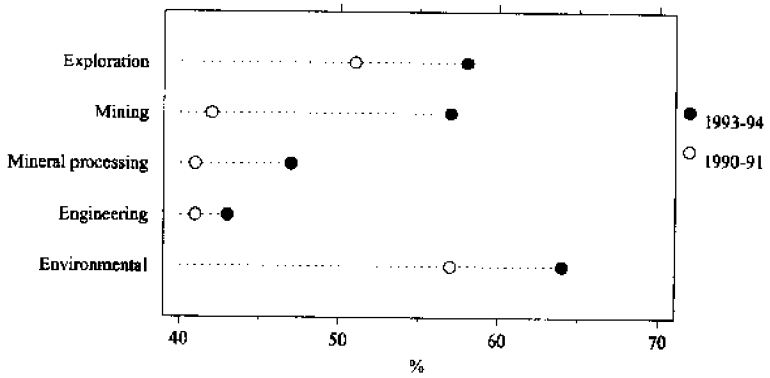
ADOPTION OF TECHNOLOGY

The coal industry continued to show the most consistent pattern of technology acquisition across broad technology categories, ranging from 75% for the adoption of exploration technologies to 93% for the adoption of environmental technologies. The services to mining industry increased its adoption of advanced technologies from 49% in 1991 to 67% in 1994.

MINING TECHNOLOGIES MOST ACQUIRED

Within individual technology categories, the acquisition of mining technologies increased to 57% at 30 June 1994 from 42% at 30 June 1991. Within this category, technologies had been adopted by 45% of establishments in the 'Other Mining' industry, compared with 23% at 30 June 1991.

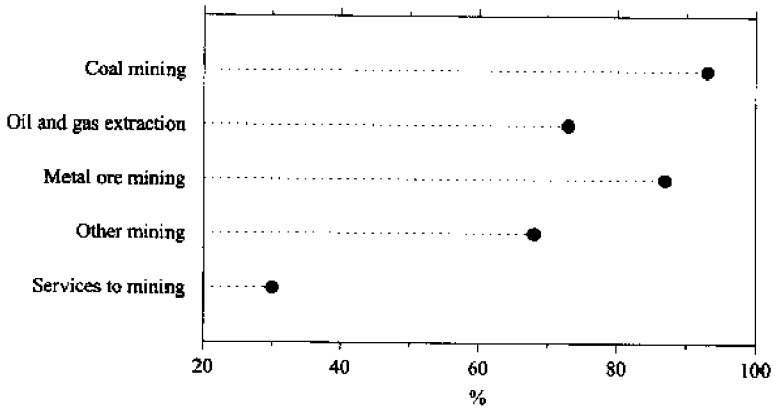
ESTABLISHMENTS USING TECHNOLOGY



Acquisition of broad level environmental technologies increased in all industries except the oil and gas extraction industry where 73% of establishments had acquired these technologies at 30 June 1994 compared with 81% at 30 June 1991.

As noted earlier the use of technologies by contracting companies is out of scope of this survey. The increasing use of contractors may contribute to variations in the reported level of technology use and/or acquisition over time.

ESTABLISHMENTS ACQUIRING ENVIRONMENTAL TECHNOLOGIES, 30 JUNE 1994



ESTABLISHMENTS WITH TECHNOLOGY BY TECHNOLOGY TYPE AND INDUSTRY AT 30 JUNE

	Coal mining		*Oil and gas extraction*		*Metal ore mining*	
	1991	*1994*	*1991*	*1994*	*1991*	*1994*
Detailed technology type	%	%	%	%	%	%
Exploration						
Aerial photography	52	57	31	36	52	69
Satellite/airborne scanner data	11	14	38	27	41	42
Airborne geophysics	14	19	25	55	51	51
Ground geophysics	40	63	69	64	52	57
Geochemical techniques	10	9	44	36	55	58
Image processing	33	52	75	73	52	61
Analytical techniques	26	37	69	64	68	72
Global positioning systems	17	23	63	82	31	46
Mining technologies						
Computer modelling and simulation systems	n.c.	79	n.c.	64	n.c.	64
Blasting analysis	26	37	—	—	40	34
Rock mechanics technology	49	42	6	9	41	40
Ground reinforcement design	33	41	—	9	33	38
Truck despatch technology	16	27	—	—	17	15
In-mine data transfer	50	58	—	9	26	30
Automated ground movement sensors	27	23	—	—	27	25
Drill rig monitoring	13	16	50	45	21	12
In-seam drilling	16	20	6	—	5	—
Guidance control mechanisms	32	30	38	9	19	25
Mineral processing technologies						
In-mine rock crushing	20	33	—	—	28	38
Automated material handling: particluate	31	44	—	9	22	30
Automated material handling: slurries	22	23	6	—	27	37
On-stream analysis	42	57	44	18	44	49
On-stream size analysis	8	10	—	—	19	17
Interactive expert systems for process supervision	8	22	19	18	19	16
Programmable logic controller(s)	65	75	38	55	60	74
Supervisory control and data acquisition	49	63	38	55	43	55
Material characterisation and liberation analysis	8	15	6	—	34	33
Engineering technologies						
Welding technology	27	35	44	45	33	38
Condition monitoring systems	57	75	69	55	54	53
Energy conservation	50	58	44	18	43	38
Environmental technologies						
Air quality monitoring	64	62	38	27	60	62
Meteorological monitoring	48	36	38	36	40	33
Water quality monitoring	74	72	50	73	69	79
Biological monitoring	23	21	25	55	38	43
Rehabilitation design	75	73	69	45	73	72
Waste disposal design	53	42	63	36	60	58
Proportion of establishments having one or more technologies	**95**	**98**	**94**	**91**	**90**	**94**

ESTABLISHMENTS WITH TECHNOLOGY BY TECHNOLOGY TYPE AND INDUSTRY AT 30 JUNE — *continued*

	Other mining		*Services to mining*		*Total mining*	
	1991	*1994*	*1991*	*1994*	*1991*	*1994*
Detailed technology type	%	%	%	%	%	%
Exploration						
Aerial photography	16	36	19	34	33	46
Satellite/airborne scanner data	3	1	17	32	21	23
Airborne geophysics	2	3	20	28	24	25
Ground geophysics	8	8	23	31	33	35
Geochemical techniques	3	4	20	36	26	28
Image processing	5	10	21	35	31	37
Analytical techniques	11	15	26	35	36	38
Global positioning systems	—	5	18	36	20	28
Mining technologies						
Computer modelling and simulation systems	n.c.	8	n.c.	16	n.c.	35
Blasting analysis	11	26	3	11	17	24
Rock mechanics technology	7	7	5	8	22	20
Ground reinforcement design	2	6	4	4	16	18
Truck despatch technology	15	30	2	5	10	18
In-mine data transfer	2	7	2	7	16	20
Automated ground movement sensors	2	6	2	6	13	13
Drill rig monitoring	5	12	10	11	14	13
In-seam drilling	—	—	7	2	7	4
Guidance control mechanisms	3	2	2	4	13	12
Mineral processing technologies						
In-mine rock crushing	5	16	1	4	12	19
Automated material handling: particulate	5	7	—	5	12	17
Automated material handling: slurries	2	4	3	2	12	13
On-stream analysis	10	7	3	7	23	24
On-stream size analysis	10	5	1	5	8	8
Interactive expert systems for process supervision	5	7	1	2	8	10
Programmable logic controller(s)	8	15	8	6	32	35
Supervisory control and data acquisition	11	15	7	6	25	29
Material characterisation and liberation analysis	8	2	4	2	13	11
Engineering technologies						
Welding technology	28	21	12	8	23	23
Condition monitoring systems	15	18	9	11	32	32
Energy conservation	16	17	7	4	26	23
Environmental technologies						
Air quality monitoring	23	31	11	9	35	35
Meteorological monitoring	7	7	10	7	25	18
Water quality monitoring	36	41	13	15	43	46
Biological monitoring	11	8	11	7	21	18
Rehabilitation design	49	65	22	25	50	55
Waste disposal design	38	17	17	8	39	27
Proportion of establishments having one or more technologies	**66**	**75**	**49**	**67**	**76**	**80**

ESTABLISHMENTS WITH TECHNOLOGY BY INDUSTRY AND BROAD TECHNOLOGY CATEGORY AT JUNE

ANZSIC Code	Industry description	Exploration 1991	Exploration 1994	Mining 1991	Mining 1994	Mineral processing 1991	Mineral processing 1994
		NUMBER					
11	Coal mining	59	61	69	68	67	71
12	Oil and gas extraction	14	9	9	8	8	7
13	Metal ore mining	97	101	76	98	84	105
14	Other mining	18	71	14	74	14	57
15	Services to mining	61	82	38	68	27	23
	Total mining[1]	**249**	**324**	**206**	**316**	**200**	**263**
		PER CENT					
11	Coal mining	67	75	78	84	76	88
12	Oil and gas extraction	88	82	56	73	50	64
13	Metal ore mining	78	81	61	78	68	84
14	Other mining	30	44	23	45	23	35
15	Services to mining	31	46	19	38	14	13
	Total mining	**51**	**58**	**42**	**57**	**41**	**47**

		Engineering 1991	Engineering 1994	Environmental 1991	Environmental 1994	Total establishments with technology 1991	Total establishments with technology 1994
		NUMBER					
11	Coal mining	62	70	77	75	84	79
12	Oil and gas extraction	11	8	13	8	15	10
13	Metal ore mining	77	86	104	109	112	117
14	Other mining	23	50	31	111	61	123
15	Services to mining	28	25	52	53	97	120
	Total mining[1]	**201**	**239**	**277**	**356**	**369**	**449**
		PER CENT					
11	Coal mining	70	86	88	93	95	98
12	Oil and gas extraction	69	73	81	73	94	91
13	Metal ore mining	62	69	84	87	90	94
14	Other mining	38	31	51	68	66	75
15	Services to mining	14	14	26	30	49	67
	Total mining	**41**	**43**	**57**	**64**	**76**	**80**

[1] A total of 486 establishments were surveyed in 1990–91. There were 559 establishments surveyed in 1993–94.

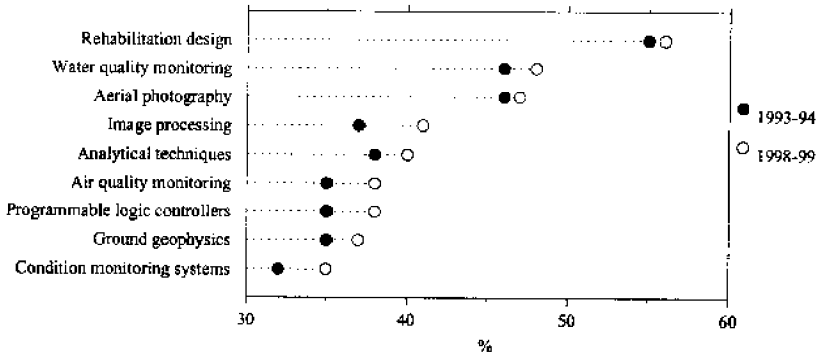
PLANNING TO ACQUIRE TECHNOLOGY

Only a small proportion of mining establishments not having a particular type of advanced technology in place at 30 June 1994 had plans to acquire that technology within five years. The only significant increase will be for in-mine data transfer technologies with a further 7% of establishments planning to acquire this technology within the next five years, increasing the proportion having it, to 27%.

Rehabilitation design technology was the most commonly acquired, with 55% of establishments already having it in place. However only a further 1% planned to acquire it within the next five years.

Global positioning system technology was currently being evaluated by 5% of establishments at 30 June 1994.

ACTUAL AND PLANNED TECHNOLOGY ACQUISITION



PLANNED ACQUISITION OF TECHNOLOGIES BY TECHNOLOGY TYPE, 30 JUNE 1994

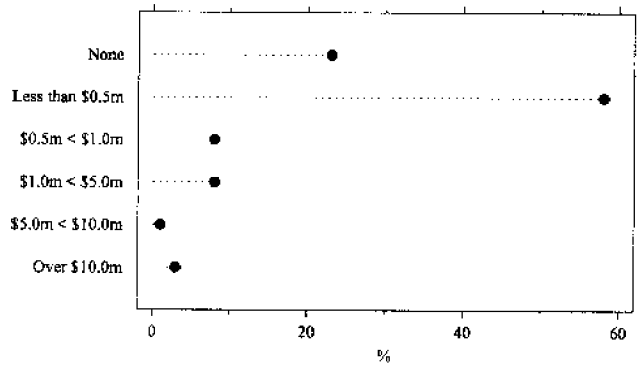
	Technology acquired		Being evaluated or tested		Planning to acquire within the next 2 years		Planning to acquire within the next 2-5 years		No plan to acquire			
									Not cost effective		Not applicable	
Detailed technology type	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Exploration												
Aerial photography	255	46	5	1	4	1	1	—	9	2	285	51
Satellite/airborne scanner data	126	23	7	1	4	1	2	—	26	5	394	70
Airborne geophysics	141	25	8	1	4	1	3	1	29	5	374	67
Ground geophysics	197	35	13	2	7	1	5	1	18	3	319	57
Geochemical techniques	156	28	3	1	2	—	—	—	17	3	381	68
Image processing	205	37	21	4	15	3	5	1	9	2	304	54
Analytical techniques	213	38	9	2	3	1	4	1	8	1	322	58
Global positioning systems	158	28	27	5	6	1	12	2	12	2	344	62
Mining technologies												
Computer modelling and simulation systems	193	35	12	2	13	2	11	2	17	3	313	56
Blasting analysis	135	24	17	3	3	1	20	4	27	5	357	64
Rock mechanics technology	111	20	11	2	3	1	18	3	12	2	391	70
Ground reinforcement design	98	18	8	1	6	1	10	2	21	4	416	74
Truck despatch technology	99	18	30	5	9	2	22	4	59	11	340	61
In-mine data transfer	110	20	18	3	24	4	18	3	33	6	356	64
Automated ground movement sensors	70	13	6	1	5	1	15	3	26	5	437	78
Drill rig monitoring	72	13	20	4	8	1	17	3	46	8	396	71
In-seam drilling	20	4	3	1	—	—	3	1	9	2	524	94
Guidance control mechanisms	67	12	5	1	3	1	14	3	24	4	446	80
Mineral processing technologies												
In-mine rock crushing	108	19	10	2	5	1	25	4	31	6	380	68
Automated material handling: particulate	95	17	19	3	5	1	11	2	32	6	397	71
Automated material handling: slurries	75	13	4	1	2	—	5	1	25	4	448	80
On-stream analysis	134	24	15	3	9	2	11	2	24	4	366	65
On-stream size analysis	46	8	16	3	9	2	11	2	28	5	449	80
Interactive expert systems for process supervision	55	10	28	5	6	1	17	3	31	6	422	75
Programmable logic controller(s)	195	35	17	3	10	2	5	1	16	3	316	57
Supervisory control and data acquisition	161	29	8	1	16	3	9	2	22	4	343	61
Material characterisation and liberation analysis	60	11	4	1	2	—	5	1	26	5	462	83
Engineering technologies												
Welding technology	129	23	3	1	—		2	—	21	4	404	72
Condition monitoring systems	181	32	9	2	8	1	11	2	26	5	324	58
Energy conservation	131	23	27	5	3	1	11	2	21	4	366	65
Environmental technologies												
Air quality monitoring	197	35	15	3	3	1	10	2	17	3	317	57
Meteorological monitoring	98	18	15	3	5	1	2	—	4	1	435	78
Water quality monitoring	259	46	10	2	6	1	6	1	10	2	268	48
Biological monitoring	102	18	11	2	—	—	4	1	17	3	425	76
Rehabilitation design	305	55	15	3	—	—	7	1	11	2	221	40
Waste disposal design	151	27	12	2	—	—	8	1	9	2	379	68

PLANNED EXPENDITURE

Compared with the 1990–91 survey, there is little change in the proportion of businesses (12%) planning to spend over $1.0 million on technology. There is an increase, from 4% to 8%, in the proportion planning to spend between $0.5 million and $1.0 million, and an increase from 44% to 58% in the proportion planning to spend less than $0.5 million. The proportion planning no expenditure on technology fell from 41% in 1990–91 to 23% in 1993–94.

The proportion of establishments in the oil and gas extraction industry planning to spend over $10 million on advanced technologies increased from 6% at 30 June 1991 to 18% at 30 June 1994.

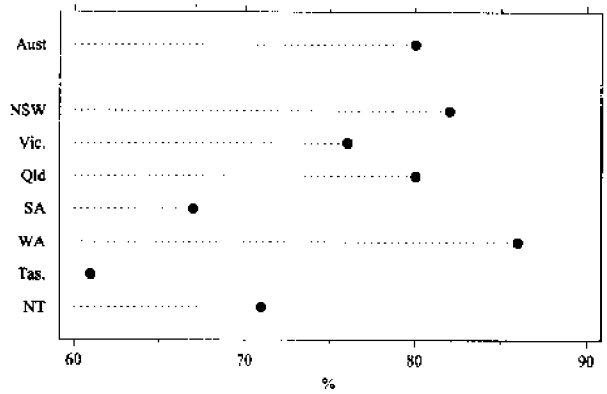
ESTABLISHMENTS PLANNING EXPENDITURE ON TECHNOLOGY, 30 JUNE 1994



ACQUISITION BY STATE

In Western Australia, 86% of establishments had acquired at least one advanced technology at 30 June 1994.

ESTABLISHMENTS USING TECHNOLOGY, 30 JUNE 1994



The broad level category most commonly adopted was 'environmental technologies' with 64% of establishments having these technologies. Acquisition of 'mining technologies' increased to 57% at 30 June 1994 from 42% at 30 June 1991. Within the 'mining technology' category Western Australia and New South Wales had the highest proportion of all States and Territories with 68% and 60% of establishments adopting the technology respectively.

Nationally, acquisition of 'exploration technologies' increased by 7 percentage points although their use was greatest in Western Australia with 64% of establishments having these technologies. Acquisition of 'mineral processing' technologies increased 6 percentage points to 47%, with the largest increase occurring in Western Australia where adoption of the technologies increased by 13 percentage points to 53% by 30 June 1994. Acquisition of 'engineering technologies' increased 2 percentage points to 43% as at 30 June 1994, with Tasmania reporting 56% (up from 31% at 30 June 1991) of establishments adopting these technologies. Tasmania had the lowest proportion of establishments with technology with only 61% of establishments having acquired a technology by 30 June 1994.

PLANNED EXPENDITURE ON TECHNOLOGY BY INDUSTRY AND EXPENDITURE RANGE

ANZSIC code	Industry description	Nil		Less than $0.5m		$0.5m to less than $1.0m	
		1990–91	1993–94	1990–91	1993–94	1990–91	1993–94
		%	%	%	%	%	%
11	Coal mining	17	6	57	53	3	15
12	Oil and gas extraction	13	18	56	45	6	9
13	Metal ore mining	27	14	52	57	9	10
14	Other mining	62	28	34	62	—	5
15	Services to mining	56	32	36	58	3	6
	Total mining	**41**	**23**	**44**	**58**	**4**	**8**

		$1.0m to less than $5.0m		$5.0m to less than $10.0m		Over $10.0m	
		1990–91	1993–94	1990–91	1993–94	1990–91	1993–94
		%	%	%	%	%	%
11	Coal mining	15	19	5	1	3	6
12	Oil and gas extraction	19	9	—	—	6	18
13	Metal ore mining	9	13	1	3	2	3
14	Other mining	3	4	—	1	—	—
15	Services to mining	5	2	1	1	1	2
	Total mining	**8**	**8**	**1**	**1**	**2**	**3**

ESTABLISHMENTS WITH TECHNOLOGY BY INDUSTRY AND STATE, 30 JUNE 1994

ANZSIC code	Industry description	NSW[1]	Vic.	Qld	SA	WA	Tas.	NT	Aust.
		%	%	%	%	%	%	%	%
11	Coal mining	96	100	100	100	100	100	—	98
12	Oil and gas extraction	—	100	100	100	83	—	—	91
13	Metal ore mining	91	88	90	75	97	83	100	94
14	Other mining	75	83	76	62	85	63	—	75
15	Services to mining	71	50	64	64	76	—	58	67
	Total mining	**82**	**76**	**80**	**67**	**86**	**61**	**71**	**80**

[1] Includes the Australian Capital Territory

ESTABLISHMENTS WITH TECHNOLOGY BY STATE/TERRITORY AND BROAD CATEGORY, 30 JUNE

State/Territory	Exploration		Mining		Mineral processing	
	1991	1994	1991	1994	1991	1994
	NUMBER					
New South Wales[1]	68	77	68	91	68	86
Victoria	14	35	5	24	9	14
Queensland	47	75	42	62	40	54
South Australia	10	16	8	11	6	6
Western Australia	96	104	69	110	64	86
Tasmania	6	6	6	8	6	9
Northern Territory	8	11	8	10	7	8
Australia[2]	**249**	**324**	**206**	**316**	**200**	**263**
	PER CENT					
New South Wales[1]	53	51	54	60	54	58
Victoria	38	60	14	41	24	24
Queensland	46	63	41	52	39	45
South Australia	37	53	30	37	22	20
Western Australia	60	64	43	68	40	53
Tasmania	46	33	46	44	46	50
Northern Territory	42	52	40	48	35	35
Australia	**51**	**58**	**42**	**57**	**41**	**47**

	Engineering		Environmental		Total establishments with technology	
	1991	1994	1991	1994	1991	1994
	NUMBER					
New South Wales[1]	78	75	91	109	107	124
Victoria	7	21	15	33	20	44
Queensland	31	51	51	76	65	95
South Australia	9	7	10	15	15	20
Western Australia	62	70	91	103	118	140
Tasmania	4	10	8	10	9	11
Northern Territory	10	5	11	10	14	15
Australia[2]	**201**	**239**	**277**	**356**	**369**	**449**
	PER CENT					
New South Wales[1]	61	50	71	72	84	82
Victoria	19	36	41	57	54	76
Queensland	30	43	50	64	63	80
South Australia	33	23	37	50	55	67
Western Australia	39	43	57	64	74	86
Tasmania	31	56	62	56	69	61
Northern Territory	50	22	58	48	74	71
Australia	**41**	**43**	**57**	**64**	**76**	**80**

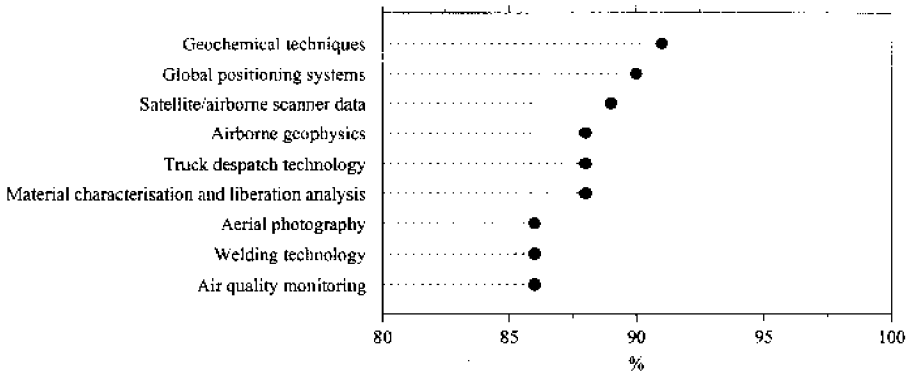
1 Includes the Australian Capital Territory.

2 A total of 486 establishments were surveyed in 1990–91. There were 559 establishments surveyed in 1993–94.

SOURCE OF TECHNOLOGY

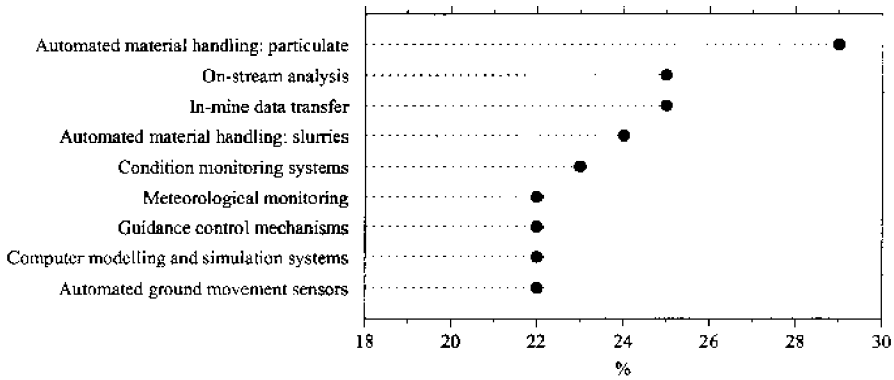
The source of most of the advanced technologies used by mining establishments continues to be Australia. For each of the technologies acquired, at least 71% were obtained from Australian sources. (The source referred to is the original source of the technology. Where the technology consisted of components or items from different sources it was classified according to the source representing the greatest dollar value of the technology. Technology developed 'in–house' is included.) Establishments with 'geochemical techniques' (91%) and 'global positioning systems' (90%) primarily acquired them from Australian sources.

TECHNOLOGIES SOURCED PRIMARILY FROM AUSTRALIA, 30 JUNE 1994



The technologies primarily to come from overseas were 'automated material handling particulate' (29% of establishments), 'in-mine data transfer' and 'on stream analysis' (both with 25% of mining establishments).

TECHNOLOGIES SOURCED PRIMARILY FROM OVERSEAS, 30 JUNE 1994



ESTABLISHMENTS WITH TECHNOLOGY BY TYPE AND SOURCE OF TECHNOLOGY, 30 JUNE 1994

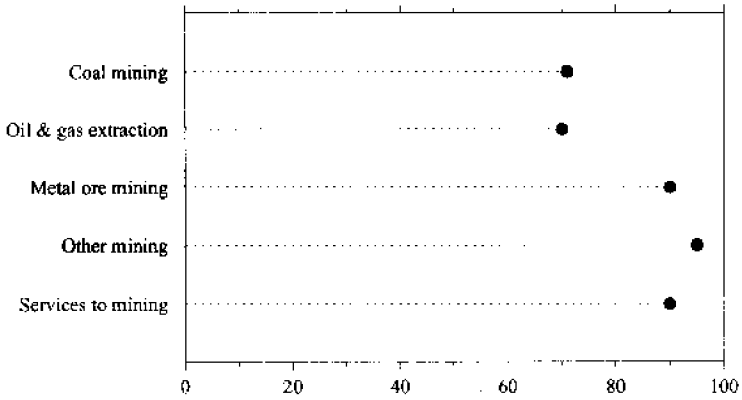
Detailed technology type	*Australia* %	*Overseas* %
Exploration		
Aerial photography	86	14
Satellite/airborne scanner data	89	11
Airborne geophysics	88	12
Ground geophysics	84	16
Geochemical techniques	91	9
Image processing	84	16
Analytical techniques	84	16
Global positioning systems	90	10
Mining technologies		
Computer modelling and simulation systems	78	22
Blasting analysis	85	15
Rock mechanics technology	80	20
Ground reinforcement design	84	16
Truck despatch technology	88	12
In-mine data transfer	75	25
Automated ground movement sensors	78	22
Drill rig monitoring	82	18
In-seam drilling	85	15
Guidance contr ol mechanisms	78	22
Mineral processing technologies		
In-mine rock crushing	84	16
Automated material handling: particulate	71	29
Automated material handling: slurries	76	24
On-stream analysis	75	25
On-stream size analysis	85	15
Interactive expert systems for process supervision	72	18
Programmable logic controller(s)	80	20
Supervisory control an d data a cquisition	79	21
Material characterisation and liberation analysis	88	12
Engineering technologies		
Welding technology	86	14
Condition monitoring systems	77	23
Energy conservation	80	20
Environmental technologies		
Air quality monitoring	86	14
Meteorological monitoring	78	22
Water quality monitoring	85	15
Biological monitoring	76	24
Rehabilitation design	86	14
Waste disposal design	83	17

OWNERSHIP OF ESTABLISHMENTS

There was little difference between proportions with and without technology, in terms of Australian or overseas ownership, with 88% of establishments with technology and 92% of establishments without technology being Australian owned.

Of coal mining establishments, 71% with technology were Australian owned, while all establishments without technology were Australian owned. In oil and gas extraction, 70% of establishments with technology were Australian owned, and all establishments without technology were overseas owned. All establishments without technology in the metal ore mining industry were Australian owned.

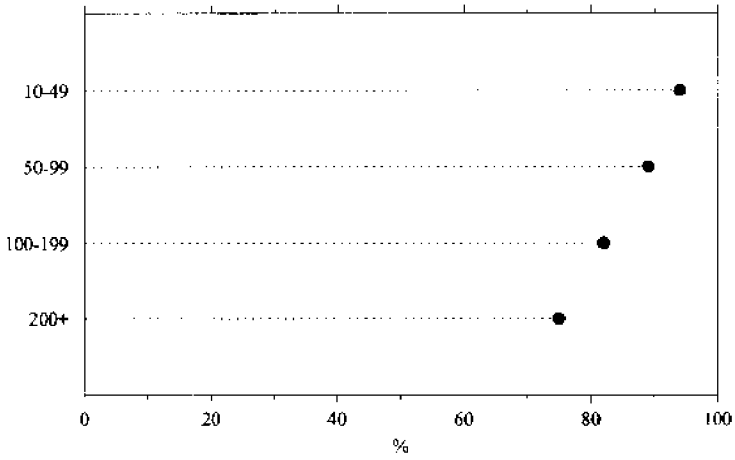
AUSTRALIAN OWNED ESTABLISHMENTS WITH TECHNOLOGY, 30 JUNE 1994



EMPLOYMENT

As the employment size increases the level of Australian ownership decreases. Three-quarters (75%) of establishments with 200 or more employees were Australian owned as at 30 June 1994. Establishments with technology and employment less than 100 have the highest proportion of Australian ownership. In the 10–49 and 50–99 employment size ranges, 94% and 89% of establishments respectively were Australian owned.

AUSTRALIAN OWNED ESTABLISHMENTS WITH TECHNOLOGY BY EMPLOYMENT SIZE, 30 JUNE 1994



STRATEGIES USED TO ENSURE STAFF ARE SKILLED

Of the mining establishments using at least one of the technologies, 83% reported no difficulty getting staff with the required skills necessary to ensure the normal operation, maintenance or programming associated with those surveyed technologies.

The most common strategies used to ensure staff are skilled was 'on the job training' for existing employees, 94% of establishments using this method moderately or very frequently. The next most commonly used strategy was the 'supplier providing training', 88% of establishments reporting frequently using this method.

OWNERSHIP BY INDUSTRY AND TECHNOLOGY, 30 JUNE 1994

ANZSIC code	Industry description	Establishments with technology		Establishments without technology	
		Australian	Overseas	Australian	Overseas
		%	%	%	%
11	Coal mining	71	29	100	—
12	Oil and gas extraction	70	30	—	100
13	Metal ore mining	90	10	100	—
14	Other mining	95	5	86	14
15	Services to mining	90	10	86	14
	Total mining	**88**	**12**	**92**	**8**

OWNERSHIP BY EMPLOYMENT AND TECHNOLOGY, 30 JUNE 1994

Employment size	Establishments with technology		Establishments without technology	
	Australian	Overseas	Australian	Overseas
	%	%	%	%
10–49	94	6	95	5
50–99	89	11	83	17
100–199	82	18	67	33
200+	75	25	—	—
Total mining	**88**	**12**	**92**	**8**

STRATEGIES USED TO ENSURE STAFF ARE SKILLED, 30 JUNE 1994

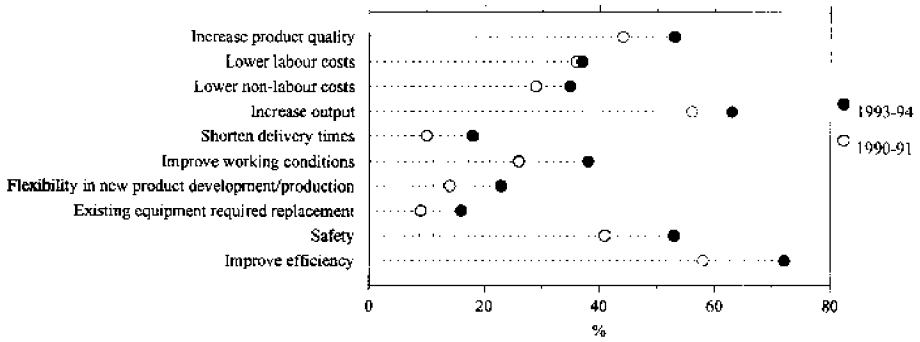
Strategies used	Frequency of usage		
	Very frequent	Moderately frequent	Never
	%	%	%
Recruit skilled employees from outside	11	55	34
On-the-job-training for existing employees	38	56	6
In-house training courses for existing employees	19	58	23
External training courses for existing employees	7	74	19
Supplier provides training	14	74	12
Proportion of establishments having no difficulty getting staff with required skills[1]			83
Proportion of establishments having difficulty getting staff with required skills[1]			17

[1] Includes skills necessary for the operation, maintenance etc. of advance equipment.

REASONS FOR INTRODUCTION OF TECHNOLOGY

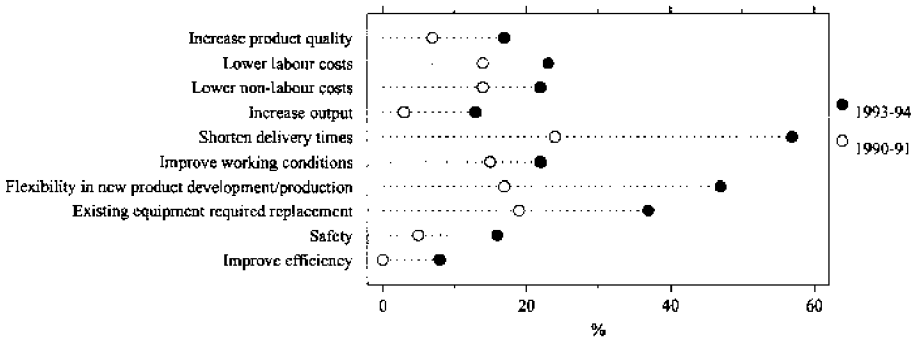
The most important reasons for introducing advanced mining technologies in 1993–94 were improvements in efficiency and increasing output. These reasons were rated as very important by 72% and 63%, respectively. Both reasons were also rated as very important (58% and 56%) in 1990–91. All oil and gas industry establishments nominated improvements in efficiency as very important, as did 78% of metal ore industry establishments.

REASONS FOR INTRODUCING ADVANCED TECHNOLOGY RATED AS VERY IMPORTANT (PERCENTAGE OF ESTABLISHMENTS)



The reasons that most frequently rated as not important were 'shorten delivery times' and 'flexibility in new product development/production' with 57% and 47% of establishments, respectively. 'Shorten delivery times' was rated as not important by 80% of oil and gas establishments and 57% of coal mining establishments.

REASONS FOR INTRODUCING ADVANCED TECHNOLOGY RATED AS NOT IMPORTANT (PERCENTAGE OF ESTABLISHMENTS)



REASONS FOR INTRODUCING TECHNOLOGY AT 30 JUNE

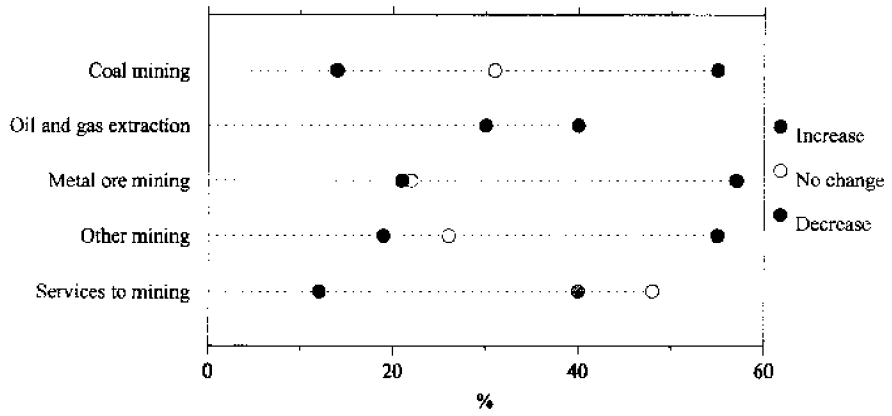
Reason		Coal mining %	Oil and gas extraction %	Metal ore mining %	Other mining %	Services to mining %	**Total mining %**
		PROPORTION WITH REASONS RATED AS VERY IMPORTANT[1]					
Increase product quality	1991	50	33	47	28	43	**44**
	1994	61	40	56	50	49	**53**
Lower labour costs	1991	49	20	43	13	29	**36**
	1994	44	30	39	41	25	**37**
Lower non-labour costs	1991	30	27	39	20	20	**29**
	1994	39	20	41	46	17	**35**
Increase output	1991	63	33	64	35	52	**56**
	1994	66	50	69	59	62	**63**
Shorten delivery times	1991	11	—	8	15	11	**10**
	1994	16	10	6	22	28	**18**
Improve working conditions	1991	27	—	31	20	24	**26**
	1994	39	10	45	38	31	**38**
Flexibility in new product development/production	1991	17	—	13	10	15	**14**
	1994	25	—	25	20	24	**23**
Existing equipment required replacement	1991	13	—	9	8	8	**9**
	1994	11	—	16	25	9	**16**
Safety	1991	55	53	46	28	28	**41**
	1994	58	50	69	49	38	**53**
Improve efficiency	1991	74	27	66	35	51	**58**
	1994	73	100	78	70	64	**72**
		PROPORTION WITH REASONS RATED AS NOT IMPORTANT[1]					
Increase product quality	1991	7	27	7	5	6	**7**
	1994	16	10	23	15	22	**17**
Lower labour costs	1991	10	13	11	15	20	**14**
	1994	16	10	13	30	32	**23**
Lower non-labour costs	1991	10	20	13	10	18	**14**
	1994	11	40	18	26	26	**22**
Increase output	1991	4	—	2	10	2	**3**
	1994	10	10	13	15	13	**13**
Shorten delivery times	1991	32	20	27	28	13	**24**
	1994	57	80	71	50	51	**57**
Improve working conditions	1991	10	13	10	15	25	**15**
	1994	15	40	9	18	43	**22**
Flexibility in new product development/production	1991	26	7	12	18	18	**17**
	1994	49	50	46	42	51	**47**
Existing equipment required replacement	1991	24	20	13	25	18	**19**
	1994	44	40	36	24	45	**37**
Safety	1991	2	—	4	10	7	**5**
	1994	13	—	8	21	24	**16**
Improve efficiency	1991	—	—	—	—	—	**—**
	1994	8	—	4	9	10	**8**

[1] Establishments were asked to rate in order of importance each of these reasons.

EFFECT OF TECHNOLOGY ON PRODUCTION

Over half (52%) of the mining establishments in the survey reported an increase in output as a result of the introduction of the technology. A similar proportion (54%) reported an improvement in product quality as a result of introduction of technology.

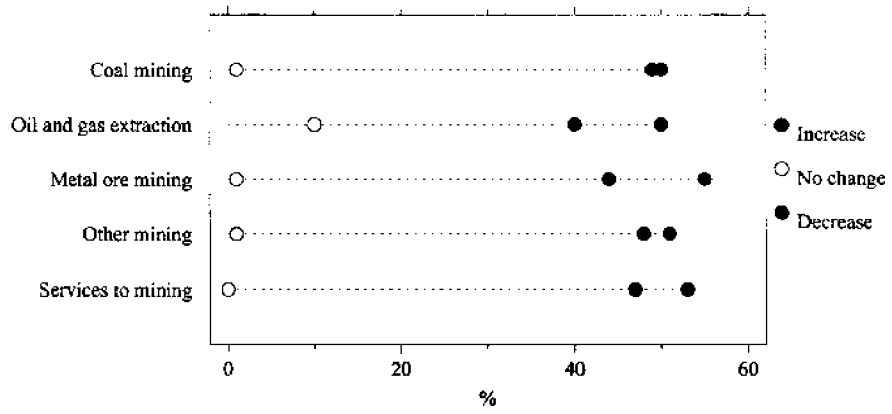
EFFECT ON PRODUCTION COSTS, 30 JUNE 1994



The introduction of technologies in the coal mining industry resulted in 55% of establishments reporting a decrease in production costs. In 'Other mining' and the 'Services to mining' industries, 'Product quality' improved by 12 percentage points to 57% at 30 June 1994, while 'output quantity' rose by 18 percentage points to 51% for 'Other mining' over the same period.

The introduction of advanced technologies resulted in a decrease in 'production costs' for 51% of establishments, an increase of 13 percentage points on the corresponding figure at 30 June 1991. No change in 'production costs' was reported by 32% of establishments.

EFFECT ON OUTPUT QUANTITY, 30 JUNE 1994



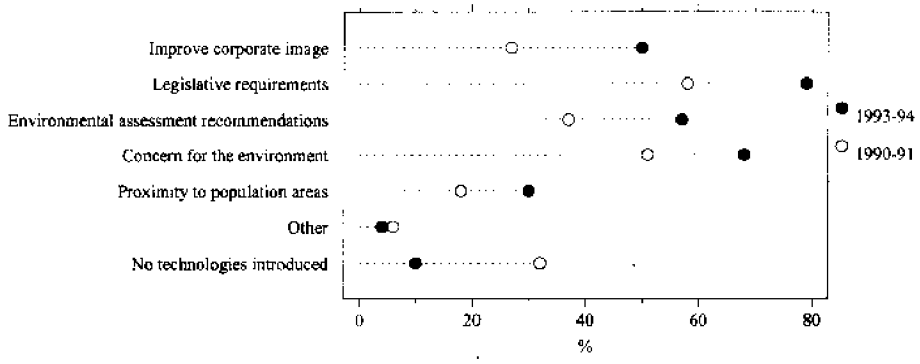
EFFECT OF TECHNOLOGY ON PRODUCTION AT 30 JUNE

ANZSIC code	Industry description	Decrease 1991 %	Decrease 1994 %	No change 1991 %	No change 1994 %	Increase 1991 %	Increase 1994 %
		OUTPUT QUANTITY					
11	Coal mining	—	1	46	50	54	49
12	Oil and gas extraction	7	10	27	40	67	50
13	Metal ore mining	4	1	49	44	46	55
14	Other mining	8	1	60	48	33	51
15	Services to mining	2	—	58	47	40	53
	Total mining	**3**	**1**	**51**	**47**	**46**	**52**
		PRODUCT QUALITY					
11	Coal mining	—	—	44	51	56	49
12	Oil and gas extraction	—	—	47	40	53	60
13	Metal ore mining	1	—	48	49	51	51
14	Other mining	—	—	55	43	45	57
15	Services to mining	1	—	54	43	45	57
	Total mining	**1**	**—**	**49**	**46**	**50**	**54**
		PRODUCTION COSTS					
11	Coal mining	49	55	25	31	26	14
12	Oil and gas extraction	40	40	27	30	33	30
13	Metal ore mining	49	57	19	22	32	21
14	Other mining	25	55	45	26	30	19
15	Services to mining	20	40	51	48	30	12
	Total mining	**38**	**51**	**32**	**32**	**30**	**17**
		PROCESSING TIME					
11	Coal mining	31	36	62	56	7	8
12	Oil and gas extraction	40	50	40	40	20	10
13	Metal ore mining	31	29	57	63	12	8
14	Other mining	18	27	75	64	8	8
15	Services to mining	21	48	56	42	24	10
	Total mining	**27**	**36**	**59**	**56**	**14**	**9**

REASONS FOR INTRODUCING CONTROL TECHNIQUES

The major reasons for introducing environmental monitoring and pollution abatement and control techniques were 'legislative requirements' (79%) and 'concern for the environment' (68%). These categories were also the main reasons at 30 June 1991 although the percentages were lower at 58% and 51%, respectively. In the 1993–94 survey, 50% of establishments reported 'improving corporate image' as a factor in introducing environmental control techniques. This was an increase from the 27% reported in the 1990–91 survey.

REASONS FOR INTRODUCING ENVIRONMENTAL CONTROL TECHNIQUES (PERCENTAGE OF ESTABLISHMENTS)



REASONS[1] FOR INTRODUCING ENVIRONMENTAL MONITORING AND POLLUTION ABATEMENT CONTROL TECHNIQUES

Reason		*Coal mining*	*Oil and gas extraction*	*Metal ore mining*	*Other mining*	*Services to mining*	***Total mining***
			NUMBER				
Improve corporate image	1990–91	41	4	52	14	21	**132**
	1993–94	55	5	68	84	70	**282**
Legislative requirements	1990–91	72	14	97	29	72	**284**
	1993–94	72	10	112	127	123	**444**
Environmental assessment recommendations	1990–91	41	7	59	23	35	**179**
	1993–94	50	6	86	99	79	**320**
Concern for the environment	1990–91	72	13	88	26	48	**247**
	1993–94	75	9	107	116	75	**382**
Proximity to populated areas	1990–91	33	1	29	13	17	**89**
	1993–94	43	1	37	68	18	**167**
Other	1990–91	6	—	4	3	15	**28**
	1993–94	5	1	1	4	13	**24**
No technologies introduced	1990–91	9	2	14	25	106	**156**
	1993–94	1	1	6	21	27	**56**
			PER CENT				
Improve corporate image	1990–91	47	25	42	23	11	**27**
	1993–94	68	45	54	52	39	**50**
Legislative requirements	1990–91	82	88	78	48	37	**58**
	1993–94	89	91	90	78	69	**79**
Environmental assessment recommendations	1990–91	47	44	59	38	18	**37**
	1993–94	62	55	69	61	44	**57**
Concern for the environment	1990–91	82	81	71	43	24	**51**
	1993–94	93	82	86	71	42	**68**
Proximity to populated areas	1990–91	33	6	23	21	9	**18**
	1993–94	53	9	30	42	10	**30**
Other	1990–91	7	—	3	5	8	**6**
	1993–94	6	9	1	2	7	**4**
No technologies introduced	1990–91	10	13	11	41	54	**32**
	1993–94	1	9	5	13	15	**10**

[1] An individual establishment could have selected more than one reason.

USE OF POLLUTION ABATEMENT AND CONTROL TECHNIQUES

The most common technique used to control dust and other substances emitted into the air was the 'application of water', with 77% of establishments using this technique. A total of 98% of coal mining establishments used this technique which was also used by the majority (92%) of units in the metal ore and other mining industries.

'Protective equipment' was used by 85% of establishments to control noise levels for employees and/or the environment. In the coal mining industry 95% of establishments used this technique. In the metal ore and other mining industries, 94% and 90% of establishments used this, respectively.

Waste water was not produced by 38% of establishments. The most common method of treating waste water was 'mechanical treatment technology' with 49% of establishments that did produce waste water, using this method.

'Rehabilitation' is performed by 78% of establishments through a variety of methods. Rehabilitation (reshaping and stabilisation of mine structures) and revegetation was reported by 64% of establishments. 'Restoration' (returning the site to the best possible approximation of the ecosystem that was present before mining commenced) was the next most common technique with 57% of establishments using this technique.

While hazardous wastes were not produced by 75% of mining establishments, the technique of 'physical treatment' (methods of phase separation and solidification where the hazardous waste is fixed in an inert, impervious matrix) was used by the majority of those establishments which did.

ESTABLISHMENTS USING POLLUTION ABATEMENT AND CONTROL TECHNIQUES AT 30 JUNE 1994

Techniques	*Coal mining* %	*Oil and gas extraction* %	*Metal ore mining* %	*Other mining* %	*Services to mining* %	*Total mining* %
Control of dust and other substances emitted into the air						
Protective activity	73	18	58	47	26	46
Ventilation	56	18	68	28	26	40
Application of water	98	27	92	92	48	77
Application of chemicals	41	9	22	20	6	19
Cleaning of exhaust gases	40	36	44	16	14	25
Other	9	—	6	4	2	4
No method used	—	—	1	—	3	1
No dust/substances emitted into the air	1	55	3	6	35	15
Control of noise levels for employees and/or the environment						
Silencers	83	64	74	64	47	64
Protective equipment	95	82	94	90	69	85
Erection of noise barriers	48	27	54	46	17	38
Modification of buildings	41	27	24	35	9	25
Limitations on hours of operation	30	—	19	52	20	30
Other	10	18	5	4	3	5
No method used	—	—	1	1	1	1
No method required	4	18	2	2	25	10
Treatment of waste water						
Mechanical trea tment technology	70	73	62	52	25	49
Biological treatment technology	38	36	22	4	5	14
Advanced treatment technology	12	18	12	2	2	6
Other	15	9	14	8	4	9
No method used	4	—	5	3	2	3
No waste water produced	14	18	19	36	66	38
Rehabilitation						
Landfill	65	55	51	48	20	42
Revegetation	88	64	87	75	26	64
Rehabilitation	84	64	92	69	30	64
Restoration	72	82	68	56	41	57
Other	5	—	3	1	1	2
No method used	2	—	2	1	3	2
No method required	7	18	4	8	47	20
Treatment of hazardous wastes						
Physical treatment	19	—	26	3	4	11
Chemical treatment	6	18	16	2	3	6
Thermal treatment	5	36	5	—	1	3
Biological treatment	1	—	2	—	1	1
Conditioning of radioactive wastes	—	—	2	—	1	1
Other	7	18	15	3	6	8
No method used	4	—	4	1	4	3
No hazardous wastes produced	68	45	47	93	84	75

EXPLANATORY NOTES

1 This publication presents statistics from the ABS Survey of Mining Technology. The survey objective was to provide information on innovation in Australian mining at 30 June 1994. It also collected information on future plans to utilise advanced mining technology as well as details on the current usage of mining technologies.

2 Details were collected from selected mining and exploration establishments about their acquisition or future intentions regarding a variety of mining technologies within the broad ranges of exploration, mining, mineral processing, engineering and environment technologies. The publication also includes details on staff training issues, employment, reasons for introducing mining technologies, planned expenditure, use of pollution abatement and control techniques and effects on production factors.

STATISTICAL UNIT

3 The unit for which statistics are reported in the Mining Technology Survey 1994 is the establishment. The establishment is the smallest accounting unit of a business, within a State or Territory, controlling its productive activities and maintaining a specified range of detailed data enabling value added to be calculated. In general, an establishment covers all operations at a physical location, but may consist of a group of locations provided they are within the same State or Territory. The majority of establishments operate at one location only.

SCOPE AND COVERAGE

4 This issue of the publication presents data according to the 1993 edition of the Australian and New Zealand Standard Industrial Classification (ANZSIC). This classification has replaced the Australian Standard Industrial Classification (ASIC). For detailed information concerning the classification used see the *Australian and New Zealand Standard Industrial Classification, 1993* (1292.0). The 1990–91 data has been revised to the new ANZSIC structures to allow comparisons to be performed. All data for this survey relates to mining establishments with employment of 10 or more and in the following industry subdivisions and classifications:

ANZSIC Subdivision	Class	Title
11		Coal
	1101	Black coal mining
	1102	Brown coal mining
12		Oil and gas extraction
	1200	Oil and gas extraction
13		Metallic Minerals
	1311	Iron ores mining
	1312	Bauxite mining
	1313	Copper ores mining
	1314	Gold ores mining
	1315	Mineral sand mining
	1316	Nickel ores mining
	1317	Silver-lead-zinc ores mining
	1319	Metal ore mining n.e.c.
14		Other mining
	1411	Gravel and sand quarrying
	1419	Construction materials mining n.e.c.
	1420	Mining n.e.c.
15		Services to mining
	1511	Petroleum exploration (Own account)
	1512	Petroleum exploration services
	1513	Mineral exploration (Own account)
	1514	Mineral exploration services
	1520	Other mining services.

5 Mining Division includes all establishments mainly engaged in mining, in mineral exploration on own account, in the provision of a wide variety of services to mining and mineral exploration on a contract or fee basis, as well as mining establishments under development. The term mining is used in the broad sense to include the extraction of minerals occurring naturally as solids such as coal and ores, liquids such as crude petroleum, or gases such as natural gas, by such processes as underground or open cut mining, dredging, quarrying, the operation of wells or evaporation pans, or by recovery from ore dumps or tailings.

6 Establishments mainly engaged in dressing or beneficiating ores or other minerals by crushing, milling, screening, washing, flotation or other, including chemical beneficiation processes, or mainly engaged in briquetting or iron ore pelletising, are included in this Division. These activities are generally carried out at or near mine sites as an integral part of mining operations. Natural gas absorption, purifying and similar treatment plants are also included in this Division.

7 Excluded from the Mining Division are establishments mainly engaged in refining or smelting of minerals or ores (other than the preliminary smelting of gold), or in the manufacture of such products of mineral origin as coke, cement or fertilisers. Also excluded are establishments which are primarily engaged in other industries such as transport and construction, but who may undertake contract work such as mine development.

UNINCORPORATED JOINT VENTURES

8 The mining industry has a large proportion of unincorporated joint ventures (UJV), particularly in the oil and gas industry. A UJV is an arrangement whereby two or more participants agree to share the costs of operation of the venture for a share of the product. An operator is appointed to do the actual mining and may or may not be one of the participants. Generally, each participant records turnover items while the operator records employment and expenses. The Survey of Mining Technology included establishments with 10 or more employees, which excluded establishments that are participants in UJV's as they usually have little to no employment.

ITEM DEFINITIONS

9 Definitions of the mining technologies surveyed are shown in the Glossary.

ACQUISITION

10 Where a particular technology was also part of another technology then both technologies were regarded as being acquired. Technology was acquired once it had been purchased, leased or if developed or assembled in-house, when it had been completed.

SOURCE

11 Where the technology consisted of components or items sourced from different countries, then the source attributed was that which represented the major dollar value of the technology.

FUTURE ACQUISITION

12 Respondents were asked to indicate plans for future acquisitions of technology using the following categories:

- being evaluated or tested,
- plan to acquire by July 1995;
- plan to acquire in 2–5 years;
- not cost effective;
- not applicable to this type of operation.

OTHER QUESTIONS

13 The remainder of the questionnaire dealt with associated issues. Establishments which reported at least one of the surveyed techniques were asked:

Staff and training

- Whether the introduction of the advanced technologies involved difficulties in obtaining staff skilled in the normal operation, maintenance or programming of the advanced equipment.
- How the establishment ensured that staff were skilled in the operation, maintenance etc. of the advanced equipment. Respondents were asked to report frequency of usage of strategies such as 'recruiting staff from outside' and 'on-the-job' training for existing employees etc.
- Reasons for introducing the surveyed technologies. Respondents were asked to report the degree of importance of each of a number of possible reasons such as Increased product quality and Lower labour costs etc.

1994–95 expenditure

14 All establishments were asked to indicate (by ticking a range) their expected 1994–95 expenditure on equipment and software associated with the surveyed technologies.

Pollution abatement and control techniques

15 Questions were asked about air, noise and water pollution controls and rehabilitation measures as well as treatment of hazardous wastes.

16 In addition, the reasons for introducing environmental monitoring technologies and pollution abatement and control techniques were asked.

Effects of introduction

17 The effect of the introduction of the new technologies and techniques on:

- output quantity;
- product quality;
- production costs; and
- processing time

was represented in terms of an increase, a decrease or no change.

RELATED PUBLICATIONS

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

The Australian Mining Industry (8414.0)
Manufacturing Industry: Summary of Operations, Australia (8202.0)
Manufacturing Technology Statistics, Australia (8123.0)
Research and Experimental Development, Business Enterprises (Inter-year Survey), Australia (8114.0)
Innovation in Australian Manufacturing (8116.0)

19 Current publications produced 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 the Release Advice are available from any ABS office.

UNPUBLISHED STATISTICS

20 As well as the statistics included in this and related publications, the ABS has a large amount of more detailed data which can be made available. Inquiries should be made to the telephone number in the Phone Inquiries section at the front of this publication or in writing to Mining Technology Statistics, Box 2272 GPO Adelaide SA 5001.

SYMBOLS AND OTHER USAGES

ANZSIC	Australian and New Zealand Standard Industrial Classification
ASIC	Australian Standard Industrial Classification
n.a.	not available
n.c.	not collected
n.p.	not available for separate publication (but included in totals where applicable)
. .	not applicable
—	nil or rounded to zero

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

SURVEY TERMINOLOGY

TECHNOLOGIES

Exploration

1 Aerial photography

2 Satellite/airborne scanner data

Includes the use of data from satellite/aircraft multispectral imaging equipment, false-colour IR photography, thermal IR and side-looking airborne radar.

3 Airborne geophysics

Geophysical detection devices used in mineral exploration from an aircraft to detect ore bearing strata such as ground penetrating radar.

4 Ground geophysics

Geophysical detection devices used on the ground or underground to detect ore bearing strata.

5 Geochemical techniques

Use of chemical assaying technology such as hydrogeochemistry, vapour geochemistry, biogeochemistry, lithogeochemistry and regolith geochemistry for determining mineral content and extraction techniques.

6 Image processing

Computer processing of video or plotter images and image analysis including 3D modelling of ore bodies and computer map plotting.

7 Analytical techniques

Use of technologies to examine ore rock samples to determine mineralisation including XRF, atomic absorption, ICP, ICP/MS and isotope analysis equipment.

8 Global positioning systems

Mining

9 Computer modelling

Includes processing plants and underground mine simulation.

10 Blasting analysis

Use of technologies to calculate blast charge, placement and effect to maximise rock fragmentation and minimise heave and structural damage.

11 Rock mechanics technology

12 Ground reinforcement design

13 Truck despatch technology

Includes conventional trucks, shuttlecars, scheduling technology and automatic weighbridges.

14 In-mine data transfer

Use of electronic data links/networks to exchange information between points within the mine including remote monitoring.

15 Automated ground movement sensors

16 Drill rig monitoring

Includes the drill rig, speed and depth of drill and remote machine monitoring.

17 In-seam drilling

For drainage of gas.

18 Guidance control mechanisms

Includes automatic and radio controlled mechanisms.

Mineral processing

19 In-mine rock crushing

Use of automated crushing and grinding machinery ranging from local microprocessor control to complete digital computer-based circuit control systems.

20 Automated material handling — particulate

E.g. overland belt conveyor systems with computer microprocessor controlled gates.

21 Automated material handling — slurries

E.g. overland pipeline systems with automated control of material delivery.

22 On-stream analysis

Use of devices to analyse ore and mineral grades, metal values, measure water content and determine the flow rate of ore pulps and solutions on a continuous basis.

23 On-stream size analysis

Use of devices to determine the particle size of ore as it passes through the system, permitting automatic control.

24 Interactive expert systems for process supervision

25 Programmable logic controllers

A solid state industrial control device that has programmable memory for storage of instructions and which performs functions such as logic sequencing, timing, counting, arithmetic and analogue loop control to control machines and processes.

26 Supervisory control and data acquisition

Control loops consisting of microprocessor or computer controllers and electronic data gathering equipment used to maintain uniform or optimum conditions at selected points within the total process.

27 Material characterisation and liberation analysis

Analysis of ore to determine exact nature of minerals contained and how best to separate the minerals from the gangue e.g. thermogravimetric analysis, electron beam microprobe, X-ray diffraction, evolved gas analysis.

Engineering

28 Welding technology

29 Condition monitoring systems

Includes breakdown monitoring systems e.g. pumps, pressure valves.

30 Energy conservation

Includes power factor correction, utilisation of gas drainage, rescheduling of power usage with off-peak management.

Environmental

31 Air quality monitoring

The programmed process of sampling, measurement and subsequent recording of the concentrations of airborne dust and other contaminants with the aim of assessing conformity to specified objectives.

32 Meteorological monitoring

33 Water quality monitoring

34 Biological monitoring

The process of sampling, measurement and subsequent recording and/or signalling various characteristics of the local biology with the aim of assessing conformity to specified objectives.

35 Rehabilitation design

Plans to reduce the impact of mining by minimising erosion and reshaping the landscape both during and after mining operations have ceased.

36 Waste disposal design

Technology used in the disposal of waste materials produced during the mining process, but excluding recycled or reused materials.

POLUTION ABATEMENT AND CONTROL TECHNIQUES

Control of dust and other substances emitted into the air

1 Protective activity

Any process intended to prevent environmental damage.

2 Ventilation

3 Application of water

Sprayed water used to prevent dust resuspension and/or remove dust from the air.

4 Application of chemicals

Chemicals used to prevent dust resuspension and/or remove dust from the air.

5 Cleaning of exhaust gases

End of line equipment for the removal of air polluting substances.

6 Other

Control of noise levels for employees and/or the environment

7 Silencers

8 Protective equipment

9 Erection of noise barriers

10 Modification of buildings

11 Limitations on the hours of operation

12 Other

Treatment of waste water

13 Mechanical treatment technology

Process of a physical and mechanical nature which results in decanted effluents and separate sludge.

14 Biological treatment technology

Removal of organic matter with the assistance of living micro-organisms.

15 Advanced treatment technology

Process capable of reducing specific constituents in waste water not achieved by other treatments.

16 Other

Rehabilitation

17 Landfill

18 Revegetation

19 Rehabilitation

Reshaping and stabilisation of mine structures.

20 Restoration

Return of the site to the best possible approximation of the ecosystem that was present before mining commenced.

21 Other

Treatment of hazardous wastes

22 Physical treatment

Methods of phase separation and solidification where the hazardous waste is fixed in an inert, impervious matrix.

23 Chemical treatment

Modification of the chemical properties of the waste.

24 Thermal treatment

High temperature oxidation of gaseous, liquid or solid hazardous wastes converting them into gases and incombustible solids.

25 Biological treatment

26 Conditioning of radioactive wastes

Processes that transform radioactive wastes

27 Other

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.

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Many standard products are available from ABS bookshops located in each State and Territory. In addition to these products, information tailored to the needs of clients can be obtained on a wide range of media by contacting your nearest ABS Office. The ABS also provides a Subscription Service for standard products and some tailored information services.

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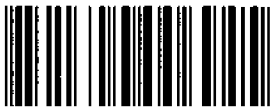

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