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Explaining Gender Segregation Processes by Occupational Choices, Hiring Strategies and Male-Dominated Cultures.

The Case of Women in Computing Professions in Australia.

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ABSTRACT

In this study, we have examined gender segregation in the computing profession over the past two decades based on statistical data and research reports. The computing profession has grown tremendously, and that qualifications and entry requirements have changed heavily over time. Demand and supply in the profession are unbalanced, which makes it more difficult to study the segregation dynamics. We have followed two lines of reasoning. Firstly, gender segregation can be considered as an elimination race, assuming that there are enough girls willing to choose the occupation but that they find all kinds of obstacles on their way to the occupation, to be followed by even more obstacles to entering the occupation and that those who do enter are likely to drop out. Secondly, gender segregation can be considered as a vicious circle, assuming that girls avoid male-dominated occupations in order to avoid the masculine culture in these occupations, or possibly because they even fear male exclusion processes within these occupations. The focus has been on three aspects of gender segregation: boys' and girls' occupational choices, employers' hiring strategies and the masculine culture in the profession. We found more evidence for the vicious circle than for the elimination race, although arguments were found for both the propositions and we sometimes faced insufficient information to draw conclusions upon. The under-representation of women in the computing profession can be explained better by the absence of women's occupational choices for the profession than by employers' hiring strategies or by the masculine culture in the profession, given the short supply in the profession. Therefore, when women's occupational choices would change, a tendency towards desegregation can be expected.

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1 INTRODUCTION

Computer technology is often perceived as a male-dominated field: the designers are male, the factories are run by men; technology in general is considered masculine. Moreover, women are considered computer illiterates, excluded from decision-making processes and only using a computer for clerical work. The gender relations in the field of electronic data processing obviously appear to be hierarchical. These stereotype ideas probably have prevented people from seeing that about 25% of computing professionals are females, a proportion large enough to bear influence on computerization. As I have argued elsewhere (Tijdens 1994), gender relations might not be as polarized and hierarchical as is usually stated. However, this paper does not investigate these relations. The main question to be discussed here is how segregation processes within the computing profession can be explained. We do so by studying boys' and girls' occupational choices, employers' hiring strategies and the male-dominated culture in the profession.

Women's and men's paid work is highly segregated by occupation. This occupational segregation has been studied in various disciplines. Economists predominantly have studied segregation indexes for a national labor market. Sociologists have studied the conditions of women's inroads into male-dominated occupations. Both groups have studied the contribution of occupational and job segregation to the gender wage gap. Psychologists have studied occupational choices, more specifically the gender-based factors in computing enrolments and achievement. Researchers in organization studies have examined the segregation processes in organizations, more specifically they have focused on the informal segregation code and other exclusion processes. In the sociology of professions, exclusionary practices have been examined.

The explanations from these different disciplines raise several questions. Do all the findings point in the same direction, as the literature on patriarchy suggests (see f.e. Walby 1989)? If they do not, what are the implications? What happens when conditions change, for example in the case of a rapid increase of the number of jobs available in an occupation? Moreover, must the gender segregation processes be characterized as static processes, thus once a male-dominated occupation, always a male-dominated occupation? Or are the segregation processes dynamic processes, and, if so, which factors influence the dynamics? Turning back to the theories, what contribution has each theory to make to the explanation of the segregation processes?

In this paper the theories are applied to the long-term development of one occupational group: the computing profession. We will study the segregation processes in computing profession over two decades in order to trace why this rapidly expanding profession has not opened up for women to the same extent as other occupations. The focus is on one country, Australia, and the investigation is based on document analyses, reviews of national statistics and research reports on work in the computing profession.[1] Detailed information on the major reports is given in appendix I.

Section 2 provides an overview of theories explaining segregation by gender, as well as the research methodology used for this paper. In section 3 we will explore segregation in the computing profession. Section 4 examines the extent to which theories could explain segregation processes in the computing profession. Section 5 draws conclusions.

2 THEORIES EXPLAINING OCCUPATIONAL SEGREGATION

In order to analyze gender segregation processes we can follow two lines of reasoning. The first line is that of gender segregation being an elimination race. This assumes that there are enough girls willing to choose the occupation, but that they find all kinds of obstacles on their way to the occupation, to be followed by even more obstacles to entering the occupation and that those who do enter are likely to drop out. This line blames the low proportion of women mainly on exclusion strategies at school, in universities as well as in the occupation.[2]

According to the second line of argument, gender segregation is a vicious circle. Following this line, girls avoid male-dominated occupations in order to avoid the masculine culture in these occupations, or possibly because they even fear male exclusion processes within these occupations. Therefore, can we assume that only women who themselves think that they can cope with the masculine culture in the occupation choose the appropriate courses and pass them, enter the occupation and stay there to the same degree as men do? This raises the question of what characteristics those women have who think of themselves as able to cope with a masculine culture. Is their attitude also based on talent, and are they more talented than the men choosing this occupation? And if so, can we therefore assume that they will perform better in university as well as in the occupation?

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1 This paper is part of a research project that aims for a comparison of gender segregation processes in the computing occupations in two countries, Australia and the Netherlands. Both countries are comparable regarding their population, their labor force, women's participation rate and level of technological development. The Dutch study has been finished recently (Tijdens 1996). It is under investigation whether the comparative study can be extented to other countries.

2 In this section we will use the word occupation rather than profession, as the theories apply to occupational segregation. Yet, the occupation at stake is considered a profession (see for example Macdonald 1995).

These are more questions than can be answered. Below, we will explore three theories that explain occupational segregation: theories on women's occupational choices, theories on employers' hiring practices, and theories on the masculine culture of the profession. The context of gender segregation usually maintains a distinction between hierarchical and occupational segregation, sometimes also called vertical and horizontal segregation respectively. Hierarchical segregation refers to the unequal distribution of women and men across job levels, while occupational segregation refers to the unequal distribution over occupations. Here the focus is on occupational segregation, but when applicable hierarchical segregation will be discussed too.

2.1 The theories on occupational choices

Economic and psychological *theories on occupational choices* focus mainly on female employees-to-be. Women, the economic argument goes, seek occupations in which a career break would have minimal effect on their income, while men do not seek these occupations (Polachek 1979). Therefore, women will have jobs with flat age-wage profiles (Jusenius 1976). Psychological gender-role socialization theories state that women, due to their primary socialization, choose occupations that are in accordance with their sex roles (Ireson 1978). Socialization is a process by which families, peers, schools and the media teach society's expectations of girls and boys. Thus, women are oriented primarily towards their families rather than their careers. In this sense, gender-role socialization explains occupational segregation because it focuses on gender-related occupational choices in childhood. This might explain why girls in contrast to boys do not choose occupations that might require mathematics or technical qualifications, while boys do not choose occupations in which caring is an important element.

These theories predict that few women would be found in the computing profession, because it does have steep age-wage profiles, does require mathematical or technical skills and does not incorporate caring tasks. Thus, girls will avoid choosing subjects related to the IT field, and as a consequence, they will not enter the occupation. Only when the occupation's qualifications will put less emphasis on technical or mathematical skills, desegregation processes will take place slowly. Girls need to become aware of these changes before they can change their occupational choice.

2.2 The theories on employers' hiring practices

One of the *theories on employers' hiring practices* is the statistical discrimination theory, stating that women are supposed to be more costly to employers than men due to their higher turnover or absence rates attributable to maternal responsibilities. Because employers do not receive any specific information about applicants other than their sex, they will treat individuals on the basis of their group's average behavior. However, looking at wage costs, one would predict that employers would prefer women, because women's wages are on average far below men's. Bergmann (1989) specifies the statistical discrimination theory by arguing that employers do not prefer women for male-dominated occupations and men for female-dominated occupations, because this would undermine the existing labor relations and status quo. This would be costly to employers. Thus, the theories on employers' hiring practices are not unanimous: they predict that employers prefer either male employees above female employees, female employees above male employees or men for male-dominated occupations and women for female-dominated occupations.

As far as segregation processes are concerned, employers' behavior is characterized by conflicting rationalism. If they prefer women due to lower wage cost, this would imply gender-based wage and employment competition, but occupational boundaries impede this general competition. If for wage policy reasons employers intend to substitute women's labor for men's labor, these occupational boundaries need to be broken down. However, male workers will organize themselves against substitution by strengthening occupational lines. On the other hand, female workers can organize themselves and demand equal pay for equal work by breaking down occupational boundaries. Moreover, occupational boundaries have to be reinforced if the clients of the organization in question prefer stereotyped jobs according to gender. Thus, by reinforcing segregation, employers avoid vulnerability to labor unrest among male workers or client dissatisfaction, but at the same time this limits their possibilities of replacement and they would not meet female workers' demands. Therefore, it is most likely that employer's hiring strategies are in accordance with gender segregation. Because our study focuses on a male-dominated occupational group, we predict that employers will hire men for these occupations. Moreover, we predict that in the event of a shortage of labor, employers will go beyond gender boundaries.

2.3 The theories on the male-dominated culture in the profession

Theories on the male-dominated culture focus on the workplace. For example, the theories on informal segregation codes state that women should not exercise authority over men (Bergmann 1986). The segregation coding process includes two elements. The first refers to the code that relationships at work should be in accordance with the hierarchical relationship between sexes at home as well as in society: women should not exercise authority over men. The second element is that women as a group, in contrast to men, are perceived as non-hierarchical: men can exercise authority over men, women cannot over women. Employers, as well as workers, male and female, are likely to enforce these codes. They probably coincide with the code that young people should not exercise power over middle-aged people. Control over the sex-typing of tasks is instrumental in maintaining gender-related hierarchical structures in the division of labor within the occupational field (Kanter 1977, Cockburn 1985). Female professionals probably avoid these segregation codes by choosing self-employment instead of wage earnership (Mackinnon 1991).

2.4 Research questions and methodology

In the beginning of this section, we presented two lines of reasoning: the elimination race versus the vicious circle. We have examined the theories about three stages in the life cycle: girls' occupational choices, employer's hiring strategies and the male-dominated culture at the workplace. In order to determine which of the two lines of reasoning is most plausible, we now divide into three:

(1) can the subjects or courses that lead into the computing profession be determined and to what extent do women choose these subjects/courses? To answer this question we

studied reports and articles about male and female participation and performance in courses in computing majors, as well as reports on establishing IT-related subjects in the educational system.

(2) are employers' hiring strategies gender-biased, i.e. are there grounds to argue that employers hire male applicants relatively more often than female applicants, and do they use any gender-biased ideas in order to sex-type vacancies? To answer this question we had to rely on figures about employment in the occupation.

(3) what is the impact of the male-dominated culture, i.e. do women quit the profession before retirement to a higher degree than men do, what are the reasons for quitting and does the absence of equal opportunity policies or family-friendly policies influence the quitting behavior? To answer this question we had to rely on a few studies, in which female professionals were interviewed in-depth.

Before answering these questions, we will explore the segregation indexes for the computing profession in Australia in section 3. In section 4 we will go into detail on the gender segregation processes in the computing occupations in Australia. The documents and research reports used in this study will be quoted there. In section 5 we will draw conclusions about the two lines of reasoning.

3 SEGREGATION INDEXES FOR THE COMPUTING OCCUPATIONS

In this section we will examine the extent of gender segregation in the computing profession. Before doing so, we will briefly discuss IT users and IT providers in Australia.

3.1 The computer industry in Australia

Usually two domains are distinguished in the demand for computing professionals, i.e. the IT providers, here referred to as the computing industry, and the IT users, organizations using IT for internal needs. The main activities of the IT providers are software and hardware manufacture, software and hardware supply, with systems building and consultancy also being significant. It is estimated that about two out of three computing professionals are employed in the IT user industry as in-house systems development and programming staff, while one out of three are employed in the IT provider industry, but that the latter is growing faster than the former.

As far as the IT provider industry is concerned, the hardware manufacturing industry was more significant 25 years ago than it is today. Today there are some isolated success stories (such as IBM in Wangaratta), but there is not a significant computer hardware manufacturing sector (White 1991). Contrast this with telecommunications equipment, where major multinationals such as Ericsson Australia, Siemens and NEC (Nippon Electric Company) Australia have substantial manufacturing operations. In less than 25 years' employment in electronic manufacturing as a whole has halved, while in telecommunications equipment it has not declined. In the early nineties, the computer and telecommunications manufacturing industry, the computer wholesale business, and data processing and computer maintenance services, were estimated to represent over 7000 enterprises, the majority being small firms. Hardware manufacturing was dominated by a few large firms (ABS 1995b).

As far as the IT user industry is concerned, over the last 25 years information technology has pervaded almost every area of Australian society. In the early seventies there was already substantial in-house systems development and programming in Australia.[3] Since the early eighties, a number of businesses have outsourced computer services activities previously carried out by their own employees. Large firms in the public sector, in banking and finance, in wholesale and distribution, and in manufacturing were the major source of contracting.[4] This expansion has been accompanied by the development of a large range of support services, including programming, systems analysis, consultancy, data entry, data processing, information storage and retrieval, and computer repair and maintenance.[5] Within the computer services industry today, firms are outsourcing some software development for their customers (Strobart 1992).

During the eighties and nineties, quite a few surveys were conducted to reveal the nature of the growing computer services industry (see Appendix 1 for an overview). The main conclusions of these surveys point in the same direction: the industry is a highly skilled activity, is research and development intensive, can become more international, and provides the opportunity for small, innovative business to grow. In the early nineties, 97% of businesses in the computer services industry employed fewer than twenty people, they accounted for 42% of industry employment and 28% of industry operating profit before tax. In contrast, the 29 businesses in the industry employing a 100 or more persons, representing less than 1% stet of the businesses, also accounted for 42% of employment and 58% of operating profit before tax. Yet, small businesses had relatively low labor costs per person employed compared with larger businesses in the industry.

3.2 Employment in the computing occupations

There are several ways to define computing occupations. If they were to conclude everyone working with a computer, probably a third of the Australian work force would be in a computing occupation. We prefer the more useful Australian Standard Classification of Occupations (ASCO 1986). This classification is meant to provide a structure for the classification of occupations by grouping all jobs into successively broader categories.[6] Within this structure, several occupations deal with computers (Table 1). These are positions in management, in consultancy, in sales, in operating, in maintenance, in information storage and retrieval or in data-entry, as well as technical and engineering positions. There are also the so-called professional computing positions (ASCO code 2707), defined under

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3 See Smith & De Ferranti 1976.

4 According to a survey conducted by Computing Australia (1986), the industries that were the major source of EDP contractor work were Public Utilities/Administration, Manufacturing, Wholesale/Distribution and Banking/Finance/Insurance.

5 The data processing and information storage and retrieval industries are still small in comparison with other computer services industries, indicating that the activities associated with these industries are still largely undertaken in-house (ABS 1995a).

6 A similar classification is used in many other countries.

eight occupations. In this paper, we will refer to this group of occupations as the computing profession. When we refer to the IT-related occupations, we mean the very broad range of occupations.

Table 1. The computing occupations in this study: ASCO code 2707.

In the computing profession	code	Not in the computing profession (not in this study)	code
Applications Programmers	2707-11	Data processing management	1311
Systems Programmer	2707-13	Electrical and electronic engineers	2211
Analyst Programmer	2707-15	El. & el. eng. associates and technicians	3201
Computer Systems Analyst	2707-17	Office equipment and computing services	4315
Software Engineer	2707-19	Data processing machine operators	5201
Data Base Administrator	2707-21		
Computer Scientist	2707-23		
EDP-Auditor	2707-25		

Employment in the computing profession

Census data on employment in the computing profession became available in the seventies with the growth of the computing profession. It had previously represented too few people to be recognised in the census. Census data for the eighties are available, but recent statistics are not available yet. The size of the profession has been estimated in many surveys conducted outside the Australian Bureau of Statistics. These surveys were conducted partly in order to help identify human resources needs in the computing profession. Many surveys are referred to in this paper.[7]

Over the past two decades, employment in the computing professon has grown tremendously, due to the incorporation of information technology into all kinds of businesses. Employment growth in the profession was far above the increase of the total work force in Australia. The profession is considered to be among the fast growing occupations (OECD 1988). Annual growth rates were about 7% between 1971 and 1976, they went up to 12% between 1976 and 1981, and again up to 16% between 1981 and 1986, but the annual rates slackened down to 13% between 1986 and 1989 (EF 1991).[8] For the nineties, apart from census data for New South Wales, no statistics are yet available.[9]

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7 We also used the Occupational Outlook, DEIR 1984 to 1986.

8 In the mid-eighties, discussions arose about the real size of the computing profession. A few surveys had been held in which the skilled, computer-related work force was estimated, though with quite different results. One study suggested the number of skilled, computer-related workers was 31000 to 40000 (see the DEIR/CTEC report 1984). Another study said the estimated number of skilled computer workers employed in Australia was to be in excess of 60000, probably nearer to 72000 (see Daniel et al. 1986). This was nearly twice as many. By 1989 census data suggested that the actual figure had probably been somewhere in between.

9 From 1976 to 1986 in New South Wales the annual growth in the computing profession was 12%, and from 1981 to 1986 even 15% (these percentages are provided by the NSW Census data, see Cameron 1991, p. 12). In all States, the annual growth in employment was estimated at about 12% in the first half of the eighties (see Kriegler et al. 1986, who had data for 1984 for all States).

Table 2. Male and female employment in the computing profession (ASCO code 2707).

Year	Male	Female	Total	S&P*	% F	Author
1973	-	-	-	7900	-	Smith&De Ferranti 76
1981	19200	3800	22970	-	20%	Crockett '91**
1984	-	-	-	36000	-	Kriegler et al. '86
1986	39900	8900	48800	-	22%	Crockett '91
1986	36900	9700	46600	-	21%	EF '91**
1989	51800	16700	68400	-	24%	EF '91
1991 (NSW only)	11880	3840	15720	-	24%	Cameron '91

* *Systems analysts and Programmers only.*
** *The data by Crockett and EF are based on the ABS-1981, 1986 and 1989 Census of Population and Housing.*

The category of programmers and systems analysts is the largest within the computing profession. As is shown in table 2, at the end of 1973 there were about 7900 full-time systems and programming staff in private enterprises, and these were expected to increase to 14500 over three years.[10] In 1984, their number had multiplied by almost five, as it was estimated that there were 21000 programmers and 15000 systems analysts (Kriegler et al. 1986).

The percentage of women in the profession

The focus of this paper is gender segregation within the computing profession. So how many women actually work in the profession? Table 2 shows that the proportion of women increased from slightly under 20% to nearly 25% between 1981 and 1989, compared with a percentage of 40% in the whole labor force in 1986.[11] The computing profession is certainly not among the most highly segregated occupations in the labor force: although it is a male-dominated profession, the increasing proportion of women within it could let it be considered gender neutral. Many occupations have a minority of males or females of less than 10%.

Regarding the proportion of women in the computing occupations, the various surveys show little divergence. The Datec survey 1982 (Datec 1982, cited in Cameron 1991) distinguished between programmers and supervising programmers, the first having a higher percentage of females than the latter (30% versus 20%). Unfortunately, they had no data on the trainee programmers. Daniel (1986) found that the percentages females among programmers and systems analysts were equal (both 23%), and the percentages were

10 See Smith & De Ferranti 1976. It is very likely that there were hardly any part-time staff at that time as part-time workers represented only a small proportion of the labor force and were made up mainly of married women. At that time, married women working part-time probably would not have been found among the systems and programming staff. Furthermore, the size of the systems and programming staff in the public sector is unknown for 1973.

11 See Crocket 1992.

slightly higher among trainee programmers (30%).[12] Although it is likely that the percentage of women is higher as work experience is shorter, we do not have data to examine this proposition. In section 4 we will discuss whether this is caused by limited career possibilities or by the younger cohorts of professionals entering the occupation being comprised of more females.

Although we intend to limit this paper to the computing profession only, some of the surveys enable us to sketch gender segregation in the whole field of computer-related occupations (see tables 3, 4 and 5, computing professions above the line). The tables show very familiar findings. In the semi- and unskilled computer-related occupations, the proportion of women is higher than in the skilled occupations. In the skilled occupations, the proportion of women is highest among the trainee positions and lowest in management. Women tend to work more in software-related occupations than in hardware-related occupations. Although it is often thought that technical occupations are very male-dominated, this appears not to be the case. Indeed, the skilled technical positions are male-dominated, but the semi-skilled technical positions are to a far lesser extent. For example, the proportion of women among the computer operators is about 30%. Among the skilled occupations, the proportion of women is highest in the computing profession.

When it comes to the IT providers, female staff in the computing services industry comprise 43% of the 23000 employed. However, this is mainly because the proportion of females engaged in non-technical work is considerably higher than the proportion of males (ABS 1995a). Yet there is considerable variation in the proportion of males to females from one sector of the industry to another. Computer maintenance services are very male-dominated (75%). Computer consultancy services are to a slightly lesser degree male-dominated (67%). Employees in the data processing services and information storage and retrieval services are predominantly female.

When it comes to the IT users, far less data were found. According to Strobart (1992), there is a higher number of top professional and technical women and women in managerial positions in the public sector than in the private sector, but no statistics are given on this.

Some detailed statistics enable us to examine the relationship between the percentage of women in the occupation and income and training (tables 4 and 5). The figures reveal that the higher the grade and to a lesser extent the annual salary, the lower the percentage of women in the occupation. The gender wage gap is already visible in the first jobs after graduating in computer science. Female graduates of the University of Western Australia, working full-time, earn on average nearly 5% less than their male counterparts.[13]

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[12] In 1984 Daniel et al. (1986) held a survey among 376 Australian hardware and software firms.

[13] The average salaries of the graduates in computer science of the University of Western Australia, according to its Graduates Destination Surveys (1982 to 1988) show:

Year	males	females	F/M ratio
1983	16426	16377	0.99
1985	21865	19625	0.90
1988	24397	23500	0.96

Both income and schooling are negatively related to the femaleness of the occupation, but income is far more so than schooling (table 3). Women are more often to be found in the occupations where people have higher school certificates only, while previous work experience is a prerequisite hardly depending upon the percentage females in the occupation. Finally, turnover rates are higher as the percentage of women rises. This is due mainly to the higher turnover rates in the trainee occupations, which have a higher representation of women. Women evidently do more job hopping than men.

Table 3. Occupational categories and percentage of women, percentage of professionals having a higher school certificate only, percentage of employers indicating that previous work experience is necessary and percentage turnover in 1983/84 in the categories.

Occupational category	% female employees	% higher school certificate only	% previous work exper. necessary	% turn over
Systems analyst	23.5	12.5	74.0	34.7
Analyst/Programmer	16.3	8.2	77.5	32.8
Programmer	22.4	27.0	56.3	49.2
Trainee programmer	29.5	31.0	24.2	101.9
Hardware engineer	1.3	6.9	70.0	24.3
Software engineer	13.6	12.5	77.8	18.2
Systems engineer	1.5	0.0	80.0	11.8
Drafting personnel	12.5	80.0	40.0	21.4
Sales representatives	12.2	31.6	61.0	37.1
Trainee sales rep.	34.9	40.0	44.5	156.0
Computer technician	0.9	6.7	61.9	9.9
Trainee technician	13.9	44.5		120.0
Computer operator	26.1	77.3	54.1	35.9
Trainee computer operator	33.3	90.0	8.3	58.6
Computer support equipment	60.6	33.0	83.3	164.0
Data entry	90.1	80.0	57.1	41.5
Project manager	8.1	13.3	83.0	36.8
Operations management	0.7	80.0	76.9	17.4
Sales management	4.8	20.0	77.8	12.1
Senior executives	10.0	23.5	81.6	23.4
Other categories	25.5	13.8	71.4	23.4

Correlation between % female and % higher school certificate only R=.417.
Correlation between % female and % previous work experience necessary R=-.262.
Correlation between % higher school certificate only and % previous work experience nec. R=-.512.
Correlation between % female and % turnover R=.489.
Source: Own calculations based on Daniel et al 1986

Table 4. Occupational categories, salaries and their percentages of women 1982.

Job title	Salary	% women
Programmer	26000	30
Supervising programmer	35000	20
Business analyst/programmer	38000	24
Senior analyst/programmer	48000	17
Systems software analyst	45000	12
Database administrator	48000	10
Communication specialist	47000	7
Data processing managers	64000	10
Information systems managers	90000	2

Correlation between % female and annual salary R=-.828.
Source: Own calculations based on Datec 1982, cited in Cameron 1991

Table 5. The percentages of women among Computer Systems Officers in Public Service Union's area of coverage 1988.

	Permanent		Temporary	
	%	No	%	No
CSO grade 1	23.5%	132	21.4%	3
CSO grade 2	21.5%	233	33.3%	2
CSO grade 3	18.8%	152	-	
CSO grade 4	14.9%	50	-	
CSO grade 5	10.0%	14	-	

Correlation between % female and grade R=-.985.
Source: The Public Service Union (1989), their figures and percentages are based on statistics provided by the Department of Finance and Employment in the Australian Public Service.

Self-employment

In the early seventies, computing professionals were employed mainly by IT users, most of which were at that time large firms, for in-house systems development and programming. This changed quickly when in the eighties the computer services industry developed and IT using firms became accustomed to contracting out this work. Recently even outsourcing the in-house development, either partly or wholly, is at stake. Computing professionals today are more likely to be employed, or self-employed, in the computing services industry. In the mid-eighties a study of programmers working at home revealed that very few of them were employees. They were very likely to be either self-employed or an 'employee of own company'. The authors assumed that their strength was based on the fact that programmers were in short supply.[14] It also indicated that the computing services industry was then a very young one, with many small businesses in which management coincided with the legal entity owning the businesses (i.e. company, partnership, sole operator, etc.). It is estimated that less than 5% of the computing profession overall is self-employed.[15] The percentage of self-employed is much higher within the computing services industry, being estimated at over 25% with over 30% of consultants being self-employed (ABS 1995a).

Are women less likely to be self-employed than their male colleagues? Hardly, as is shown in table 6. In the computing profession, women are to a slightly lesser extent self-employed than men (2.5% versus 3%).[16] This relationship is reversed in the computer services industry with 26% of the males working being self-employed compared to 27% of the women. In consultancy only, the percentages are higher, with 31% of the males and 33% of the females self-employed.

Table 6. Employment status by gender and working hours, 1993.

	Male		Female	
	full-time	part-time	full-time	part-time
Computing Services Industry				
proprietors/partners/directors	4754	472	1555	1246
computing and technical staff	12003	388	3423	314
other employees	1876	270	2410	1349
total	18633	1130	7388	2909
% self-employed (full-time+part-time)	26%		27%	
Consultancy only				
working prop/partners/dir	4281	357	1348	1152
computing and technical staff	9032	307	2776	246
other employees	923	192	1393	592
total	14236	856	5517	1990
% self-employed (full-time+part-time)	31%		33%	

Source: Own calculations, based on 'Computing services industry Australia' (ABS 1995a)

In short supply

For a very long period computing professionals have been in short supply, mainly because the demand has risen at a spectacular rate, while the supply has not risen to the

[14] The study of Probert and Wacjman (1988) and Wacjman and Probert (1988) is based on interviews with two groups of new technology homeworkers -computer programmers work and word processors. The authors state that there is little evidence that employers would seek to use outworkers for data-entry needs or for programming. Most computer programmers were men.

[15] See Occupational Outlook 1984-1986 and ABS 1990.

[16] ABS 1990, table 6.

same extent.[17] The demand slackened during the economic downturn of 1982 and 1983, surged strongly in line with the economic recovery in 1984 and then stabilized at a high level from about mid-1986.[18] In 1987 these professionals were still in short supply: 33 to 45% of employers reported shortages of various types of computing professionals, despite the strong growth in training (DEET 1988). In the mid-eighties the shortage of programmers remained acute, particularly applications programmers, as did the shortage of systems analysts and project leaders.[19] Trainee programmers and systems programmers also were in short supply, but not to the same extent. Anticipated employment growth was highest for specialist engineers and was slight for computer operators, technicians and data-entry staff (Daniel 1986). Unemployment has not been an important factor for graduate students; private enterprises are their major employment sector, with opportunities spread equally among men and women.[20]

In the IT providing industry, the shortage was strongly related to firm size, larger firms having more problems than smaller firms. The larger firms particularly were in short supply of project leaders, managers and communications personnel. Morris et al (1987) have two explanations: the small, and thus young firms have not reached a stage where they need to grow and take on new staff, and they have reduced the effect of employee turnover by introducing employee ownership. In the case of large firms, turnover was high, with junior staff moving sideways after only eighteen months or so to broaden their career.

Skills requirements

What kind of skills have the computing professionals? This has changed very much over the years. In the seventies, trainees usually were recruited internally, they had no previous IT training, but they would receive on-the-job training, which included training provided by the IT suppliers (Smith & De Ferranti 1976). The career path in the computing profession was from trainee to programmer and than to systems analyst as the specialist gained years of experience and additional training. As far as the attitudes of employers towards training were concerned, the provision of tertiary degree courses in data processing and computing not seen to be so important. The availability of additional retraining or continuing education was seen to be more important. Not only the professionals needed schooling: the employers thought that those in the work force using IT needed computing training as part of their basic training. Suppliers of computing equipment or services were

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17 In 1973 the systems and programming staff in private enterprises were expected to increase by a factor 1.5 over three years and the expected growth in firms from 21 to 50 employees was particularly marked, according to the firms' expectations (Smith & De Ferranti 1976). Over the period 1976 - 1985 the employment prospects of computer graduates have been much better that have those of graduates as a whole (Graduate Careers Councils of Australia 1985).

18 According to the DEET occupational assessment program and associated survey (DEET 1988).

19 In the late eighties the shortage was still expected to be greatest for applications programmers (68% of the 385 firms in the survey by Morris et al. 1987, pp. 48, table 4.4), followed by project leaders/managers (43%) and systems analysts (40%). Trainee programmers were 31% and systems programmers 29%. According to Daniel (1986), in the mid-eighties the demand was strongest for programmers and systems analysts.

20 Based on the Graduate Destinations Survey 1989, University of Western Australia, Nedlands.

seen to be the main providers of the training, including the basic IT training. The private and the public sector did not differ in this respect.

In the eighties the availability of tertiary degree courses increased while the significance of on-the-job-training appeared to be declining.[21] However, this affected qualification requirements for trainee positions more than those for senior positions, for which former work experience remained essential. The majority of firms in the computing services industry believed that prior experience was necessary for systems analyst and analyst/programmer positions and over half of the firms believed that it was necessary for a programming job (see table 3).[22] By the late eighties, most employers demanded tertiary qualifications as a prerequisite for entry-level positions (EF 1991). Cameron (1991) adviced the professional association to emphasize the necessity of an entry requirement of a 3-4 year degree or diploma. In line with the findings of the sociology of professions, professional associations are likely to require a high entry level, in order to protect the professional status (Macdonald 1995). However, others stressed that three out of four jobs in IT do not need people with tertiary qualifications, and that starting off as a junior programmer with the right attitude is important.[23]

Of course, not only computing professionals needed to be qualified sufficiently: the entire work force had to be educated about information technology. Whereas in the seventies the IT suppliers were supposed to provide training, in the eighties the educational system was thought to play an important role.

Very often the entry requirements for the profession were not met, because supply was far behind demand, and because some of the trainee positions, especially positions also requiring business qualifications, were internally recruited. To what extent did computing professionals have the qualification levels that they were supposed to have?[24] In the mid-

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21 Between 1976 and 1983, the number of graduates from universities and CAE's increased from 175 to 1013 (Graduate Careers Council of Australia 1985). In the late eighties, computing courses were provided by 17 universities and 24 colleges of advanced education, producing around 2000-2500 computing graduates and postgraduate diplomats per year. Outputs appeared to have grown strongly in the eighties. From 1973 to 1987 there was an annual average growth in completions in computing specialization of 14%. Between 1987 and 1989 completions in computing have risen from 3216 people to 3670. This represents an average annual growth of approximately 7%, indicating that the growth in completions is slowing down. The 3670 people had completions in bachelors degrees (almost two-thirds), graduate diplomas and associate diplomas. However, private colleges and in-house training also contribute to the supply of computing professionals, but data on their current levels of activity are not available, according to EF (1991). In the past two decades, vocational training for the computing profession received little attention from TAFE (DEET 1995b). Yet in recent years, TAFE has moved to provide associate diploma courses in computing as well as in electrical engineering. Although it was difficult to obtain data on completions in TAFE courses, the data available show that in 1989, there were 174 completions recorded in computing and 186 in electrical/electronic engineering (EF 1991).

22 According to Daniel et al. (1986), this was 75% of the firms in their survey.

23 See Computerworld, October 15, 1993: Women in IT: it's a great career.

24 In the mid-eighties, engineers in the computer industry typically had a degree in computer science or a degree in engineering (according to Daniel 1986). In the programming division a similar pattern appeared. Systems analysts, analysts/programmers and programmers usually

eighties, about one third of computing professionals did not possess formal qualifications, but they tended to be in the older age groups. Some of them held managerial positions, based on expertise and authority. About one fifth had some qualification, i.e. a diploma, or a certificate from a private training institution, or training from TAFE or training from some other institute. The remainder of professional staff had either a university degree or College of Advanced Education training. It is not likely that this percentage has changed tremendously, as by the late eighties and early nineties firms increasingly recruited employees in IT-related occupations who had knowledge of computing as well as of the business at stake.

Employment grew much faster than the supply from universities did. In the early eighties, the number of completions grew by 14%, while the average annual growth in employment of the computing profession and data processing managers was 16%. In the late eighties, percentages were 7% and 13% respectively. Computing professionals immigrating to Australia contributed to meeting the demand, but there were also a substantial number of departures.[25] Employers took initiatives to increase supply from the universities and other educational institutions.[26] The State funded universities for additional

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had a degree in either computer science (aggregate 58%) or a general degree (aggregate 20%). The remainder of professional staff had a Higher School Certificate or equivalent. Typically the programming and analyst staff who did not hold degrees were highly experienced senior and older personnel. Another study (Morris et al. 1987) came to comparable results. According to their results, 56% of the computer science staff had a university qualification, usually a bachelors degree, and 22% College of Advanced Education training, 10% private institution training and 10% TAFE training. By the late eighties, the percentages of computing professionals holding formal qualifications had increased slightly. About one third of computing professionals did not possess formal qualifications, but they tended to be in the older age groups (EF 1991). Cameron (1991) produced comparable data. In NSW, according to Census data 1986, 33% of the NSW Computer Professionals (ASCO code 2707) had no qualifications, about 30% had some qualification, i.e. a diploma, a certificate, or qualifications not stated and about 31% had a bachelor degree and the remaining 7% had a graduate diploma or a higher degree. One out of ten computing professionals had a University degree with a major in computing. It is not likely that this percentage has changed profoundly, as by the late eighties and early nineties organizations increasingly wanted employees in non-technical and managerial positions with IT skills or at least a good working knowledge of IT.

[25] The number of migration arrivals in a computing profession has grown steadily from 490 in 1983/84 to 1546 in 88/89 (EF (1991). In 1988/89, the numbers of computing professional immigrants were equivalent to about half the levels of completions from higher education, but this was not sufficient to bring supply and demand in balance (EF 1991). The Occupational Share System had been allocated at least 500 places a year in the past four year for Skilled Migration (DEET 1988). Cameron estimates that immigration and emigration counts for an increasing number of arrivals in the NSW occupational group of programmer/analysts, but also for an increasing number of departures, though the departures outnumber the arrivals by about 1 to 3 during the eighties (Cameron 1991 p. 30), showing the international nature of the labor market for computing professionals. Australia has significantly relied on immigration to meet its needs for highly experienced and specialists workers in this profession. Yet, the number of immigrates were not sufficient to bring supply and demand in balance.

[26] For example, 25 employers have sponsored the program by the University of NSW to combine broad academic education with practical skills in the Business Information Technology course, and in NSW also 74 young people are trained in a two year computer programming course (EF 1991).

places,[27] but did little to set up training programs for youth and the unemployed, whether for men or for women. The computing association was advised to emphasize the necessity of increasing the number of students and trainees who incorporate IT subjects as a major part of their qualification and to attract women in the industry.[28]

4 THE SEGREGATION PROCESSES IN THE COMPUTING OCCUPATIONS

In section 3 it was shown that the proportion of women in the computing profession has grown during the eighties and that one out of four computing professionals is a women. In this section we will apply three theories on our findings of the Australian computing occupations and discuss their explanatory power. We will study occupational choices, employer's hiring strategies and the male-dominated culture in the profession. These are considered to be three steps in the segregation process.

4.1 Occupational choices

Throughout the eighties, the perception prevailed that women would remain computer illiterates and were less prepared than men for the imminent changes that would be brought by the increasing use of computers. Policies to educate women in the IT field followed two lines of reasoning.[29] The first one focused on experiments providing girls basic IT training in primary and secondary education. Girls had to learn about IT to ensure that the future female work force would keep up with the men. The second line focused on women's entrance to the so-called non-traditional jobs as part of the job creation programs in the eighties.[30] A number of initiatives to promote the participation in women in a wider range of occupations have been reported, but no programs were set up to enable entering into the computing profession, which surprises considering the high demand in the profession.[31]

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27 In 1988, the universities were funded for 915 additional places (EF 1991).

28 In her report for the Australian Computing Society Cameron (1991) stresses the need to increase the number of students and trainees who incorporate IT subjects as a major part of their qualification, the need to increase the number of trainees and the number of organizations willing to recruit inexperienced staff (p. 35-6) and its implications and to attract women in the industry.

29 See for example DEET 1989, O'Donnell and Hall 1988.

30 The Women's Bureau of the Department of Employment and Youth Affairs (1985) has argued in favor of the creation of training programs which would improve women's access to non-traditional occupational sectors, including sectors requiring new technological skills. See also Wacjman 1990, who argues that it is important that women should gain entry to new industries, rather than concentrating on apprenticeships in the traditional and often contracting industries.

31 In their overview of women's participation in the Labor Market Program's no IT-related training programs are mentioned (DEET 1990).

In this section boys' and girls' occupational choices relevant to the computing profession will be examined. Which choices are made at secondary level, which at tertiary level? We will end with some remarks on the proposed models of the elimination race and the vicious circle.

Occupational choices at secondary school level

It can be assumed that at secondary school level access to a microcomputer at school or at home to a large extent influences choices in favor of a computing job. In the early eighties pupils did not have any access to computers, and one study on occupational choices indeed shows that in the early eighties, neither teenage boys nor teenage girls were choosing computing jobs (Currie 1982).[32] It is not surprising that the vast majority of the female professionals, interviewed by Teague and Clarke (1991: 365) and by Kaeding & Wheldrake (1993), had originally not intended to enter IT, primarily because they were unaware of the nature of the work. It was not until the late eighties that boys and girls had an idea what the computing profession would be like and by the early nineties many of them had access to computers. In these cohorts good career prospects are mentioned most often as the reason for choosing computer science (Teague & Clark 1991).

Once an occupation becomes familiar, sex-role stereotyping of occupations is an important phenomenon in career choices. It is shown that girls will choose either female-dominated or integrated occupations, and that boys will choose male-dominated or integrated occupations (Currie 1982). Neither will choose an occupation dominated entirely by the opposite sex. What about the computing profession, being a slightly male-dominated occupation? There are far more factors discouraging girls from choosing this profession than encouraging them to. They are not likely to choose the profession because they encounter computers in computing magazines, films, videos, and papers portrayed alongside men twice as often as alongside women, and in these portrayals men are shown as the experts, while women are clerical workers or sex objects (Teague and Clarke 1991: 365). Girls may be discouraged further from choosing the computing profession by adults' stereotyped perceptions of the suitability of forty occupations in computing for men and women (Clarke cited in Clarke and Chambers 1989). The occupations of data entry and primary school computing teacher were seen as more suited for women, while the occupations of computer programmer, computer sales person and computer science lecturer were seen as more suitable for men. These findings are supported by the female professionals interviewed by Kaeding & Wheldrake (1993). All these women agreed that the attractions of IT for women were evident only once an individual had had exposure to the field. The women could not state any factors that were drawing women into the profession, IT being associated with maths and science, which many females do not pursue at tertiary level, IT being male-dominated and seen as a traditionally male profession, and IT being seen as too technical and not people oriented. So, why would girls chose a career in computing? No answers could be found in the literature, and we therefore stick to the hypothesis that girls who somehow know how to cope with a male-dominated occupational culture will be more

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[32] This was a study about occupational choices of twelfth year students at 21 Western Australian high schools. The computing profession was not among the 31 occupations that were mentioned by at least 1% of the girls or 1% of the boys.

likely to choose courses that will provide inroads into the computing profession than girls who are not certain about their coping strategy.

More boys than girls choose computing science. The percentages of women enrolled in computing science in universities has not varied much over the years. Detailed 1995 statistics of the University of South Australia indeed show that 8% of the commencing bachelor male students and 2% of the commencing female students had chosen computing courses (University of South Australia 1995). However, one cannot conclude from these percentages that the computing courses are extremely male-dominated. Twenty-two percent of the commencing students in computer science are female, and 35% in business (management) information systems.

Occupational choices at tertiary level

How do tertiary computing students perceive the sex-typing of the computing profession? Teague and Clarke (1991, p. 365) argue that students perceive computing careers as involving endless hours sitting alone in front of a machine trying to make their code function according to someone else's specifications. Clarke and Chambers (1989)[33] asked computer science students to sex-type thirteen computer occupations. Although sex-typing appeared to be stronger among the male students than among female students, there was a similarity between men and women in the perceived gender-based suitability of particular occupations. The male students perceived three occupations as being more suitable for women (data entry, primary school computing teacher and computer operator) and seven occupations as more suited to men (computer programmer, secondary school computing teacher, computing lecturer, systems analyst, computer salesperson, computer centre manager and professor of computing). The female students sex-typed fewer occupations. They perceived two occupations as being more suited to a woman (data entry and primary school computing teacher) and five occupations as more suited to a man (computing tutor, computing lecturer, computer salesperson, computer centre manager and professor of computing). It might be assumed that girls are less likely to sex-type the occupations as that would limit their occupational choices.

How does the sex-typing of occupations influence a student's occupational choices? Crockett (1992) analyzed why female students would prefer a male-dominated occupation over a female-dominated occupation. His study shows that high scores on a science aptitude test influenced this choice positively, while high scores on an arts aptitude test had a negative influence. Yet perceived aptitudes were more important in the occupational choice process. Female students perceiving their science ability as high and their verbal ability as low were more likely to choose the male-dominated occupation. Female students who had been to a girls-only school did not differ in their occupational choices from girls who had not been in a girls-only school. Female students favouring interesting work were more likely to choose the male-dominated occupation than female students favouring helping people.

An elimination race or a vicious circle?

[33] See also Teague and Clarke (1991).

Two lines of reasoning were followed: the elimination race versus the vicious circle. From the elimination race line we hypothesized that relatively more female students would enrol in computer science than there are in the profession and that drop-out chances are higher for female than for male students. From the vicious circle line we hypothesized the reverse. As far as enrolments are concerned, only a minor group of the secondary school pupils chose computing science. Among this group, women have made up about one quarter to one third, and their proportion increased during the eighties. In 1983, of the computer science graduates completing their degree, 23% were women, a number that increased to 30% a year later but dropped to 27% in 1985 (Daniel 1986). Compared to an increasing percentage of 20% female professionals in 1981 to 24% in 1989, the proportion of women among completing students is indeed higher, but the differences are very minor. This gives a slight advantage to the elimination race model. However, we have to remember that in the eighties more than half of the trainees were recruited internally. This implies that many computing professionals did not choose the occupation as adolescents.

The studies reviewed were not unanimous, but the majority found that women had a higher chance of dropping out. According to one study, the number of women enrolled for computing science courses in New South Wales was about halved over the duration of the course, while the men dropped out to a far lesser extent.[34] Another study showed comparable findings. In the mid-eighties women constituted about a quarter to a third of initial enrolments in most computing courses, but outnumbered men by about three to two among those who withdrew during the first eight weeks of the course. Women were less likely to pass the first level units or to gain the highest grade in the first level units. Women were more likely to enrol in courses with a heavy emphasis on Information Systems in preference to courses which placed a heavy emphasis on mathematical proofs and problem solving. Differences in courses preferences were reflected in patterns of attrition rates and achievement.[35] We have to be careful in interpreting these percentages as they have not been compared to overall drop-out percentages, figures that were unavailable. Also, these findings were not supported by Clarke and Chambers (1989), who found an absence of gender differences in achievement. Yet they did find clear gender differences in students' intentions to undertake further computing studies. Again, there is a slight advantage for the elimination hypothesis.

4.2 Employers' hiring strategies

Completing a degree in computer science is not the only way into the profession, as this counts for only 18% of recruitments. But those who have completed a degree in

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[34] In New South Wales in the eighties the percentage of women enrolled for computing science courses declines over the duration of the course from 41% in year 1 to 27% for years 3 and 4 (Cameron 1991). In the nineties in the School of Computer Science at the University of New South Wales, it is said that on graduation about half the women drop out and after five years the women have halved again, while there is only a 10% drop-out for the men (Computerworld, October 22, 1993).

[35] Judy Kay et al (1986), cited in Clarke and Chambers (1989).

computing science are very likely to work in the profession.[36] Employers' recruitment strategies are diverse, partly because applicants with a degree in computer science or a computer major are in short supply. Recruitment sources vary greatly, internal transfers counting for the largest part to be followed by external work force mobility (table 7). Recruitment of re-entering women is possible, as was proven by the female professionals who were not working in the IT field before their career break (Kaeding & Wheldrake 1993). However their numbers are very small. In this section we will discuss women's inroads into the profession. Again, we will end with a few remarks on the hypotheses of the elimination race versus the vicious circle.

Table 7. Recruitment source of computing professionals in NSW 1989

Recruitment source			
Computer science degree	16%	Govt/private training	9%
Other university degrees	8%	High school	2%
CAE/Tech. Institutes	18%	Internal transfers	23%
TAFE	3%	Workforce external mobility	21%
		Total	100%

Source: Cameron 1991, pp. 16

Women's inroads via traineeships

Women and men who want to enter the occupation are most likely to do so via traineeships. However, the cost of providing traineeships and employing trainees is high for firms and in general they might prefer to spend money on employing experienced staff who are considered to be more productive. A shortage of experienced staff will lead employers to consider employing trainees, despite the cost. We can assume that the ratio of trainees to programmers and analysts will decrease when experienced staff are not in short supply. The few figures that we have indeed show some variation over time, but the ratio has always been less than .1.[37] During the eighties, less than half of the trainees came straight from educational institutions. Others were internally recruited or recruited from other organizations.[38] Yet, when in the late eighties the number of graduates in computing science increased, there appeared to be fierce competition for the trainee positions.[39] Since then, the majority of applicants selected were university graduates.

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36 According to Cameron (1991) in the 1986 Census data it was shown that about 80% of the employees with graduate degrees in computing were employed in the IT industry.

37 Whereas Daniel (1986) found a ratio of trainees to programmers and analysts of 4%, Cameron assumes that the ratio for NSW is 8%, based on the Datec findings from 1982.

38 The IBM/Urwick National Manpower Study of the Data Processing Industry (1983), surveying a sample of computer users with more than 50 staff found that less than half of the trainees came straight from educational institutions (45%). 34% of the trainees were internally recruited and 22% were recruited from other organizations (cited in Cameron 1991, p. 20).

39 Cameron (1991, p. 25) refers to a company receiving 800 applications for 30 trainee positions.

Unfortunately we found no reports examining whether employers were more likely to hire men over women, given the number of applicants. Yet, there is some evidence regarding employers' attitudes towards female professionals. In a study of 14 IT businesses in Adelaide, nearly all employers expressed very positive views about the special qualities women brought to the industry (Strobart 1992).

Women's inroads into the profession by internal recruitment

We have little data on how the number of trainee positions is affected by internal recruitment. People who were recruited internally usually did not have any IT experience, but when they became trainees, they were quite likely to receive IT training. In the late eighties, the proportion internally recruited was more than half of all computing professionals, although this percentage might have been declining slightly in later years. Therefore it is not surprising that the vast majority of the female professionals in the IT business had originally not intended to enter IT and had entered the profession via internal recruitment.[40]

A case study of the Australian telecommunications industry stated that in the eighties Telecom had two paths for technical training, one of which required a completed Year 11 or 12 high school qualification and a TAFE certificate, the second which had no such entry requirements but provided on-the-job training as trainee technical officer in a sub-professional group (Giles 1985). A small number of women had moved into both areas, but the group of female recruits was very small, due to the high proportion of young women who dropped mathematics at an early stage in their high school careers.

Women's inroads into senior positions

Senior programmers and analysts are drawn largely from people promoted from trainee positions and from immigrants (Cameron 1991: 34). Once female professionals are into the trainee positions, are they likely to be promoted to the senior positions? We would assume they had equal chances, as programmers and analysts with more than two years' experience are still in short supply. Unfortunately, hardly any figures were found to shed light on this issue. In the early eighties, it was said that the public sector was an important source of initial work experience for new graduates, who will eventually move into private-sector employment (Graduate Careers Council 1985).

Training can be considered a prerequisite for promotion. There seems to be no gender bias in access to training, as nearly all interviewees in the Kaeding & Wheldrake report (1993) said they had received training, with a slight majority of them actively encouraged to undertake training or education. At the same time individual responsibility for one's own training had been encouraged. Yet, there is evidence that in general women undertake less in-house training, but more external training (Miller 1994).[41]

Women's inroads into management positions

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40 See the reports by Teague and Clarke (1991, 365) and by Kaeding & Wheldrake (1993).

41 This was based on the 1987 Australian How Workers Get Their Training survey.

It is estimated that annually about 15% of senior programmers and systems analysts progress to management positions (Cameron 1991).[42] Do women encounter the famous glass ceiling at this stage? There is mixed evidence so far. The glass ceiling does not seem to be experienced by the female professionals themselves: all ten interviewees in the Kaeding & Wheldrake report (1993) felt that if they showed interest in management their respective companies would be supportive.[43] Yet over half of the twenty women IT leaders interviewed by Computerworld in 1993 said that there certainly is a glass ceiling, and that leaving their present organization and going elsewhere would be the only way to overcome it.[44] The employers in the 14 IT businesses interviewed by Strobart (1992), agreed that the women who were managers were seen as a select group: extra dedicated, motivated and ambitious. Moreover, they were seen as being of the highest caliber, possibly outperforming the men, and were highly valued by the employers for their contribution to the firm.

Can we conclude that female professionals are treated on an equal basis with their male colleagues as far as promotion into management positions is concerned? And that the informal segregation code that women should not supervise men, which is present in so many businesses, has been abandoned in the IT businesses? The studies show that the women have to be ambitious and eager to reach management positions, but there is no evidence whether or not this applies to the same extent to the male professionals. And will this equal treatment remain when experienced positions are not in short supply, as they have been until now? More research is needed to examine these questions.

An elimination race or a vicious circle?

This section will close with a few remarks on the debate about the elimination race versus the vicious circle. From the elimination race line of reasoning it was hypothesized that employers will hire males over females, given the number of applicants. Moreover, employers would promote males over females to the senior positions and to managerial positions, given the number of candidates. From the vicious circle line of reasoning it was hypothesized that male and female professionals would have equal chances to take further steps on a career path, but that the number of professionals would remain low due to the few women that had chosen the right university courses.

In this section, however, it was shown that the professionals were recruited from many sources, of which a university degree in computer science played only a minor role. This makes our examination more difficult, as supply is in fact endless, and no statements can be made as to whether employers prefer men over women. The few employers that had been interviewed did not give the impression that they would be likely to have gender-

42 A 1984 survey into women in management showed that in the 239 firms surveyed in the private sector, 15% had men managers and 16% had women managers in the functional area of EDP/Accounts/Finance, but due to a far higher non-response for the women managers than for the men managers conclusions can not easily be drawn. The study showed that in general the women managers were concentrated in the lower levels management (Still 1986).

43 Three of the interviewees were already at management level, one was a project manager, three had no ambitions, two had ambitions to start their own business, and the remaining person seemed determined to go to the top.

44 See Computerworld, October 15, 1993: Women in IT: it's a great career.

biased preferences. The little evidence that we have supports the vicious circle line of reasoning over the elimination race line of reasoning. On the other hand, the female professionals who have made a career path in IT do not agree on the presence or absence of the glass ceiling in IT, but a slight majority seems to be in favor of the latter. This is in favor of the elimination race argument. As the profession has been in short supply in the past two decades, we cannot make statements about what would happen, should the supply increase.

4.3 The male-dominated culture in the profession

We now turn to the workplace. How likely is it that women who have entered the computing profession will remain working within it? Are drop-out rates higher for female professionals? There are no statistics that give straightforward answers to these questions.[45]

Existing literature and research reports cast some light. We will focus here on documentation of the male-dominated culture within the profession and of how women cope with it. We hypothesize that the more male dominated the culture, the more likely a female professional will quit the profession before retirement. We examine three aspects of the professional computing culture: the gender composition of the workplace, the presence of family-friendly policies, and the strategies women use to cope with this culture. Finally conclusions are drawn.

[45] Census data are likely to provide statistics on job mobility and possibly on interruption, but not on mobility between occupations. Turnover rates in firms, if available, will also not allow conclusions on the issues at stake. In turnover or so-called external mobility statistics the destinations are usually not egistered. According to Cameron (1991) external mobility used to be limited by hardware knowledge, that is a computing professional with experience in systems programming for DEC equipment in banking was not likely to change to an engineering company using IBM mainframes. This changed in the eighties, when the large hardware suppliers had reduced the standards for operating systems. Yet by then knowledge of business became important, thus limiting external mobility in another way. Turnover rates in the computing profession used to be high due to external mobility, but the professionals tend to stay in their profession, changing their employers only. Interstate mobility is difficult to assess. Cameron assumes that 10% of trainees will leave the profession and/or the industry before they have obtained two years' experience.

The gender composition of the workplace

Computing professionals are likely to work either in an IT department of an IT-using firm or in an IT-providing firm. No reports were found on the gender composition of IT departments, but some were found on the gender composition rate of IT businesses.

The gender composition is defined as the rate between the percentage of women in management and the percentage of female employees in the business. When the rate is close to 1, the gender composition rate is far better than when the rate is close to 0. We assume that as the gender composition rate improves, the female professionals will experience an increased sense of well-being, because the firm they work in will be less vertically segregated, and therefore they will not experience hierarchic stereotyped gender relations and quit the firm. Equal opportunity policies might influence the gender composition rate of the firm, but there is little data available to confirm this. One set of data from a small sample of 14 IT businesses in Adelaide (Strobart 1992) does let us infer that equal opportunities policies have a slight positive effect on the gender composition rate.[46]

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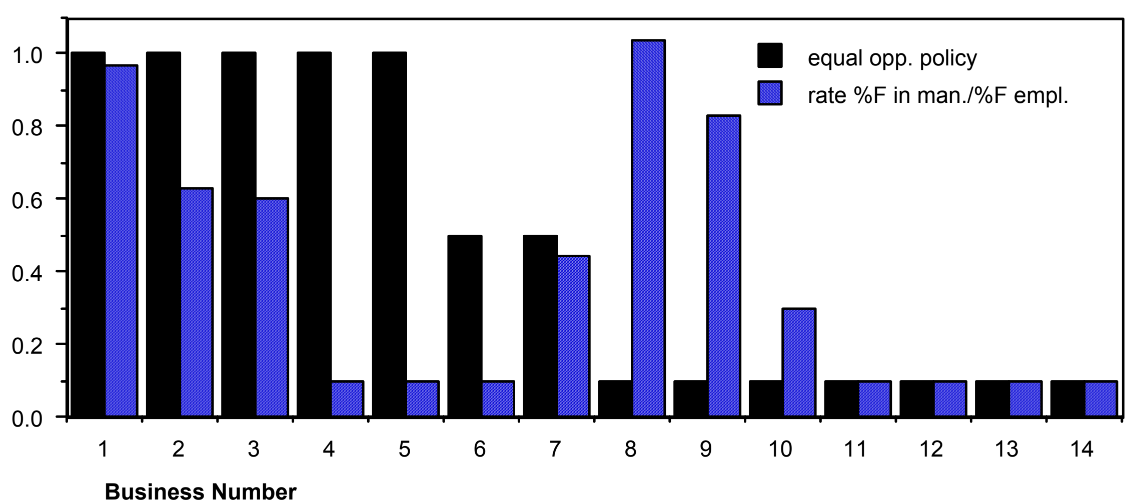
[46] Strobart (1992) examined the role of women in IT Business in Adelaide in relation to a flat or network management structure. Based on her data, it was possible to examine the relationship between equal opportunity policies and the gender composition rate. The graph shows that of the five business having equal opportunity policies (No's 1 to 5), only one has a gender composition rate of 1, which means that the gender composition in management reflects almost totally the gender composition of the total work force in the firm. Two have a rate slightly over 0.5. The remaining two have a low rate. From the seven firms that have no equal opportunity policy (No's 8 to 14), two of them reflect gender compositions nearly 1. One has a gender composition rate that comes up to 0.3. For four of them the gender composition rate is very low. Two firms were not able to say whether they had equal opportunities policies (No's 6 and 7). Their gender composition rates are respectively 0 and over 0.4. From this small sample we can draw the conclusion that equal opportunities policies have a slight positive effect on the gender composition rate.



The gender composition of the firm could be influenced by the gender composition of the customers. There are two reasons why female professionals are more likely to deal with female customers. First, management might assume female professionals to perform better in the case of female customers. Second, it is more likely that female professionals will have business-related knowledge that applies to female-dominated working areas than to male-dominated areas. In the 14 businesses interviewed by Strobart (1992) women were under-represented in the professional staff, with the exception of one business who served firms in the health sector. The reason for this was that its client base was female-dominated.

Family-friendly policies

One aspect of the male-dominated culture is the absence of any family-friendly policies. As these policies are made by firms, and not in the profession as such, we will stick to the IT-providing businesses. It is assumed that female professionals who want to have children have higher drop-out rates when their business does not provide policies to support employees with family responsibilities. This would be in accordance with ILO Convention No 156, to which Australia is a signatory. Family-friendly policies usually include the possibility of part-time work and parental leave, as well as the provision of child care facilities.

In the reports studied we did not identify the presence of child care facilities or parental leave in the computer industry. Or, as Kaeding & Wheldrake (1993) quite clearly state, the IT-providing industry does not provide any child care facilities in order to prevent career breaks. Yet, the interviewed female professionals varied greatly in their opinions whether family-friendly arrangements had to be provided by the employer.

How do the female computing professionals cope with family responsibilities? The report by Kaeding & Wheldrake (1993) shows that the women without children (half of the interviewees) were unsure how to combine care for children with a career in the profession. Some of them did not want to have children, others were postponing maternity. The few women who re-entered the profession after a career break reported that they had to overcome problems. At the same time they viewed their career break positively, as it pressed them to create new opportunities for themselves. One woman retrained in a related field, as she was said to be too old to re-enter her former job. Another women started her own business instead of re-entering as an employee (Kaeding & Wheldrake 1993).

Part-time jobs are scarce in the IT-providing industry. In 1986, the proportion of part-time employees was 7% and these were concentrated in data entry (Daniel 1986). In 1993, none of the four companies studied had part-time workers; only one had a job sharing scheme (Kaeding & Wheldrake 1993). In the computing services industry 6% of men are working part-time, while 28% of women are part-time staff (ABS 1995a). The incidence of part-time employment was lowest in the male-dominated computer maintenance services (3%) and highest in the female-dominated data processing services (42%). Moreover, in the computing profession a dedication to the job seems to be required that usually equates to at least full-time availability (Strobart 1992).

Does self-employment enable female professionals to work part-time more easily? It even could enable them to combine paid work and child care. Statistics show that in the computing services industry self-employed women work part-time to a much larger extent than the computing and technical staff (44% to only 8%, see ABS 1990). This also appears to be the case for men: 9% of the self-employed work part-time, compared to 3% of the computing and technical staff. The study by Mackinnon (1991), who interviewed self-employed female professionals working at home in the Adelaide area, indicated that these women did not mix child care and work. Some of the self-employed women were single, some had no children yet, and some did not wish for a child. Others had older children.

Strategies to cope with a male-dominated culture

The male-dominated culture of the profession might be a major reason for dropping out. What is female professionals' experience of this male dominance and how do they cope with it? No studies could be found detailing how women experience the male-dominated culture of the profession. One study was found about gender bias in IT firms. The interviewees in the Kaeding & Wheldrake report (1993) varied in their opinions as to whether they experienced gender bias in the company. Some saw positive and some negative biases.

Few studies shed light on women's coping strategies. Several managers of the 14 Adelaide IT businesses identified having to fit into a male-dominated world as one of the problems unique to female professionals (Strobart 1992). Mackinnon (1991) assumes that female professionals probably avoid the male-dominated culture by choosing self-employment instead of wage earnership and that self-employment will give them the advantage of a 'woman-friendly' work environment. However, the impression outsiders have of the female professionals' appearance is that they look feminine, but that they are also self-confident, independent and determined, which are not predominantly female characteristics. In interviews with the female professionals, it is quite clear that they all find their job challenging, enjoy a fast-moving environment, and feel they have the autonomy and freedom to get the job done.[47] Moreover, all female IT professionals interviewed believe that IT offers a good career track for women. These women are professionals, they are proud to be in the profession, and firmly advise girls to enter the profession.

Do the female professionals benefit by virtue of their gender, as has been assumed by feminist scholars?[48] Half of the interviewees in the Kaeding & Wheldrake report (1993) did not believe that there were any specifically female qualities which advantaged women in IT, the other half believed this was the case. The most common quality cited was good communication skills; others were empathy, generosity and willingness to help, and good organizational skills. On the other hand, half of the interviewees also thought that there were male qualities which advantaged men in the IT field, specifically that men were more aggressive, competitive and forward. Comparable results came from the interviews with managers in 14 IT businesses (Strobart 1992). One group of managers was eager to

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47 From Computerworld's interviews with 20 women IT leaders (Computerworld, October 15, 1993: Women in IT: it's a great career). The ten women interviewed by Kaeding and Wheldrake (1993) considered IT to be a good career choice for women, and they stated that the future for women in IT is good, and they believed that more women would enter this field. The interviews with ten IT women by Teague and Clarke (1991) give exactly the same impression.

48 In the late eighties and early nineties this issue has been discussed to a large extent at several Women, Work and Computerization conferences.

recognize and praise the different qualities they perceived that the female professionals brought to their work. The other group protested almost too strongly that they saw no differences. The interviewer thought this attitude probably would protect them from charges of being sexist.

An elimination race or a vicious circle?

Which conclusions can be drawn from this section with respect to the elimination race versus the vicious circles discussion? Are drop-out chances higher for female than for male professionals? Due to a lack of statistics, drop-out chances could not be indicated. We therefore had to rely on interviews only.

Two major statements can be made from the interview findings. Firstly, the female professionals seem to adapt quite easily to the male-dominated culture of the workplace, at least where daily practices are concerned. Although the female professionals' appearance is feminine, but they are also self-confident, independent and determined, which are not predominantly female characteristics. Secondly, when it comes to family responsibilities, there is a huge problem. Part-time work, parental leave and child care arrangements are not a feature of IT businesses. The female professionals find this very difficult to cope with. Some of them want to remain childless and some postpone having children. It seems that the female professionals who have children are very likely to quit the profession for a few years. The female professionals who take a career break are likely to re-enter after a few years. Re-entrance is possible, as experienced workers are still in short supply. Some female professionals then also consider setting up their own business or retraining. Self-employment is not considered a solution to child care problems but will allow professionals to work part-time.

5 CONCLUSIONS AND DISCUSSION

In this study, we have examined gender segregation in the computing profession over the past two decades. The computing profession has grown tremendously, and that qualifications and entry requirements have changed heavily over time. Demand and supply in the profession are unbalanced, which makes it more difficult to study the segregation dynamics. We have followed two lines of reasoning: gender segregation as an elimination race versus a vicious circle. The focus has been on three aspects of gender segregation: boys' and girls' occupational choices, employers' hiring strategies and the masculine culture in the profession. The main findings are presented below.

We will review here firstly the process of making occupational choices. Over the past two decades women's participation in tertiary studies has increased dramatically, and nowadays women outnumber men. Women have made huge inroads into law and medicine, but minor inroads into the computing profession, and no inroads whatsoever into the technical professions. The statistics indicate that the proportion of women in the profession increased from slightly under 20% to nearly 25% between 1981 and 1989, compared to a percentage of 40% in the whole labor force in 1986. The computing profession is not an extremely male-dominated profession, it is somewhere in between a male-dominated and an integrated occupation. In the long run, the profession is likely to become an integrated profession, because the proportion of women has increased continuously and is likely to increase further. Today, women make up about one quarter to one third of the students in computing science, and an even higher proportion of business information systems students. Some arguments are in favor of the vicious circle: in the past decade few girls have chosen to be educated for the computing profession, mainly because of the absence of a clear image of the profession. This has led to a under-representation of women in the computing professions. However, once having chosen this field of study, a larger proportion of female computing students aims to work in the profession compared to their male counterparts. There were also arguments in favor of the elimination race: retention rates at tertiary level are higher for female than for male students.

Secondly, we discussed employers' hiring strategies in the IT-using as well as in the IT-providing industry. It was shown that the professionals were recruited from many sources, of which universities were only one. Due to an absence of data, there was no evidence for employers preferring male over female candidates. Yet, from the interviews with employers and the fact that the profession has been in short supply, one could conclude that there is no gender bias in hiring strategies relating to external candidates. We found no evidence for gender bias in internal promotion. Female professionals themselves do not agree on the presence or absence of the notorious glass ceiling in their professions. The evidence so far seems to be in favor of the vicious circle, given the short supply of course.

Thirdly, we studied the masculine culture in the profession. We concluded that female professionals seem to adapt quite easily to the masculine culture in the workplace, as far as daily practices are concerned. Yet when it comes to having children, female professionals face enormous problems, which they find very difficult to cope with. Female professionals are likely to quit the profession for a few years after the birth of a child. The women are likely to re-enter the profession, and take the opportunity to retrain or to set up their own businesses, if our small sample is representative. We had insufficient data to favor either the elimination race or the vicious circle in this area.

To conclude this study, we found more evidence for the vicious circle than for the elimination race, although arguments were found for both the propositions and we sometimes faced insufficient information to draw conclusions upon. The under-representation of women in the computing profession can be explained better by the absence of women's occupational choices for the profession than by employers' hiring strategies or by the masculine culture in the profession. Therefore, when women's occupational choices would change, a tendency towards desegregation can be expected. Two types of further studies would be necessary to clarify the pattern: a cohort study following the careers of computing science and business information students and a study of the retention rate in the computing profession by tracing drop-outs, for example members of the computing association or employees in an IT-providing industry.

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APPENDIX 1: OVERVIEW OF THE SURVEYS CARRIED OUT IN THE COMPUTER INDUSTRY

In 1974, Smith & De Ferranti (1976) conducted a survey of firms, using computer equipment.

In 1984, Daniel et al. (University of New South Wales 1986) took a sample of over 376 firms in the computer industry and held a postal survey. The study showed that software supply and manufacture are the provinces of smaller firms, with only five large employers. There were a few large firms operating primarily as systems builders, but the remaining industries were mostly small, the majority employing fewer than ten people. Consultants were typically very small companies of professional computer experts.

In 1986, the Department of Industry, Technology and Commerce held a postal survey of the Australian software industry, defined as those activities which vary from the design of systems (and hardware for such systems) to the development and marketing of software packages, including in-house activities (Morris, Tardif & McAlister 1987). The authors concluded that the software industry is a highly skilled activity, is R&D intensive, can become more international, and provides the opportunity for small, innovative business to grow. In the eighties, software has become a crucial component in the competitiveness of the manufacturing and services industry in Australia. The study also reports that the majority of the firms have an employment size of 1 - 9 (57%), and that 35% have an employment size of 1 to 4.

On the basis of the survey results, employment is estimated at between 15,000 and 16,500 persons (including employment of software personnel in the major hardware companies, but excluding the in-house software development activities). The latter are estimated to employ at least half the above estimate again. The survey results indicated that Australia's demand for software skills over the next two years will be greatest for applications programmers (68% of the responding firms), followed by project leaders/managers (43%) and systems analysts (40%). Trainee programmers were 31% and systems programmers 29%. The skills shortage is strongly related to the size of the firm. Of those which employ less than twenty people, only a third saw the lack of skilled staff as a major problem, while twice as many of the larger firms thought it a problem. This is the case for all software skills, but particularly for project leaders/managers and communications personnel.

The shortage of technical and professional skilled labor in the information industries has been identified as a critical impediment to the development of these industries in Australia. The shortages are generally at the experienced and specialist end of the market, which underlies the need for industry to make on-the-job training opportunities available to inexperienced workers. According to the survey 6.3% of the 385 firms were sole proprietorship and 2.8% were partnership. As far as the professional staff was concerned, 21% had 10 to 20 years of experience, 36.5% had 5 to 10 years, 23% 2 to 5 years, 8.4% had 1 to 2 years, and 6.5% less than 1 years. 4,2% had over 20 years. Fifty-six percent of the computer science staff had a university qualification and 22% a college of advanced education training, 10% a private training institution and 10% a TAFE training.

In 1987-88, the Australian Bureau of Statistics (ABS 1990) carried out a postal survey in the private sector of the Computing Services Industry, including providing hardware and software consultancy and professional services, systems analysis design and programming, building custom designed systems, data processing and preparation services and microfiching and microfilming services (ANZSIC-class 6381). The Computing Services Industry was estimated to comprise almost 3,7000 enterprises, employing over 24,000 people. The industry was strongly concentrated in New South Wales, accounting for 49% of the industry's turnover, and to a lesser degree in Victoria and ACT. Over 95% of the enterprises in the industry were small business, employing less than twenty persons. Yet, the largest 12 enterprises (those employing over 200 persons) employed over 24% of the industry's staff and accounted for 31% of its turnover (ABS 1990, p. 2).

In 1992-93, the Australian Bureau of Statistics carried out a postal survey in the Information Technology Industry (ABS 1995b). This survey included the ASIC classes 2841, 2842, 2849, 2852, 4613, 4614, 4615, 7120, 7743, 7831, 7832, 7833, 7834. The results showed that these classes comprised 9,497 enterprises, of which 7,243 were engaged mainly in IT activities and 260 undertook IT activities as a secondary activity. The 7,243 enterprises employed 136,788 people and the secondary IT producers employed 8,664 people. Almost 90% of the IT specialists employed 1 to 9 people; this was to a lesser extent the case for the secondary IT producers (63%). This survey did not provide information on self-employment, nor on male/female employment or part-time work.

In 1992-93 the Australian Bureau of Statistics also carried out a survey in the Computer Services Industry (ANZSIC-classes 7831, 7832 and 7834). At June 1993 there were 4,894 businesses (management units) in the computer services industry, employing about 30,000 people (ABS 1995a). Almost 90% of these businesses were classified to the computer consultancy services industry (ANZSIC 7834). The consultancy services employ 75% of all persons employed in the computer services industry. Computer maintenance accounted for 16%, and data processing services for 7%. The information storage and retrieval industry was the smallest industry, accounting for only 2% of employment. In terms of number of businesses, the computer services industry was dominated by small businesses, with 97% of businesses employing fewer than 20 people. These small businesses accounted for 42% of industry employment and 28% of industry operating profit before tax. In contrast, the 29 businesses in the industry employing 100 or more persons (representing less than 1% of the businesses) accounted for 42% of employment and 58% of operating profit before tax.
Business operating in NSW dominated the computer services industry. The 2,000 businesses operating in the csi in NSW accounted for 47% of employment and 54% of operating profit before tax. Businesses in NSW and Victoria together accounted for 77% of employment and 81% of operating profit before tax.
Direct comparisons to the 87-88 survey are not feasible. Yet, for these three industries (ANZSIC 7831, 7832 and 7834), the number of employing businesses increased by 40% from 3,321 to 4,652 from 1987-88 to 1992-93, while the number of employed persons increased by 7%. Over the same period the total number of employed persons in Australia increased by 5%. Just under 87% of those employed in the csi worked full-time. The incidence of full-time employment was highest in the computer maintenance services (97%) and lowest in data processing services (58%). There were considerable differences in the proportion of males to females in the fur ANZSIC classes. Just over 75% of those working in the computer maintenance services were male. This was followed by the computer consultancy services (67%). However, employment in the data processing services and information storage and

retrieval services was predominantly female. The incidence of females in the computer services industry working part-time was also considerably higher (at 28% of total female employment in the industry) than for males (under 6%). The incidence of females working part-time was particularly high in data processing services where just over 56% of females worked part-time. There was a considerably higher proportion of males compared with females working in the csi as working proprietors/directors and computing/technical staff. In contrast, the proportion of females engaged in non-technical work was considerably higher than males in each of the 4 ANZSIC industries.

In the computer maintenance services labor costs were $49,800 per person compared with a low $ 28,200 per person employed in data processing. Small businesses had relatively low labor costs per person employed ($29,800) compared with other businesses in the industry ($52,800). The highest return on assets for small businesses was for those in the information storage and retrieval services industry, where a large 25.3% return on assets was reported. Over the last 25 years computer and information technology has pervaded almost every area of Australian society. The expanded use of technology has been accompanied by the development of a large range of support services. These infrastructure services include data entry, data processing, information storage and retrieval, computer repair and maintenance, programming, systems analysis, etc. (ABS 1995b). Such services are either carried out by employees of an organization, or by specialist business that comprise the computer services industry. Over the last 10 years, a number of large businesses have outsourced computer services activities previously carried out by own employees. Nevertheless, the data processing and information storage and retrieval industries are still very small in comparison with other computer services industries, indicating that the activities associated with these industries are still largely undertaken in-house.