'The ratio of men to women in the IT industry does not reflect that in the population. Discuss the reasons for this and propose remedies'

Kathryn S Macarthur (ksm204@ecs.soton.ac.uk)

January 14, 2008

1 Introduction

Balancing a job and a family has always been an issue for women in industry, especially one as demanding as the IT industry [7]; this is perhaps one of the reasons why the ratio of women to men in the IT industry is much lower than that in the population.

Women only seem to be under-represented in the IT industry itself, rather than in IT in general. In terms of recreational computing, the social networking website Facebook[1] actually has more female members registered for the University of Southampton network than male; in total, as of 3 January 2008, the University of Southampton network has 20, 112 members, 45% of which are female and 41% male (14% of members' genders are not listed).

This report aims to discuss possible causes of and remedies for the low number of women in IT.

2 Causes

2.1 Discrimination

Some attribute the low number of women in the industry to sexual discrimination in the workplace. A number of laws are in place to try and stop discrimination, but the homemaker stereotype applied to women is an old one, and so is very hard to overcome.

The ACM code of Ethics and Professional Conduct [1] states "[An ACM member must] take action not to discriminate" on any grounds, whether by race, gender, or other social and personal factors. Some may argue an act is not discriminatory if it has always taken place and continues, especially when it is not considered discriminatory until viewed in a contemporary light. Rules can be changed, but changes can only be effective in society if people change their attitudes accordingly [9].

2.2 Education

In [10], Robinson suggests that women are 'channelled' into non-technical jobs by the education they receive, from primary school level all the way up to university. There are a number of reasons highlighted in literature regarding this; they are discussed below.

[1] Facebook: See http://www.facebook.com/

2.2.1 Bias in Teaching

Parents and teachers tend to underestimate the potential that girls have in maths and science, and so become much less likely to encourage girls with talent in these areas to continue education in them and eventually forge their career based around these subjects [8].

Observation of behaviour of lecturers in maths, science and engineering classes has been done [8], and without any intention to, they tend to bias themselves toward male members of the class. Males in lectures are more likely to be asked to answer the more challenging questions than females, and after questions have been answered, males are often given much more positive responses than females. One would assume that the smaller amount of females in these classes would lead to the lecturer being more likely to remember their names; however, studies have shown that the lecturer is far more likely to remember names of males than females. It should be noted that these observations hold over lecturers of both genders [8].

2.2.2 Self-esteem

A study by psychologists in 1981 (cited by Klawe et al in [8]) found that a women's level of self-esteem and self-confidence dropped throughout an undergraduate degree in science or engineering, despite the fact that, on average, those women did academically better than men on the same courses. One would assume that this drop in self-worth was the reason for the dropout rate for women in PhD programs standing at around double that for men in 1995 [8].

2.2.3 Gender bias in Vocabulary

In [2], it is suggested that certain vocabulary and metaphors used in computing are not value neutral for members of both genders, and so might exclude women, or include them in undesirable ways. Feminist theory agrees with this suggestion, saying that the military and masculine origins of computing are reflected in combative themes and aggressive imagery used; for example, phrases such as 'killing a process', 'crashing', 'aborting', 'fatal errors' are very indicative of a military background [4][11]. Phrases such as these, combined with extensive use of arcane technical computing 'jargon', are unappealing to most women, due to differences between the genders in psychological composition. This lack of appeal can then lead to women feeling alienated and discourages them from the field [11].

It should be noted that this kind of bias is not only exhibited in computing terminology: it can also be found in the visual aspects of computing. Icons used in widely used software and operating systems exhibit subtle visual biases; for example, the generic 'settings' icon used by most software is a spanner emerging from a toolbox, a stereotypically male visual cue [4].

2.2.4 Statistics

Appendix A contains statistics relating to numbers of men and women taking technical subjects to degree level and beyond. The statistics were obtained from an academic in the School of Electronics and Computer Science (ECS), University of Southampton, and are provided in the appendix. All figures mentioned in this section can be found in Appendix A.

The chart in Figure 7 shows small numbers of women present in all levels of academia, and also rather interestingly large numbers of women studying PhDs. This could partially be causing low numbers of women in the IT industry, and the large numbers of women in lower echelons of industry. Studying a PhD constitutes another 3 years not spent in industry, meaning a woman will have less time to achieve a higher industrial position following this than if she had left university and started working immediately.

Figure 8 shows the percentage of women taking all years of technical degrees in ECS is consistently below 20%. The figure also shows that the female intake has not really increased over time; first years are only marginally higher in number than second years, but numbers of fourth years are much larger than both. These figures cannot be assumed to be completely representative of an overall trend in such subjects though; overall numbers of new students dropped after a large fire in one of ECS's main buildings in 2005.

Figures 9, 11 and 12 show that the large percentage of women taking technical subjects in ECS tend mostly to shy away from the more technical subjects such as Computer Engineering (also known as Digital Systems Engineering).

2.3 Workplace

Most women present in the IT industry tend to be mainly clustered around the lower echelons of the field [11]. This would appear to be because the majority of women in technology begin in the lower echelons of the field and rather than move up the career ladder, they move into a different industry and move up the career ladder there.

Successful women in IT tend to lead groups helping other women in the field. This is both a good and bad thing as whilst helping the women, they are possibly acting to their own detriment. Being involved in such groups takes time away from professional activities and can also make employers associate the women with 'women's issues', causing commitment and contribution to other aspects in the field to be overshadowed or forgotten. It can also contribute to the assumption that women do not do anything technical, only discussing 'women's issues' [8].

2.4 Computing Culture

Computing culture paraphernalia constantly reiterates masculine themes, whether intended or not [11]. The majority of computer-related magazines are filled with advertisements such as that in Figure 1, which depicts a woman as an adornment, a passive, technically unskilled functionary and sex object used to sell computers and games rather than a person of equal competence and intelligence to a man. This could be more of an issue with the media in general rather than specifically magazines and adverts featuring computers, but the magazines themselves do not make any effort to change this apparent trend, and instead help to perpetuate it by publishing such adverts.

3 Remedies

3.1 Education

Alternative representations of material presented in education could increase the appeal of computing to women at a young age [4]. Simply presenting material in a combination of verbal, visual and aural manners would help to support rational ways of knowing and being in the world, as well as helping children of both genders to learn in their own way. Psychological research into learning patterns showed that men and women learn in different ways; men learn in an autonomous manner, and women in a relational manner and mixing representation of material would appeal to both genders. This could be done by speaking to instructional designers and encouraging them to design lessons in a less linear, objectionist and traditional manner.

Computer clubs for girls (CC4G)[2] in the UK is an initiative designed to encourage girls into computing by showing them possible applications for computers while trying to maintain a using computers as a fun

[2]CC4G: See http://www.cc4g.net/public/index.html

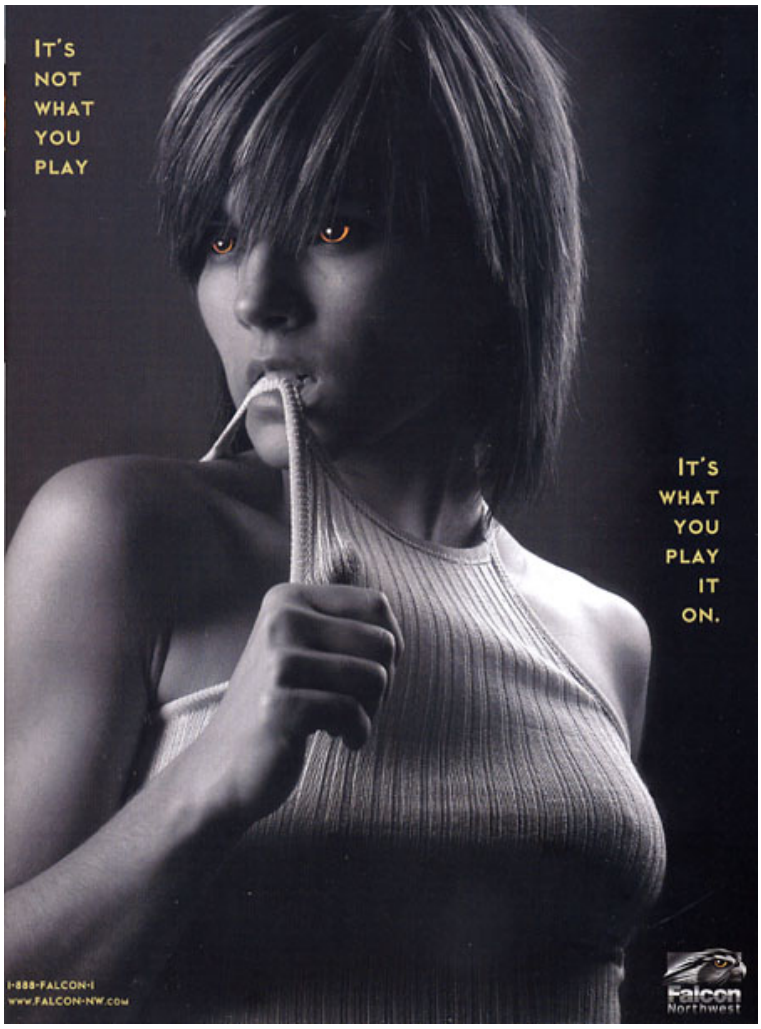

Figure 1: Advert for Falcon computers. Taken from
http://ninthwavedesigns.typepad.com/.shared/image.html?/photos/uncategorized/falconnwad.jpg

activity. I believe this kind of initiative is a good way of removing the male persona applied to computers nowadays, but obviously changes produced by CC4G will not be seen for a number of years yet, when the girls who first tried it grow to university age.

3.2 Research

I believe that further research into the field of women in computing and why numbers are so low would help to find an appropriate solution. Research into the field usually tends to be as a secondary facet of a larger primary interest more acceptable to academic establishments, but this is changing in current climates [3]. The University of Southampton is a good example of this changing attitude: whilst researching this report I spoke with Reena Pau[3], a current PhD student in ECS who is undertaking her PhD on the issue of the lack of women in computing with two leading female academics as her supervisors. This kind of aid and acceptance should be continued and encouraged in universities across the UK and abroad to help raise awareness of the issue.

The International Federation for Information Processing (IFIP)[4] identify 2 main approaches to research in the area in the UK (described in full in [3]), brought together on an international scale in the IFIP's Women, Work and Computerization conference.

The first approach is conducting research into the limited presence of women in IT by focussing on education, training and equal opportunities. The association for women in computing (AWC)[5] is one of the most active organisations supporting this kind of research; formed in 1987, it aims to promote interest in and increase the number of women taking relevant qualifications in college and university and in the industry. The AWC maintains a mailing list and newsletter, as well as an annual conference and workshops, whilst providing support and friendship to members.

The second approach is to research into the sociological and philosophical aspects of the issue, by trying to identify the nature of IT work which makes it more attractive to men. Research would be conducted into this 'gendering' of technology, and links between IT and feminism. This approach is more suited to social scientists, scarcely funded and thus not attractive to many. Lack of funding is one of the contributing factors to the scarcity of research into the problem and must be changed if any improvement is to be made.

3.3 WCAR and TAP

The growth of the world wide web in the last ten years has meant that information relating to women in computing is more readily available; however, the sheer volume of information available reveals a need for an easy, unified way to access it. The WCAR list and the Ada project endeavour to provide this access method for different aspects of the issue.

The Women in Computing Academic Resource (WCAR) list[6] was created by Laura Downey in 1994, and lists identified colleges and universities with formal or informal programs for encouraging and retaining women in computer science [5]. The list mostly consists of colleges and universities in the US, but does hold some entries for UK universities, such as the University of Wolverhampton and the University of Edinburgh. The WCAR began with research into women-friendly graduate programs and gives the opportunity for other women to identify and discuss academic environments which are friendly to women.

The Ada Project (TAP)[7] began at Yale University in 1994, and was named after Ada Lovelace, known for her work with Charles Babbage on his analytical engine. The project has since been maintained by volunteers

[3]Reena Pau: Contact rp05r@ecs.soton.ac.uk
[4]IFIP: See http://www.ifip.or.at/
[5]AWC: See http://www.awc-hq.org/
[6]WCAR list: See http://www.womenswork.org/wcar/
[7]TAP: See http://women.cs.cmu.edu/ada/

from Carnegie Mellon University since 2005. The site has information on conferences, projects, organisations, fellowships and available positions for women in technology. It also contains bibliographies of links to online papers and websites on the subject rather than locally duplicating them, thus saving themselves bandwidth. The website proved its worth after receiving 2500 hits from 1700 distinct machines in the first two months of operation alone [6].

3.4 Groups

A number of groups have been set up around the world to focus on getting more women into the IT industry: the National Centre for Women and Information Technology (NCWIT)[8], the Anita Borg Institute for Women and Technology (ABI)[9], the ACM Comittee on Women in Computing (ACM-W)[10], BCS Women[11], and Systers[12], which is an email-based discussion list aimed at women in technology.

The ABI organise an annual series of conferences called the Grace Hopper Celebration of Women in Computing[13], which aim to bring together women in the IT industry, highlight success of women in the field and provide role models for all women in IT [8].

3.5 Childcare

Provision of childcare facilities in workplaces could help to raise the number of women in the IT industry, as a woman's most important years in establishing her career will often coincide with the years in which she will bear one or more children [8]. The abundance of men in the IT industry means that sometimes childcare facilities provided by companies are below par or even non-existent. This kind of neglect would discourage women from the industry from the outset of their careers.

4 Conclusion

In my opinion, one of the main barriers to women in IT is the pessimism which shrouds it. Many papers I have covered speak negatively about the topic, with horror stories about stereotyping and discrimination only perpetuating the problem they speak of. Young women interested in entering the field should not be told that it is dominated by men and that they are therefore unlikely to get a good job, therefore discouraging them from continuing. I believe if this negativity were reversed in a manner showing the entrant the potential they could realise and how exciting the field is, then the ratio might become closer to that evident in real life.

I believe that the number of women in the IT industry can be raised by putting remedies mentioned in this report into practise, especially that of carrying out research into the reasons why women do not often pursue IT careers. More women in the area would be beneficial to the industry as a whole because women can bring skills to the workplace different to those brought by men.

[8] NCWIT: See http://www.ncwit.org/
[9] ABI: See http://anitaborg.org/
[10] ACM-W: See http://women.acm.org/
[11] BCS Women: See http://www.bcs.org/bcswomen
[12] Systers: See http://anitaborg.org/initiatives/systers
[13] Grace Hopper Celebration: See http://gracehopper.org/2008/

References

[1] ACM Code of Ethics and Professional Conduct. *SIGCAS Computers and Society*, 21(2-4):6–7, 1991. ISSN 0095-2737.

[2] *Gender Issues in Computer Networking*, New York, NY, USA, 1994. Elsevier Science Inc. ISBN 0-444-81927-4.

[3] Alison Adam. Women and computing in the uk. *Communications of the ACM*, 38(1):43, 1995. ISSN 0001-0782.

[4] Katy Campbell. *Computers, Ethics and Society*, chapter Gender Bias in Instructional Technology, pages 171–184. Oxford University Press, 3 edition, 2003.

[5] Laura L. Downey. Announcing a new resource: the wcar list. *Communications of the ACM*, 38(1):43–44, 1995. ISSN 0001-0782.

[6] Elisabeth Freeman and Susanne Hupfer. Tap: tapping internet resources for woman in computer science. *Communications of the ACM*, 38(1):44, 1995. ISSN 0001-0782.

[7] Denise W. Gürer. Pioneering women in computer science. *Communications of the ACM*, 38(1):45–54, 1995. ISSN 0001-0782.

[8] Maria Klawe and Nancy Leveson. Women in computing: where are we now? *Communications of the ACM*, 38(1):29–35, 1995. ISSN 0001-0782.

[9] Sheila McLean. *The Legal Relevance of Gender - Some aspects of sex-based discrimination*, chapter Introduction, pages 1–15. Macmillan Press, Hong Kong, 1988.

[10] O. F. Robinson. *The Legal Relevance of Gender - Some aspects of sex-based discrimination*, chapter The Historical Background, pages 40–60. Macmillan Press, Hong Kong, 1988.

[11] Ruth Woodfield. *Women, Work and Computing*. Cambridge University Press, 2000.

A Statistics from Southampton University

The following pages contain full statistics obtained from Su White[14] as of December 2007 for the School of Electronics and Computer Science (ECS), University of Southampton. They also contains charts of various subsets of the statistics.

[14]Su White: Contact saw@ecs.soton.ac.uk

Year	Male #	Female #	Male %	Female %
Computer Science and Software Engineering				
1	84	12	88	13
2	62	2	97	3
3	53	10	84	16
4	37	6	86	14
Electrical Engineering				
1	21	1	95	5
2	19	5	79	21
3	17	5	77	23
4	7	4	64	36
Electromechanical Engineering				
1	14	0	100	0
2	12	0	100	0
3	11	0	100	0
4	2	1	67	33
Information Technology in Organisations				
1	22	10	69	31
2	19	7	73	27
3	29	5	85	15
Computer Engineering/Digital Systems Engineering				
1	6	1	86	14
2	10	2	83	17
3	10	0	100	0
4	9	0	100	0
Electronic Engineering				
1	66	10	87	13
2	58	5	92	8
3	66	6	92	8
4	34	6	85	15

Figure 2: Table containing statistics of Undergraduate students in ECS as of December 2007

Cohort	Male #	Female #	Male %	Female %
Computer Science and Software Engineering	236	30	0.89	0.11
Electrical Engineering	64	15	0.81	0.19
Electromechanical Engineering	39	1	0.98	0.03
Information Technology in Organisations	70	22	0.76	0.24
Computer Engineering/Digital Systems Engineering	35	3	0.92	0.08
Electronic Engineering	224	27	0.89	0.11

Figure 3: Table containing overall numbers of Undergraduate students in ECS as of December 2007

Cohort	Male #	Female #	Male %	Female %
Complexity Science	7	0	100	0
Microelectronic Systems Technology	1	0	100	0
Web Technologies	19	9	0.68	0.32
Microelectronic System Design	25	2	93	7
Nanoelectronics	7	0	100	0
Radio Frequency Communications	38	11	78	22
Software Engineering	24	2	92	8
System-On-Chip	11	2	85	15

Figure 4: Table containing overall numbers of MSc students in ECS as of December 2007

Field	Male #	Female #	Male %	Female %
Computer Science and Software Engineering	82	27	0.75	0.25
Electronic and Electrical Engineering	156	24	0.87	0.13

Figure 5: Table containing overall numbers of PhD researchers in ECS as of December 2007

Level	Male #	Female #	Male %	Female %
Post-Doctoral	68	16	0.81	0.19
Academic	57	5	0.92	0.08
Lecturer	40	3	0.93	0.07
Professor	36	1	0.97	0.03

Figure 6: Table containing overall numbers of staff members in ECS as of December 2007

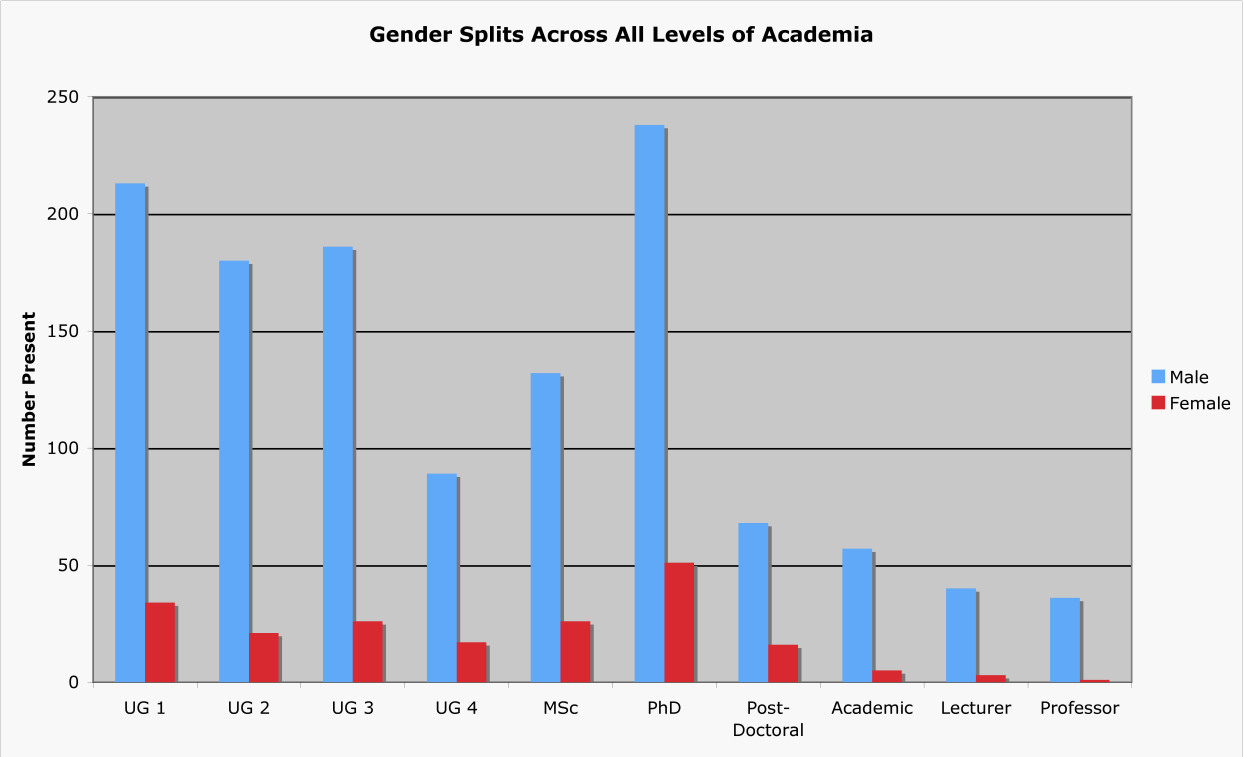

Figure 7: Chart showing numbers of males and females present in all levels of academia, from Undergraduates to Professors, in December 2007.

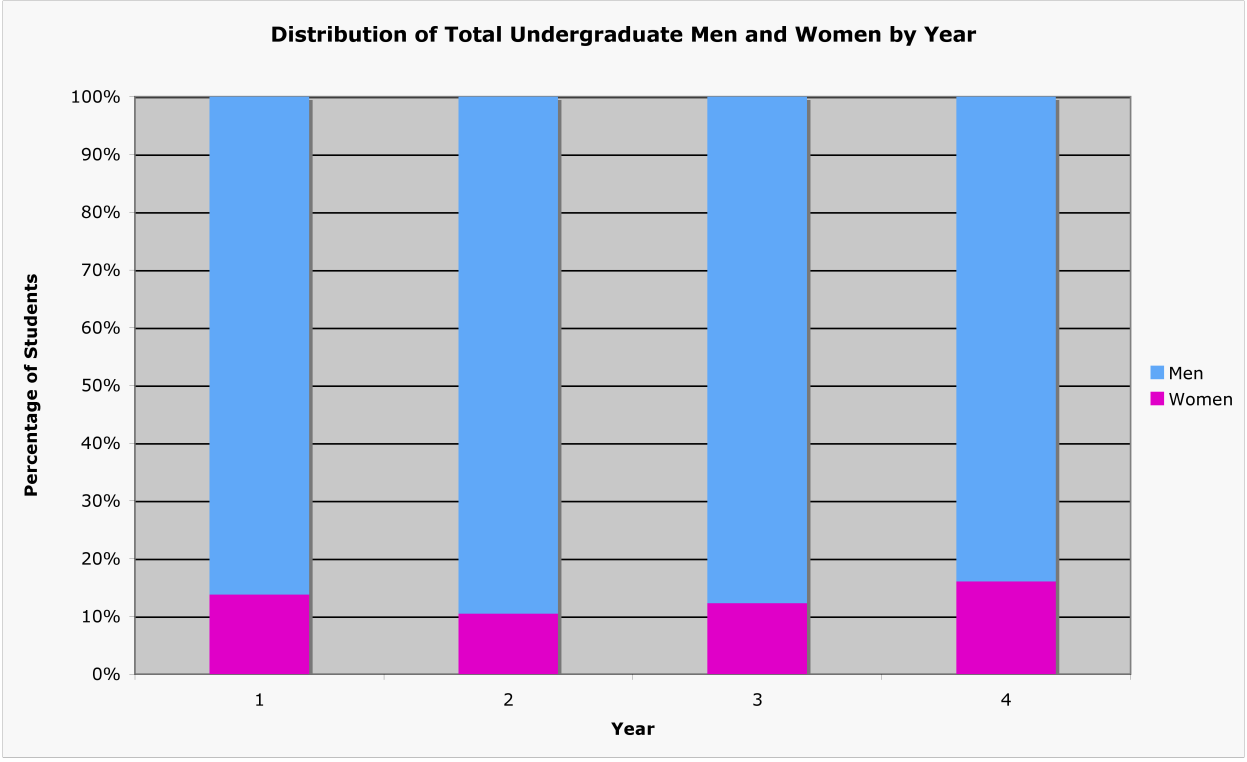

Figure 8: Chart showing distribution of men and women across the 4 years of Undergraduate programmes in December 2007.

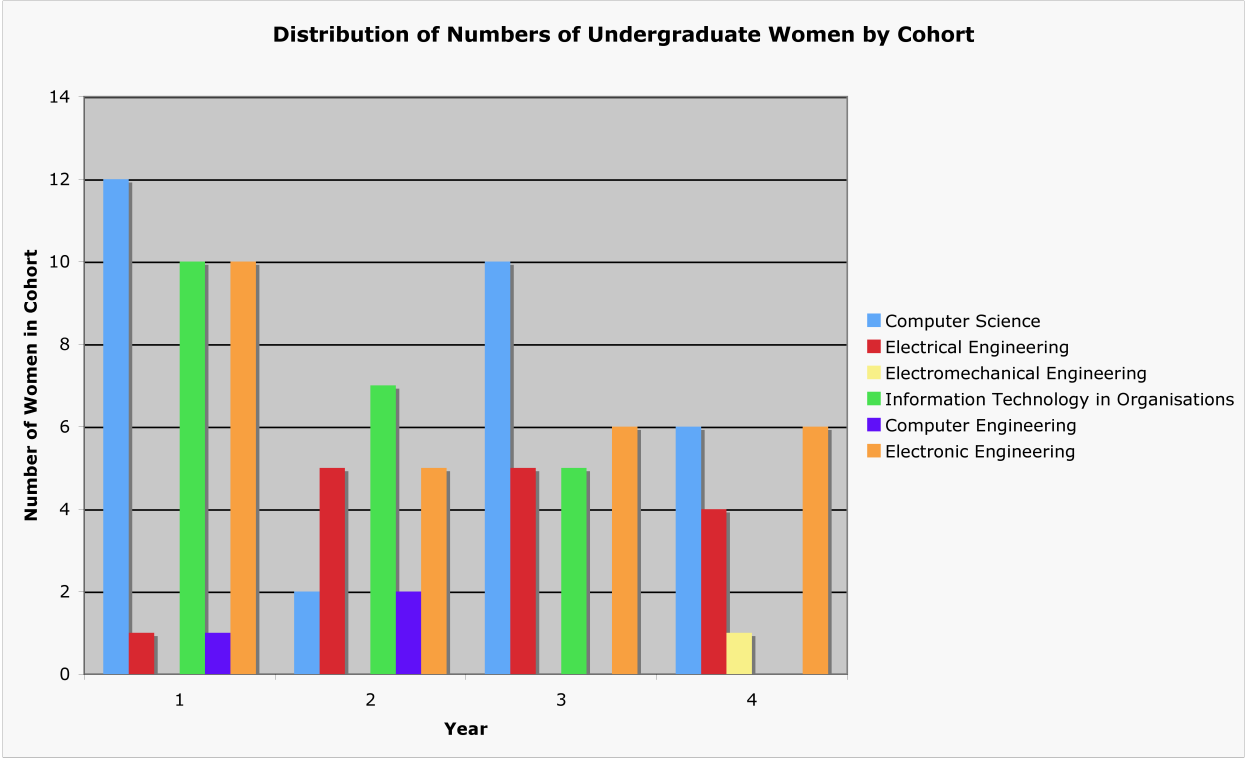

Figure 9: Chart showing numbers of women present in Undergraduate programmes by year and cohort, in December 2007.

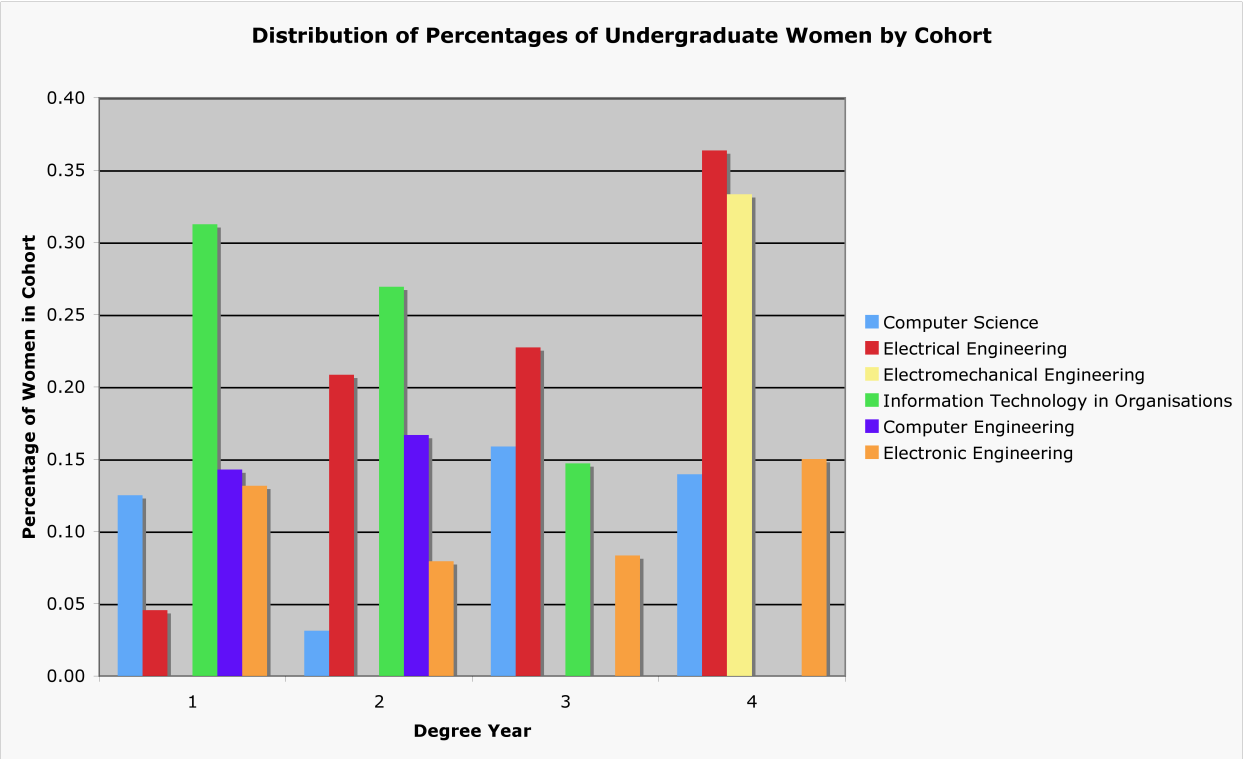

Figure 10: Chart showing numbers of women present in Undergraduate programmes by year and cohort as percentages of total students on those programmes, in December 2007.

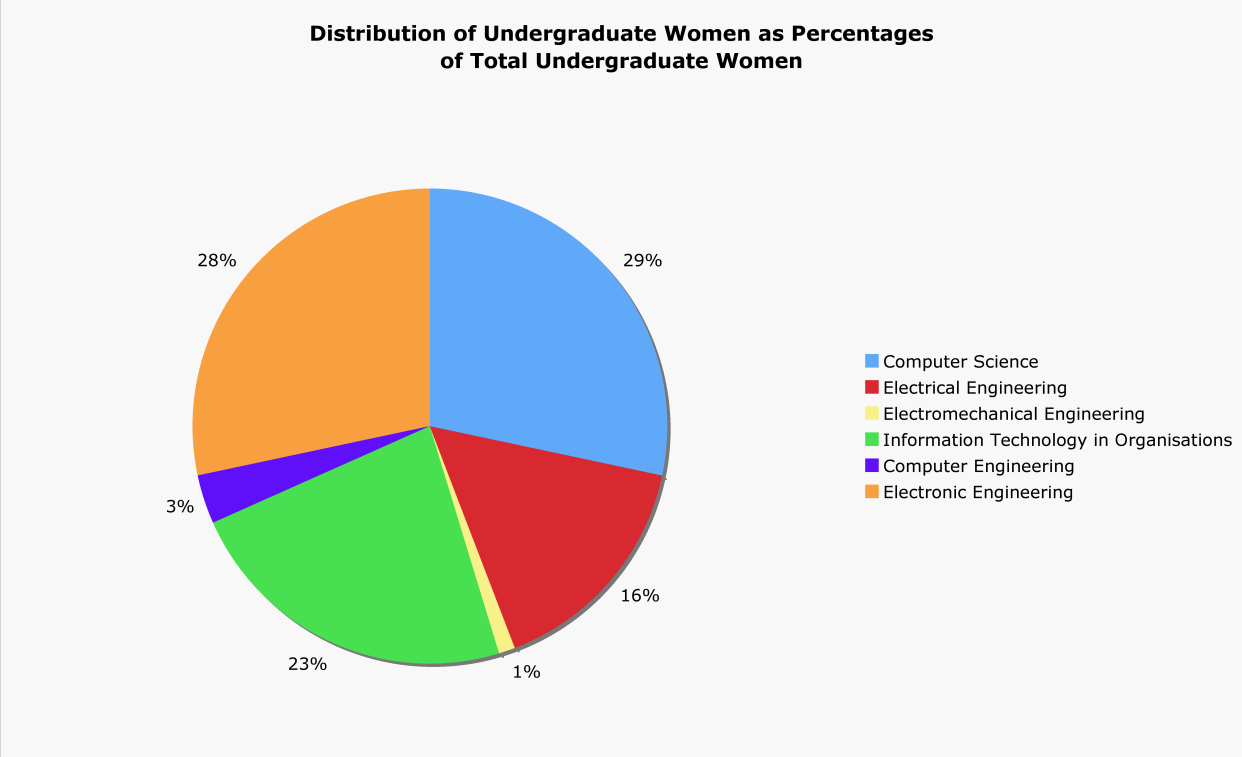

Figure 11: Chart showing distribution of women on Undergraduate programmes as percentages of the total number of women taking Undergraduate programmes in December 2007.

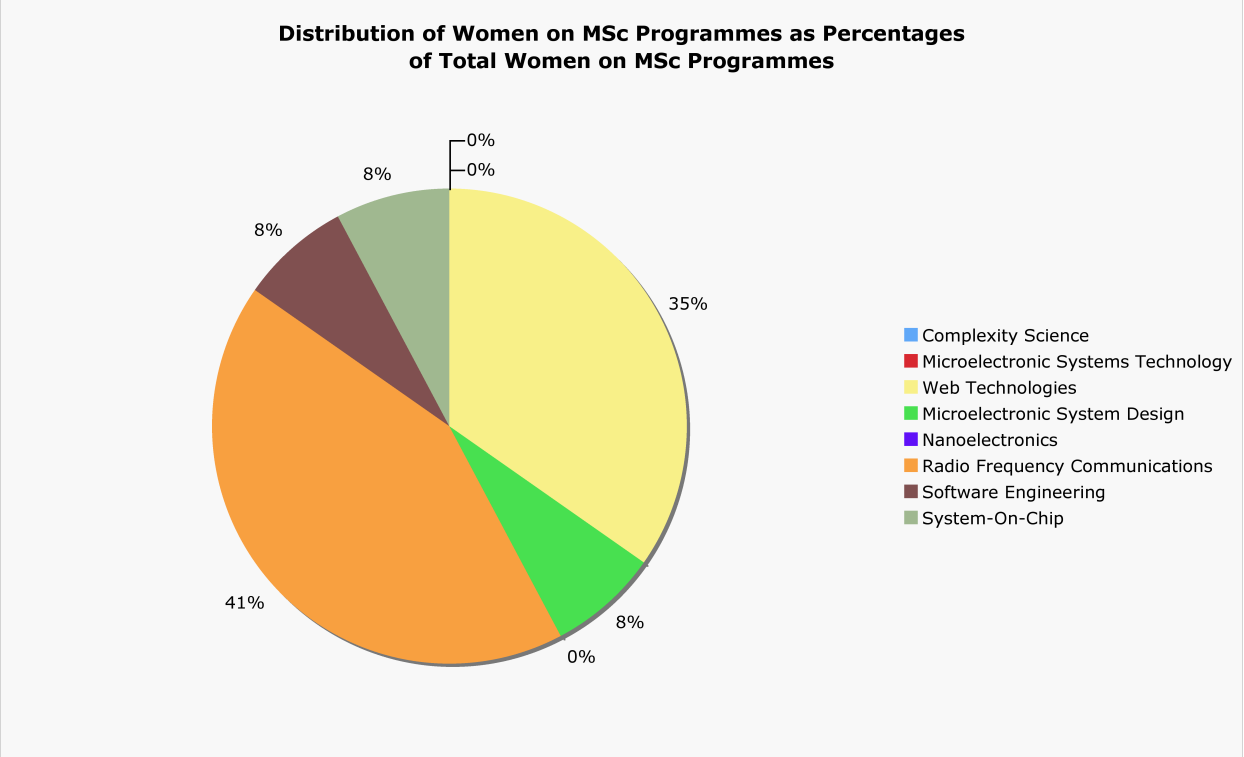

Figure 12: Chart showing distribution of women on MSc programmes as percentages of the total number of women taking MSc programmes in December 2007.

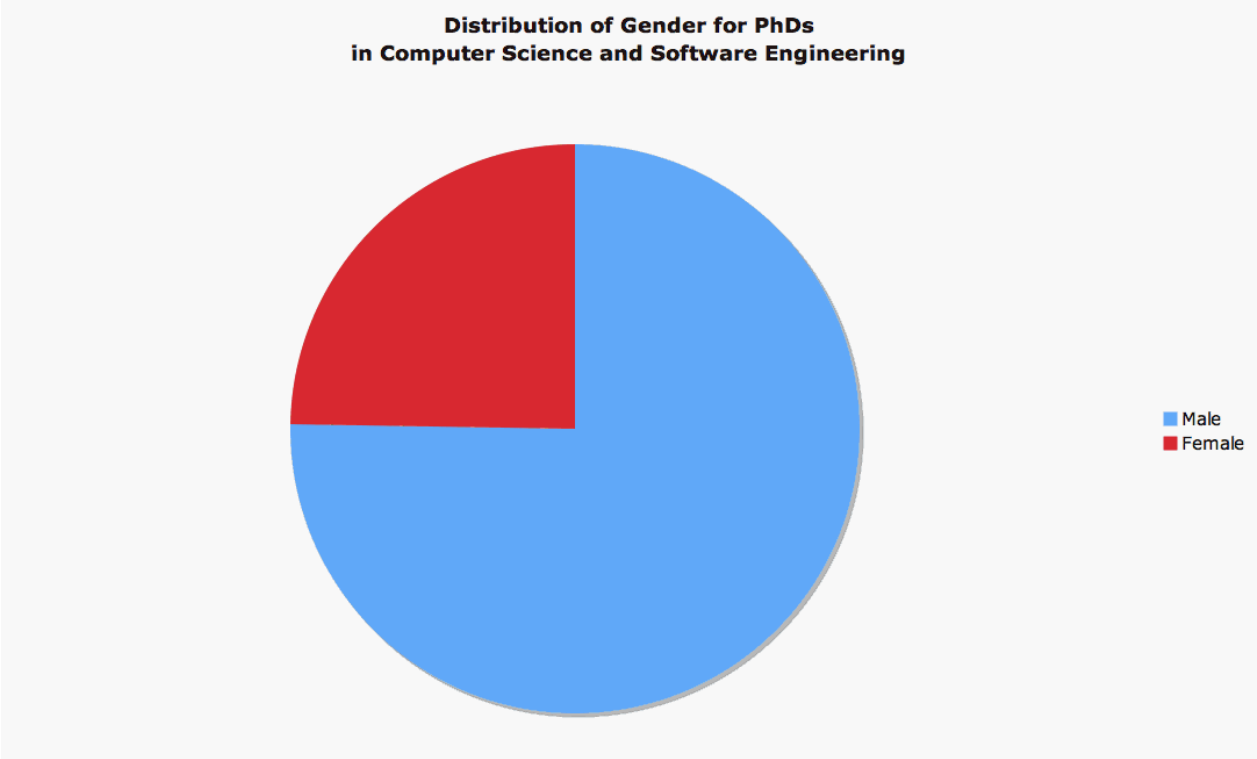

Figure 13: Chart showing distribution of males and females undertaking PhDs in Computer Science and Software Engineering in December 2007.

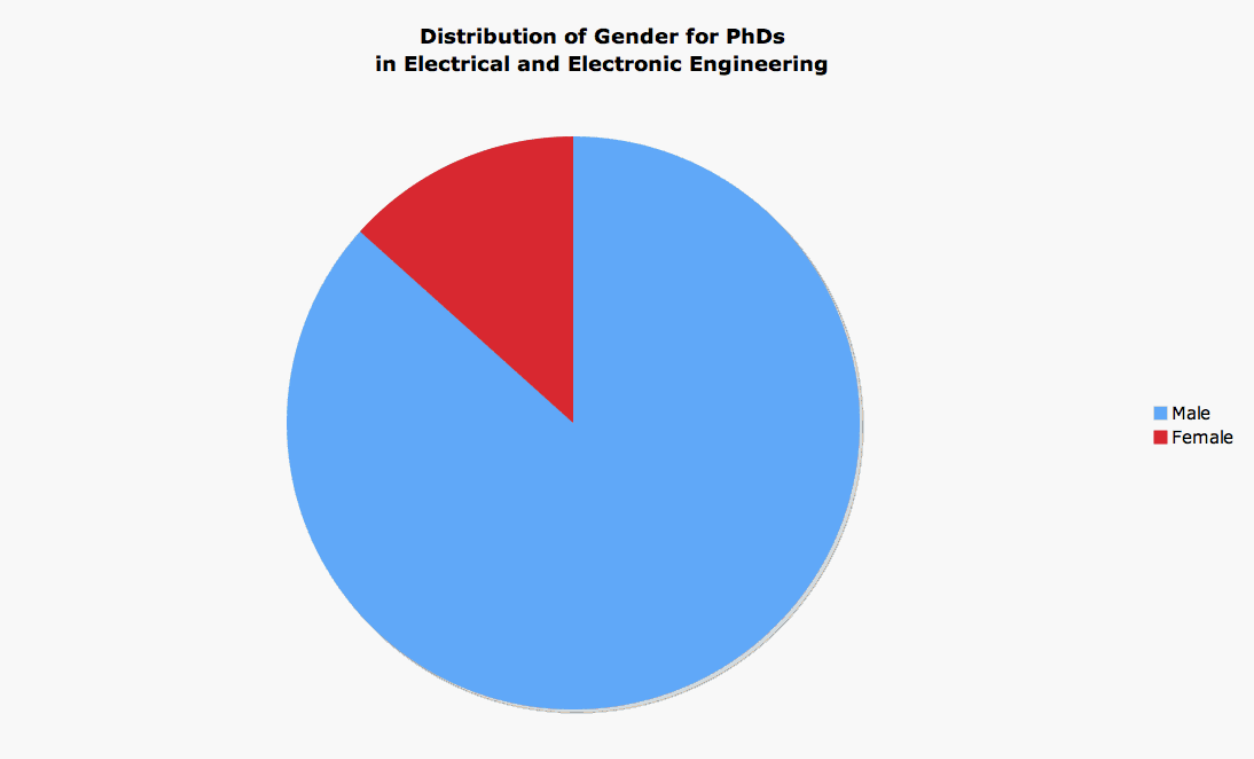

Figure 14: Chart showing distribution of males and females undertaking PhDs in Electrical and Electronic Engineering in December 2007.

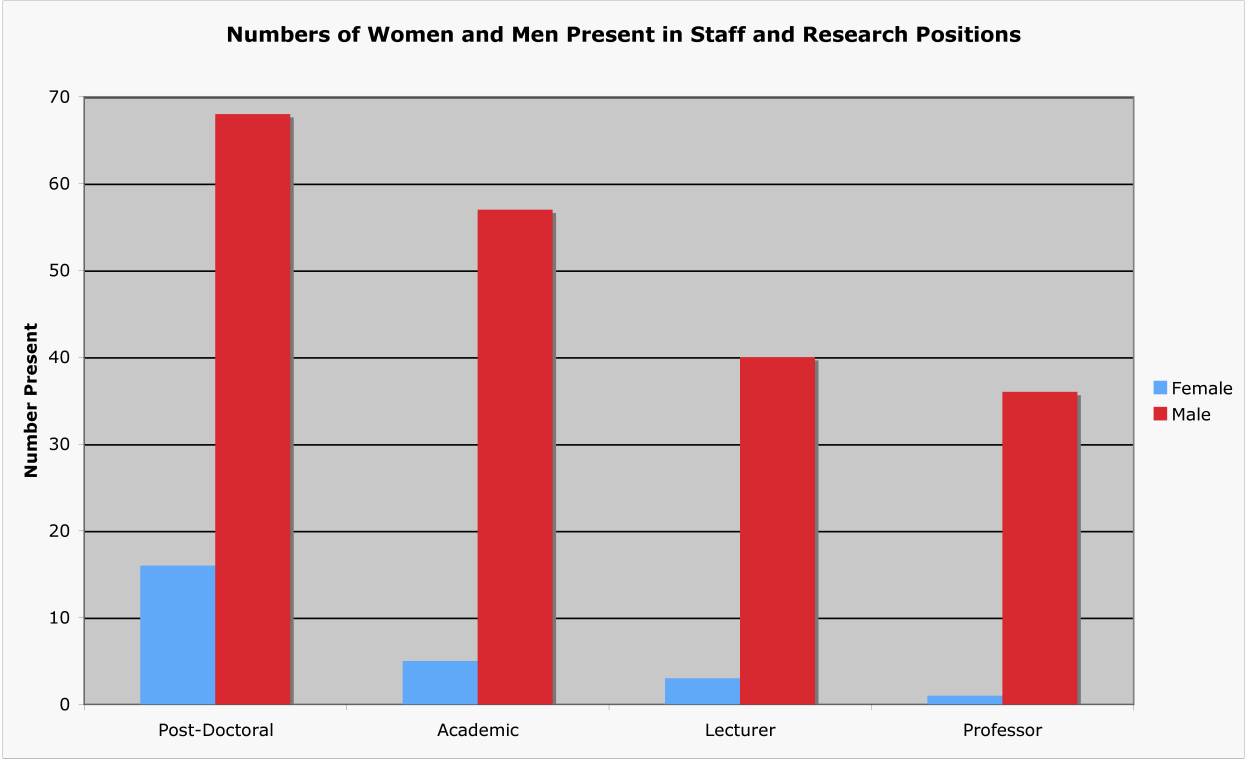

Figure 15: Chart showing distribution of males and females holding staff positions in ECS in December 2007.