Proceedings of the Third
Computing Women Congress (CWC 2008):
Student Papers

Editors:
Annika Hinze
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Preface

The Third Computing Women Congress was held at the University of Waikato, Hamilton, New Zealand from February 11th to 13th, 2008. The Computing Women Congress (CWC) is a Summer University for women in Computer Science. It is a meeting-place for female students, academics and professionals who study or work in Information Technology. CWC provides a forum to learn about and share the latest ideas of computing related topics in a supportive environment. CWC provides an open, explorative learning and teaching environment. Experimentation with new styles of learning is encouraged, with an emphasis on hands-on experience and engaging participatory techniques.

Each year, the CWC invites women in computing, IT, and related interdisciplinary fields to submit proposals for lectures, courses, and seminars. Contributions from the whole spectrum of computer science and also IT-related gender research are welcome. Participants from all levels of experience and with diverse backgrounds are welcome to present or teach.

The congress aims to provide role models for those early in their computing careers and also a meeting place for those well into their careers. Students at undergraduate and graduate level, and professionals from academic, scientific or commercial backgrounds are all welcome. By learning from each other's skills and experiences, we seek to form a community that shares interests and knowledge. CWC 2008 is part of a series of biennial congresses for women in IT.

For CWC 2008, we invited students to submit papers describing their research or significant individual projects to a special session. The purpose of this session is to recognise excellent work being conducted by CS/IS/IT students, and to offer a friendly forum for students to showcase their work and receive constructive feedback.

Submissions were reviewed by the organizing committee of the CWC, and the authors of accepted papers are given the opportunity to present their work to CWC attendees. This volume of accepted papers is published as a working paper of the Computer Science Department of the University of Waikato.

The CWC 2008 Proceedings contains the following student papers:

• Nuchjira Laungrungthip:
Image Processing to Predict the Solar Exposure at a Location

• Annette Baumann:
Community Building in University Education

• Shirley Gibbs:
Exploring the Gap between Employers' Expectations and New Graduates' Computing Competency

• Diane P. McCarthy:
Engendering ICT Project: The Story So Far

The selection of papers shows a wide range of projects that reflect the diversity of women working in and with computer science.

The Margaret Jefferies Award for the best student paper at the CWC is given to Nuchjira Laungrungthip for her paper (Image Processing to Predict the Solar Exposure at a Location) related to her Master's Thesis project.

Annika Hinze
Andrea Schweer
Kathryn Hempstalk

Hamilton, February 2008

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Image Processing to Predict the Solar Exposure at a Location

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Abstract. This project seeks to determine the solar exposure at a location at any time of the day on any day of the year, using a new technique which involves image processing. A series of photos is taken from a location of interest and are then processed to separate the areas of sky from the rest of the image. The sunlight that will fall on the location from where the images were taken can then be calculated. Critical to the success of this project is the image processing technique to separate the sky from the rest of the image. This paper is concerned with finding a technique which can separate areas of sky for a number of images taken under different conditions.

Keywords: Solar exposure, skyline, image processing.

1 Introduction

The sun is very useful in different situations such as heating domestic water or powering a solar house [1]. The position of the sun in the sky changes continually during the day and seasonally throughout the year. Exposure to the sun, at a particular location at different times of the year, can be affected by obstructions such as hills, trees or buildings.

Knowing the solar exposure at a particular location would help an architect to design an energy efficient house and also help a builder determine the position where a solar collector would get the most sunlight.

The solar exposure at a location may be of interest for a specified time or integrated over a time period such as an hour, day, week, or month.

The concept of a device that predicts the solar exposure at a location was developed by McKinnon [2]. The following steps are involved:

1. Take a series of digital images of the sky from the location of interest in known directions.
2. Find the sky in each image using image processing techniques.
3. Determine whether a ray from the sun can reach the location by passing through the sky part of one of the images.
4. Repeat step 3 for all times of the year of interest.
5. Display the information.

A commercial device using the same principles is the Solar Access Measure Device (SAMD) [3].

2. This Study

This project seeks to develop a robust image processing technique for identifying the sky region of an image to enable accurate calculation of the solar exposure at a location at any time of the year.

   The general approach is to determine the edges of sky regions using pixel intensity gradients[1]. The following steps are involved:
1. Extract a colour channel.
2. Apply the Canny edge detection algorithm [4] to determine the boundaries in the image.
3. Apply the morphological closing algorithm [5] to close gaps in the boundaries identified by the Canny edge detector.
4. Identify which of the bounded regions are sky.
5. Display and store the segmented image.

3. Exploration of Implementation Options

In order to implement the algorithm described in section 2, it is necessary to investigate the most appropriate settings for the colour channel and other algorithm parameters to ensure that the final implementation is as robust as possible enabling it to work successfully on a wide range of images. This section describes the details of these investigations.

3.1 The Images

Because sky detection could be affected by a range of weather conditions a series of test images including bright sky- no cloud, bright sky – scattered clouds, overcast sky– white clouds, and overcast sky – grey clouds were used. Two examples of each sky typed were tested giving a total of 8 images.

3.2 Choosing a Colour Channel

The objective of extracting a colour channel is to increase the contrast between the sky and the rest of the image. The colour channels tested were blue, red, green and grayscale, and H, S, V, Y, Cr, and Cb [7]. By comparing average pixel values in the sky and non-sky regions of the images, it was found that the blue channel gave the best contrast even for grey overcast skies.

3.3 Finding the Edges in an Image

The objective of this step is to find the edges in an image so as to determine the boundaries between contrasting regions. There are several methods to perform edge detection such as the Sobel, Roberts Cross, Prewitt, Laplace, and Canny edge detectors. The most widely accepted of these, the Canny edge detector [4], is used

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[1] In US Patent 20070150198 the manufacturers of the SunEye device [3] also refer to using row and column pixel gradients as a possible approach, but do not elaborate.

here because it reduces the possibility of missing actual edges and detecting false edges. It also attempts to minimise the distance between the detected edges and actual edges. and ensures that an actual edge point in the image produces only one edge [8]. When using the Canny edge detector [4], the upper and lower thresholds must be adjusted to detect the edges between sky and not sky but avoid unwanted edges such as those around clouds.

3.4 Closing Gaps in Edges

The approach being taken to finding the sky is to find the edges surrounding all possible sky regions. Although the Canny edge detector will help to do that, it may well leave gaps in some edges. If these are not closed the area of sky will "spill" through the gap. To counter this, the morphology closing operation [5] is applied to the binary image of edges using a 3*3 structure element.

3.5 Identifying all the Pixels in a Region

Having determined the boundaries of all the regions in the image we can find all the pixels in any given region using the FloodFill algorithm [6].

3.6 Finding Appropriate Upper and Lower Threshold Values

To determine the settings for the Canny edge detector upper and lower thresholds that ensure correct determination of the sky region across the range of test images, the following approach was taken:
1. Manually set the thresholds for each test image and determine the area and perimeter of the sky region.
2. Calculate the area and perimeter of the sky region for each test image when the upper and lower thresholds are varied across a wide range and store the results in a database.
3. Use a database query to determine the range of upper threshold and lower threshold values which give a sky area and a sky perimeter within 0.3% and 5% respectively of the correct value for all images in the test set.

Figure 1, shows threshold ranges suitable for all images as well as those that are satisfactory for all but one of the images. The lower threshold that works well for all images is in the range 186 to 217 and the upper threshold is in the range 16 to 61.

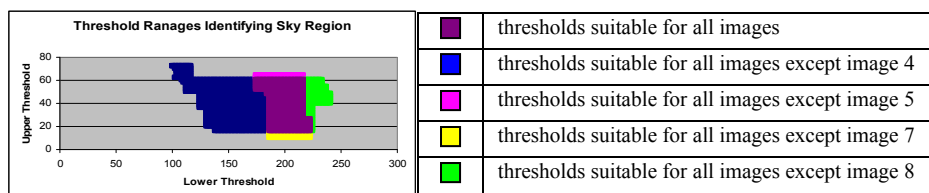|	
■ (purple)	thresholds suitable for all images
■ (blue)	thresholds suitable for all images except image 4
■ (magenta)	thresholds suitable for all images except image 5
■ (yellow)	thresholds suitable for all images except image 7
■ (green)	thresholds suitable for all images except image 8

Fig 1: Shows the threshold ranges which gave area and perimeters of the sky region within 0.3% and 5% respectively of the correct values.

5. Discussion and Conclusions

In this paper, image processing techniques are used to find the boundaries of regions in an image including the sky regions. We have shown that the Canny edge detector followed by a 3*3 structure element for the closing morphology algorithm applied to the blue colour channel can satisfactorily find the boundaries of the sky region of an image provided appropriate upper and lower thresholds in the range 186 to 271, and 16 to 61, respectively for the Canny edge detector are used.

The set of images used for this study does not include an image for an overcast sky – black clouds, as there was not one available. However, as long as there is sufficient contrast between the sky and other objects in the image, we would expect the threshold and structure element values found here to work satisfactorily for an image.

There will be some situations where image processing alone will not correctly determine sky area boundaries. Images that are saturated by being taken directly into the sun will require some user interaction to identify the boundaries of the sky area.

The values of 0.3% for the area criterion and 5% for the perimeter criterion were selected following some initial experimentation. A more stringent area criterion was used to reflect that fact that when the sun path calculations are carried out, their accuracy will largely reflect the area of the sky region rather than the perimeter.

Further work is being carried out to automatically determine which of the bounded regions are actually sky. The approach being taken is based on the brightness, colour, and relative area of the regions.

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Community Building in University Education

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Abstract In university education the training for and the practice of a profession is still distinguished, but on closer examination the processes of knowledge acquisition and knowledge work are setting up a closed loop. These individual knowledge processes, termed e-learning and knowledge management if computer-assisted, focus on transfer of knowledge through cross-linking of people and documentation of knowledge. As far as communication and collaboration is concerned, the community knowledge processes have to be investigated more carefully. Students and scientific staff are counterparts facing each other in teaching as well as in research. Thus a valuable opportunity to enhance university education is often missed. The process model presented in this paper aims to bring together both groups as one joint collaborative learning community and, especially from the point of view of information technology, to facilitate interaction in this fundamental part of the scientific community.

1 Introduction

The individual processes of knowledge acquisition and knowledge work on the one hand as well as the community processes of collaborative knowledge construction between the groups of students and scientists on the other hand are both setting up a closed loop. In the following we will explain this claim step by step and the aspects of e-learning and knowledge management contributing to the intra-group and inter-group interaction through web-based information technology.

2 Knowledge acquisition and knowledge work

In general there is a clear distinction between the education for and the practice of a profession. Hence the university plays a well-defined role in a typical student biography. Freshmen enter the university as learners and leave it after their education with a pool of knowledge. Thereupon, the graduates enter their profession and constantly evolve this pool of knowledge by working with it in the enterprise.

On closer examination of the model concept shown in Figure 1 it appears, that the two associated processes of knowledge acquisition, i.e. learning, and knowledge work are not at all strictly separated from each other.
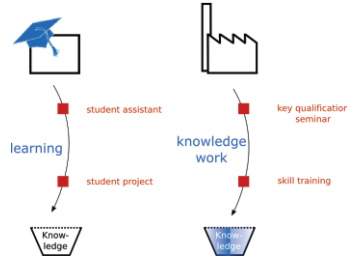
Figure 1: Processes of learning and knowledge work

On the one hand also students use forms of operational knowledge work. Student assistants for example are experts for workflows within the university organization and are integrated into the research practice within student projects. On the other hand employees do not leave the role of the learner on the first working day in the enterprise. They visit for example further training seminars for key qualifications and courses for job-specific skills e.g. a new software version, changes in industrial law or current control engineering for biomass heating systems.

Following the well-known spiral model [1] an iterative knowledge process is revealed in Figure 2. Learning and knowledge work, termed e-learning and knowledge management if computer-assisted, are actually two sides of the same medal for an individual.
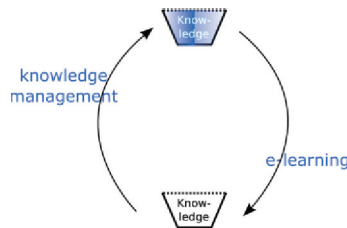

Figure 2: Closed loop of e-learning and knowledge management

3 E-learning and knowledge management

Regarding the university context of education for and the practice of a profession, it is interesting to bring together the individual processes of learning and knowledge work and to combine forms of technical and organizational support. These stem from computer-assisted education (e-learning) and professional practice (knowledge management) as well as their connection.

With the knowledge processes in mind, both cases have in common the transfer of knowledge through cross-linking of people and the documentation of knowledge, as well as its support by web-based information technology. The respective target groups, both students and scientific staff, are the knowledge shareholders in the university context.

Further reforms in university education give rise to two, so far unconsidered, options. Strengthening e-learning for scientific staff as well as introducing knowledge management for students are decisive to close the loop between e-learning and knowledge management.

The chance to get involved in research projects, e.g. the project SiROP (Student Research Opportunities Program) under leadership of the ETH Zurich [2] offers additional practical experience to students and can contribute to sustainability of knowledge in the university despite the short duration of study. Moreover, assignments for study work can be based on previous results, instead of reusing the same assignments in each term. Such assignments correspond better to problems in the professional world, which helps to prepare students better for working life.

Scientific staff, on the other hand, experience an improvement of further training offers concerning the presentation of the material as well as its availability independent of time and location. Learning processes and learning results can be optimized if knowledge acquisition is done in small cooperative groups. Beyond that, computer-assisted learning environments make more communication possibilities available between participants and offer instructional support [3].

4   Community knowledge processes

Students and scientific staff, the target groups and knowledge shareholders in university education, form the basis of the scientific community. For this reason collaborative knowledge processes have to be investigated apart from the individual processes of knowledge acquisition and knowledge work. Students and scientific staff are mostly counterparts facing each other in teaching as well as in research and interaction takes place particularly within those two groups. But also between the groups important interaction patterns occur.

Staff/students collaborating with students/staff

The members of the two groups are facing each other in their roles as teachers and learners, as researchers and student assistants. In lectures and exercises the scientific staff imparts knowledge to students, in research projects students work out knowledge for the scientific staff. Upon closer examination of these knowledge processes in-between teaching and research, we find another loop of receiving knowledge and passing on knowledge as shown in Figure 3.
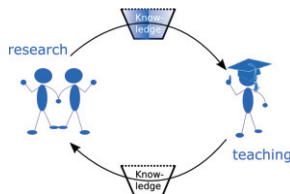

Figure 3: Collaborative process between teaching and research

By connecting students and scientific staff in a collaborative knowledge process, a joint learning community is build. As with learning communities in general, the aim is to increase the common knowledge. All members are gathering, structuring, sharing and incorporating knowledge from different sources. Through cooperation, exchange of experiences, construction of knowledge and mutual learning a common sense and identity emerges in the community [4].

5   Evaluation of web-based collaboration tools

The research-driven seminar "Innovation@CoTeSys" is the first course at TU München to bring together both groups and affiliate students for faculty development (see [5] for details). The project is accompanied with a set of simple web-based tools supporting cooperation and knowledge exchange.

As basis a web content management system was chosen and enriched with the features of a Wiki to collaboratively build a common knowledge base, a folder-like workgroup setting to share documents and a contact directory pattern to organize member information. In a second step it is planned to connect directly to the university contact directory in order to extend the contact pattern to full user profiles. We are working on an interchange setup with the central university portal that already provides news feeds, discussion forums, the university web calendar and a widget container for personal information workplace [6]. In the further course of the project, we would also like to offer a concept mapping and a e-portfolio tool, support for modeling didactics and learning sequences as well as blended learning scenarios.

Finally the connection of individual and organizational knowledge processes with the added benefit from IT support will promote in a "university 2.0" sense building a joint student/scientists community in university education.

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Exploring the Gap between Employers' Expectations and New Graduates' Computing Competency

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Abstract. This paper outlines a study of employers' computing requirements of new graduates and the actual computing competency of these graduates. It reports on preliminary studies and outlines some of the issues encountered. Employers and students have been interviewed and a gap been identified between what is required and what students believe they already know. Confusion is often encountered when the term 'computer literacy' is used. There seems to be no consistent definition of what is expected when this term is used.

Keywords: Computer literacy, computing experience, business graduates, skills gap, tertiary institutions, end user computing.

1   Introduction

There are expectations that students entering tertiary education will have sufficient computing skill and knowledge to progress through their tertiary study and on to their working life. It is assumed by some university educators, future employers and parents that students will have higher, more advanced computer abilities than their peers of the past (Fernandez, 2006). These expectations have grown out of the time in which we now live. Students entering university from secondary education have grown up with computers in schools and at home. Technology is rapidly changing and young people have an expectation they will be able to keep up with these changes. They have high belief of their own ability and knowledge. Often these expectations are expressed in terms of computer literacy. This term is used widely with many different definitions.

Computer literacy is hailed as one of the requirements needed for most career options and is therefore promoted and spoken about and, to an extent, promised for all students leaving a schooling system. Bartholomew (2004) likens the skills associated with computer literacy to the children's tale, "The emperor's new clothes". She asks if we have been duped by a system that hasn't produced what was promised. She

reminds the reader that the meaning of computer literacy has evolved from having the ability to program a computer using an assembly language to more general conceptions such as: "whatever a person needs to know and do with computers in order to function competently". This type of generalisation has lead to different expectations being held by different sectors of computer users. A student may well consider themselves to be computer literate if they are able to beat their friend in a computer game or download music files to their MP3 player, whereas a prospective employer wants to employ people capable of using different computing tools to solve real world problems. Mason and McMorrow (2006), argue that it is difficult to try and define computer literacy as one skill set. They say that there are two separate components to computer literacy: awareness and competence. While a person may be aware of technology, they may not have the necessary competence to use it accurately. An alternative understanding, often held by employers, is:

[Computer Literacy] is little more than the ability to use several very specific applications (usually Microsoft Word, Microsoft Internet Explorer, and Microsoft Outlook) for certain very well-defined simple tasks, largely by rote .- Wikipedia.com

A common way of assessing computing ability is through self rating. This method is often relied on by employers who accept a candidate's own estimation of their computing skills. The method of self rating or Computer Self Efficacy (CSE) is used to estimate a person's computer ability. While this method is commonly used it has been found to be not very accurate (Easton & Easton, 2004; Ballantine, Larres & Olyere2007; Karsten & Roth, 1998; Wallace & Clariana, 2005). Often it is found that those who have a lower level of knowledge are the ones who are most likely to give themselves a higher rating (Ballantine et el, 2007).

The challenge is to define what is expected of young people and compare that with what they already know. We can then investigate the gap between the expectations and the realities. We can also re-examine the term computer literacy and see where it fits in today's society.

This paper will describe a preliminary study and examine the gaps between the expectations of New Zealand employers and Lincoln University students and graduates. It will also outline the results from survey and interviewing students.

2   Background

Lincoln is a small university of around 4000 students. For the previous twenty years a compulsory computing course (COMP101) has been taught to first year commerce students. Recently it was mooted that this course should become optional. The key rationale behind this is that students already know how to use computers therefore they need no further computing tuition. The resulting controversy reignited the author's interest in computer literacy. This led to some informal interviews with people employing business graduates. The purpose of the interviews was to ascertain what it is that employers expected from business graduates, how they expressed their

expectations in advertisements and whether the graduates' skills matched the requirements.

The author also interviewed current students. These students came from a variety of disciplines and were at varying stages of their university careers. Some, but not all, of these students had completed COMP101. The interviews focused on how these students ranked their computing ability, how they rated their experience and knowledge prior to coming to university, and whether they considered that ranking has altered since beginning university. Additional information was gathered from a survey given to students beginning COMP101. The survey asked a series of demographic questions and asked students to rate their computing ability and confidence. Some competency based questions which tested basic spreadsheeting and database concepts, end user computing skills that students will need for their study and beyond, were included.

3   Results of Preliminary Study

A preliminary survey of employers of business graduates was carried out to test the expectation that new graduate employees will have a good level of computing skills. The survey indicated that employers do have expectations of computing skill levels. However, employers seem reluctant to test for computing skills during the recruitment process, saying this would be costly both financially and time wise. Employers seem resigned to relying on the self-assessment by a candidate as an accurate appraisal of computing skills.

Results indicate employers are finding they have to lower their expectations to fit the computing skills university graduates are bringing to the workforce. This gap in skills is seen by some as handicapping the ability of employers to recruit suitable graduates.

A second preliminary study was under taken with current Lincoln University students. They were asked a range of questions which related to their experience prior to coming to university, their thoughts about their own ability and their expectations of how computing would be part of their working lives. It became clear that many students arriving at university directly from high school have a greater confidence in their own computing ability than previous cohorts. When asked how they rated their level of computing when arriving at university they often give themselves a high rating. These same students are likely to lower their own rating once they realise that there is more to learn. The mature aged students are likely to be more modest in rating their ability and sometimes underestimate what they already know.

The results of the survey show that while students are likely to rate their confidence and ability levels as being average or higher this was inconsistent with the results of the skill test. It was interesting to note, when looking back at previous surveys, that the students of 2007 were no more competent in these areas than students of eight years ago. This can be seen from the graphs in the Figure 1.

Fig. 1. Percentage of people, at self perceived confidence levels, who got 0 to 3 problem solving questions correct in COMP101 surveys

4   Summary

It is clear from the results of the preliminary work that this is an area that requires further investigation. The key findings from the preliminary study are:

> Employers find they have to lower their expectations to fit with the computing skills of university graduates; many more students arriving at university have a greater confidence in their own computing ability than in the past; survey results indicate the perceived confidence of students may not equate to actual understanding; confusion exists over the meaning of the term "Computer literacy" and a method is required to articulate employers' requirements for the computing skills of new graduates.

This study is being undertaken as part of the thesis requirement for a Master of Applied Science. It is intended that key areas identified in the preliminary work be used as the basis for further expanded study.

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Engendering ICT Project: the story so far.

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Abstract. The New Zealand Government's policy frameworks emphasize ICT has a powerful, ongoing, economic and social significance for our nation state, yet the need to have women participate in ICT careers is still ignored despite documented shortages. A paucity of recruitment and retention strategies to encourage women's uptake of tertiary training courses in ICT reflects the neo-liberal policy vacuum. Using critical discourse analysis (CDA) this paper summarizes some constraints in current government policy, such as *The Digital Strategy*. The ICT culture of claimed gender neutrality and how women appear within ICT arise out of and perpetuate these discourses. Using a feminist poststructuralist framework, this persistent global problem is examined locally in two Institutes of Technology and Polytechnics (ITPs) in New Zealand. In focus groups and in-depth interviews, women students explore their subjectivities and agency as emerging ICT professionals, and their experiences of acquiring technical skills in undergraduate courses, and the industry.

1 Introduction

What is really obvious to me in my teaching life is that very few women are choosing business computing[1] as a career. I teach an ethics and professionalism course for business computing students in a two-year undergraduate diploma qualification at a polytechnic. This diploma equips students with practical skills to work in the Information and Communications Technology (ICT) sector, and to provide technical support to businesses. My small classes comprise mainly young men. Women tend to be older, some mothers, or existing or former employees, and are often only one or two in number. Rarely are they school leavers [1].

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[1] Business computing refers to students studying computing integrated with business related courses to work in practical roles such as technicians, programmers, web designers, project managers, and customer support in ICT businesses and to support ICT systems for businesses, such as law firms, travel companies, and the public sector, such as district health boards and education.

There is a real concern in ITPs (Institutes of Technology and Polytechnics) and the ICT industry[2] about recruitment and retention in ICT [2, 3]. The Ministry of Education's tertiary enrolment statistics for ICT in 2004 indicated a continuing yearly downward trend of 16.9% for male students, and 15.35% for female students, with females trailing male enrolments by an average of 12.9%.

2 Theoretical Framework

I have chosen to use poststructural feminism as my theoretical framework including technoFeminism [4]. Poststructuralism is a particular research lens or framework, which Tong [5] refers to as "'strands', 'perspectives' and 'views.'" Poststructural feminists share the feminist goal of "research as re-visioning," to transform a man made world and "fashion it anew" p. 182 [5]. It is suggested that feminist perspectives are not pure, and they co-exist, influence, inform and are embedded within each other [6].

TechnoFeminism fuses "the insights of Haraway's cyborg feminism with those of a constructivist theory of technology," p. 103. Wajcman's analytical lens challenges us to explore how women's agency creates our networked, ever changing 'knowledge society,' [4], offering a two way promise: "a different way of understanding the nature of agency and change in a post-industrial world, as well as the means of making a difference" p130.

Discourses about power and embodiment influence our gendering. We can theorise about how we position ourselves as gendered beings [7]. Butler describes gender as an incessant "kind of doing" that we are not always knowingly or willingly performing p.1 [7]. As women in ICT, we can encounter schemes of recognition available to us which may "undo" us, as we try to work and live in a masculinized field, typical of science and technology p.2 [7].

Women need to be in the jobs that "create and design the technical systems in the new economy" p31 [4] to influence their creation and use, in this new era of technological change. Technology may enable women to engage in new forms of education, work, and social action, including practical emancipatory politics. TechnoFeminism attracted a positive response from some feminist researchers within the field of social studies of science and technology [8-10], and a less favourable response from others, [11].

3 Critical Discourse Analysis

Influences of government policy perspectives on women and ICT was traced using Critical Discourse Analysis, (CDA) [12, 13] to analyse key texts arising out of '*The*

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[2] The ICT industry is a broadly scoped term, used to describe companies engaged in developing of hardware and software, and providing a variety of web based services for clients, including support. They range in size from large transnationals with offices in New Zealand, to small start up companies, at the local level.

Digital Strategy' policy initiative between June and September 2006 and its context [14]. CDA, as practised by Fairclough [12] Luke [13] and Olssen, Codd, and O'Neill [16] critiques government policy by both paying close attention to 'textually orientated discourse analysis' and focusing on their historical and social context [15]. This analysis is in an era of policy and ideology against government intervention, which was condemned as "collectivist, socialist, and economically misguided" [16]. *Learning for Life* reforms transformed tertiary technical education into a "quasi-publicly consumer good" p. 371 [17, 18] where increased participation of students was seen as realisable through competition between the 'providers' with the financial burden being unevenly borne by institutions, students, and their families [19, 20]. The shift of tertiary funding, policy and implementation to the new Tertiary Education Commission (T.E.C.) in 2003, promised closer alignment of the tertiary sector to the needs of the knowledge economy and "greater system connectedness to New Zealand businesses, communities, iwi and enterprises," [21].

In education, meaning is formed through sets of discursive practices, such as legislation, policies, and speech acts which are perceived as reality by agencies such as media, tertiary institutions, lecturers, teachers, parents and students. Power and knowledge are inextricably linked through the educational policy experts who define, classify, and describe these practices discursively. They hold authority to create policy identical to their authority to have it carried out at institutional and individual levels [13].

4 Method

The analysis used a key word search of *The Digital Strategy* and related documents, web site, and a selection of images in the popular media. *The Digital Strategy* document was released, after a consultation cycle, in May 2005. It was jointly written by a wide range of government departments and agencies and represented all current government policy within this field. Significantly, the Ministry of Women's Affairs did not participate in the writing of the policy, nor the Human Rights Commission, which has an Equal Opportunities Commissioner, Professor Judy McGregor, in Wellington. Documents were searched in PDF format with the keywords 'women and technology', 'education and training in technology', and 'equal opportunity and treatment', to see to what extent the policy identified the need for training in ICT, and the need to recruit women into the field.

5 Findings

Women were not mentioned as Enablers of *the Digital Strategy* policy, under Content, Confidence, or Connection, even though the Advisory Group Chairperson is a woman, the Chief Librarian is a woman, for one of the major projects, and the *Digital Horizons* policy in schools is being implemented by a feminised workforce of primary and secondary teachers. Women were not mentioned as Users under the Communities, Business, or Government strands. It appears that the policy had been

formulated without consideration of the need to recruit women into the ICT industry, or how this should be done. The way the policy was described and reported excluded women as a visible group, in spite of the young Maori woman on the cover, and the visuals of school aged girls. Nor does it acknowledge women's broad socio-cultural demographics.

While the policy described educational initiatives being undertaken with an ICT focus, this focus is on computer literacy, and providing hardware, 'learning objects,' and professional development, in the five education sectors, from early childhood to tertiary, and community education, rather than on recruiting women into specialist training

The same generalist and gender neutral discourse was present in the web site, and tertiary policy documents, in spite of the requirements of S. 169 of the Education Act to provide "equity of access…needs of learners, stakeholders, and the nation,…sustainable economic and social development…and capabilities to national economic development, innovation, international competitiveness, and the attainment of social and environmental goals…" of which recruiting women to help overcome industry shortages is fundamental.

6 Conclusion

The need for women to be recruited as specialists into ICT is being ignored, with women assigned a community status, or depicted as 'young helpers' not ICT specialists, or being inadequate in their use of technology. They are subsumed into a prevailing assumption that ICT is gender neutral in its application and use, and that no gender based recruitment is required to meet industry needs In the absence of gendered initiatives, the policy vacuum is filled with essentialist and stereotypical embodiments of women in the popular media. Their inclusion in the media powerfully reinforces the perceptions of a masculinised and unattractive career in ICT [22-25]. With these powerful images being presented to parents, young people, and other potential ICT students, it is little wonder that student numbers are declining.

7 Current Research: work in progress

Policies and practices in recruitment and retention of women in ICT in the United States, United Kingdom, Australia and New Zealand, indicate the problem is global, persistent, cyclical, and, I suggest, rooted in the ways women are encouraged to construct their identities. The problem is attracting worldwide research and concern. As their choice of career goes against the grain, women students and recent graduates from two ITPs were recruited as research participants for semi structured interviews in focus groups and with group leaders. The focus is on the relationship between these women's subjectivities and agency as emerging ICT professionals and the ways they make meaning of acquiring technical skills during their two and three year training and their initial employment in ICT. Strategies will be trialed as my Ph D.

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