

Report on Gender Equality Issues at UW-CS

Task Force on Gender Equality at UW-CS

November 2007

Contents

1	Background	2
1.1	Methods	2
1.2	Overview of findings and recommendations	4
2	Recommendations relevant at multiple levels	4
3	Recommendations for outreach	10
4	Recommendations for the undergraduate program	12
4.1	Data	12
4.2	Attracting High School Applications	12
4.3	Attracting High School Acceptances	14
4.4	Retaining Undergraduate Students	14
5	Recommendations for the graduate program	16
5.1	Data	16
5.2	Attracting Graduate Applications	17
5.3	Attracting Graduate Acceptances	20
5.4	Retaining Graduate Students	21
6	Recommendations for faculty	22
6.1	Data	22
6.2	Attracting Faculty Applications	22
6.3	Attracting Faculty Acceptances	24
6.4	Retaining faculty	25
A	Acronyms used in this report	30
B	Links to conferences and scholarships for women	31
C	Grace Hopper Conference	31
C.1	Underwriting	32
C.2	Sending students	32
C.3	Feedback from the attendees	32
C.4	Suggestions for future years	34
D	The cs240 survey	35

1 Background

It has been a much-noted problem that the percentage of women participating in computer science is small and in fact, decreasing [6]. This is a North-American wide phenomenon, and numbers at the University of Waterloo are following the same trend (see the Data sections.) Many researchers have investigated this problem, and offered suggestions what should be done in general to help remedy it (see for example [15, 21, 9, 28].)

To see what specifically should be done about it at the University of Waterloo, Tamer Öszu, the director of the David R. Cheriton School of Computer Science at University of Waterloo (henceforth referred to as UW-CS) established a task force in March 2007, with the mandate to address issues of gender balance at all levels of computer science. Specifically, the mandate asked:

- What are activities that we should be engaged in, but we currently are not?
- What are activities that we are engaged in that we should not be engaged in?
- What are activities that we are engaged in, but should be doing differently?

Members of the task force were chosen from all levels in the school, and intentionally included both women and men. They were:

- Shai Ben-David
- Therese Biedl (chair)
- Christina Boucher (graduate representative, until 4/2007)
- Samantha Breslin (undergraduate representative until 4/2007 and from 9/2007)
- Lori Case
- Victoria Gibbs (undergraduate representative, 5-8/2007)
- Georgia Kastidou (liaison to Graduate Recruiting Committee, 4/2007 - 6/2007)
- Edward Lank
- Annie Lee (graduate representative from 5/2007)
- Greg Zaverucha (graduate representative)

The task force met regularly throughout the next 7 months. We broke each of the levels down by the problem of “attracting applications”, “attracting acceptances” and “retention”. The task force split into subgroups that studied these subareas and reported back to the task force as a whole regularly. In the process, we also identified some issues relevant to multiple levels, and the problem of outreach.

We spent much time reading related literature, extracting recommendations that have been made elsewhere, and debating whether these might be applicable to UW-CS. We also spent much time on gathering data on the current situation, and did statistical analysis where multi-year data was available. We talked to many members of UW-CS on an informal basis. Due to lack of resources, we did only limited original data collection in a systematic way.

1.1 Methods

Many conjectures have been raised in the literature as to why women are less attracted to CS than men, at least in North America. In deciding whether a recommendation (either found in the literature or developed ourselves) should be made, we operated based on the following assumptions¹ about women’s preferences and/or background:

¹These general statements are based on findings in the literature obtained by taking averages. They may not apply to all women.

- Women have the ability and drive to succeed in science and engineering. There are no significant biological differences between men and women in performing science and mathematics that can account for the lower representation of women [28].
- There is a scarcity of female role models. There exists a predominant view of CS as the exclusive domain of men [34]. Computer science students are seen as narrowly focused intense hackers who have played with computers since early childhood [5].
- Men and women view computers very differently. Male students describe an attraction to the computer for the computer's sake, and learning about computers as a pleasurable end in itself. Women more frequently want to see context and connections of computing to other areas. For them, computer work must do something useful for society [23]. Women are hesitant to join a world which they see to be dominated by love of the machine and life spent in front of a computer screen. They sense that the links to other interests in their lives will disappear [9, 23].
- Women have less self-esteem and are struggling to maintain their own confidence (see e.g. [11, 23]). This starts early (as early as seventh grade) and confidence continues to decline every year as they are in university [15]. A lack of self-confidence is one driving force that causes many women to leave or to not even enter the field of CS [15].
- Women tend to enter the field of computer science [...] at a much later time in their life than do men [16, 24]. Canadian girls have somewhat less access to computers than boys, and boys use computers in more diverse ways [40]. Generally, women have less prior computing experience. However, experience level is not a predictor of success in the program [9, 24].
- Females and males respond to stress differently (not only in humans, but in many mammals.) Stress enhances learning in males, but impairs it in females [30]. Women prefer a non-competitive environment and place more emphasis on social aspects (see e.g. [3].) They prefer class discussions and cooperative learning techniques as teaching style [31]. Many women do not feel comfortable fighting off their male colleagues. The discomfort is aggravated by "males that tend to show off, take over the computer lab, profess their unwavering knowledge, and make fun of others when they make mistakes" [15].
- Much of the gender-bias is cultural: In many other countries girls pursue mathematics and science at the same rate and with the same expectation as boys [22].

Before going into specific recommendations for specific areas, we wanted to outline some of our basic philosophies about attracting more women into CS.

- Our main focus should be to make women feel welcomed and wanted in Computer Science. Our objective is to find the best way of using scarce resources (both money and time) to achieve this.
- Pure affirmative action strategies (e.g. offer positions to women even if they are less qualified) seem too drastic, and often not even desired by the woman that receives the position. It would reinforce the (already existing and damaging to self-esteem) idea of "You are here only because you are female" [9]. It would also lower overall quality, which is undesirable.
- Actions that provide an advantage to women without being a disadvantage to men generally are acceptable. An example of this would be to send information (e.g. about how to apply to graduate school) to women only. The information is available to everyone; by specifically sending it to women we help them, but we are not excluding men. Similarly we feel it is acceptable to provide activities designed specifically for women, such as social events. We debated advantages of financial advantages (in the form of scholarships) exclusively to women, and felt that they are appropriate but should be used wisely (see Recommendation General-7.)

1.2 Overview of findings and recommendations

Both UW-CS and the university as a whole has instituted many policies to avoid gender-discrimination, and we found no evidence of intentional slight against women. But this alone is not enough. We must work actively to avoid any (unintentional) disadvantages for women, and consider preferences of women in all aspects of our program.

In this task force report, we make many recommendations, on all levels, ranging from the profound (what can we do to change society's perception?) to the mundane (baby change tables in DC?). Some of these recommendations concern multiple levels and/or arose from other recommendations; we mention these first. We then follow up with recommendations for each level: for outreach, undergraduate students, graduate students and faculty.

Our recommendations include three suggestions for change in administrative structure: We recommend a Women-in-CS committee (WICS²), a female graduate advocate, and an outreach committee (see Recommendations General-4, General-6 and Outreach-1.) The former two were already established during the work of the task force.

With each recommendation, we also suggest into whose area of responsibility it most likely belongs; we hope that this will ease actual implementation of the recommendations.

2 Recommendations relevant at multiple levels

This section concerns items that are relevant at multiple levels, as well as items that have arisen out of other recommendations.

- Monitor and communicate the status of women in CS.

One of the most important aspects to help increase female participation is to make everyone aware of the extent of the problem. Everyone we spoke to was aware that the percentage of women in CS is low, but few knew just how incredibly low it is, and that it is shrinking. Most people were aware that female participation is lower in CS than in Mathematics, but few knew just how much lower it is. Some other data (such as the higher female percentage that combines CS with a non-mathematics area) came as a surprise even to us.

While most data about women in CS here at UW is available from the Institute of Analysis and Planning (IAP), or from the appropriate associate directors, it is not communicated on a regular basis, and/or not put into contrast with previous years or numbers at other universities.

We have provided lots of data in this report, but it should be communicated to the school on a regular basis, always in contrast with previous years and other universities, to keep the school aware of areas in which we do well and areas where we have shortcomings. Wherever there may be interesting trends, the data should be broken down further (e.g., undergraduate students by plan, graduate students by visa status or research area.)

We suggest that WICS keep a repository of all such data, and communicate with IAP and the appropriate associated directors to add data as it becomes available. The actual gathering and presentation of new data and trends may be better in the hands of the appropriate associate directors as they report admission numbers to school council.

Recommendation General-1: *Monitor and communicate regularly gender ratios on all aspects of CS.*

Responsibility: *Associate directors, WICS.*

- CS is programming vs. problem solving, and societal impact of CS.

A common misconception in society is that CS is the same as computer programming. This is unfortunate in general, but especially so for women, who do not want to join a world of hackers, and who prefer to work for promoting social good more so than for the computer's sake. At all levels, we

²Appendix A provides a list of acronyms used in this report.

should therefore strive to stress the problem solving nature of CS, and the benefits of CS to general society, and emphasize that while programming is a tool, there is much more to CS than programming. (Dijkstra’s famous quote should be used often: “Computer Science is no more about computers than astronomy is about telescopes”.) Specific examples include:

- During outreach activities, whenever we visit high schools, and at all recruiting fairs, remind the presenters of how to present CS. Provide them with good examples of real-life problem solving with CS. Train high-school teachers and counselors whenever the opportunity arises.
- Continue to monitor the picture that we present of CS on the web page and in our recruiting material. For example, currently the web site emphasize “Spin-off companies (you can own your IP..)” and “winner in competitions”, which stresses competition more so than social good. But UW-CS does a fair bit of research that is beneficial to society (for example privacy enhancing technologies and delay tolerant networking in developing countries.) These should be more prominent.
- Whenever possible careers in CS are being presented (e.g. in flyers or during career panels), place emphasis on careers that are clearly CS, yet involve much more than programming. The recent ACM flyer about computing careers [1] struck us as an example of well-balanced examples of the impact of CS.

The Faculty of Mathematics recently created a recruiting video for recruiting undergraduate students (<http://www.math.uwaterloo.ca/navigation/Prospective/promotions/>.) The movie does make an effort to show women, but none of them is in CS. In fact, the careers from CS that are presented are all essentially hard-core programming careers; it would be good to show other CS careers that are concerned more with problem solving and social benefits.

Recommendation General-2: *At all levels, keep “CS is more than programming” in mind, and give examples of CS as problem solving with large impact on social good.*

Responsibility: *Director, Outreach committee, Undergraduate Recruiting Committee, Graduate Recruiting Committee.*

- Increase community spirit within CS, especially for women.

Both graduate students and undergraduate students mentioned that they feel isolated within the CS program. As women express more interest in a well-rounded social life than men, and especially benefit from peer-support [8], we think that this is a contributing factor to the higher attrition rate among women.

Isolation is likely related to the sheer size of UW-CS, especially at the undergraduate level. Another contributing aspect is the co-op-program and the separation in different streams; as soon as students have made friends they are being separated again. Also, CS courses by nature tend to be more about the lecturer presenting and less about students discussing with each other. Most of these aspects are immutable, but as a consequence, we should make it a priority to build community among CS students.

The Commons committee has been established for exactly this purpose, and arranges many activities for faculty, and to some degree graduate students. However, they are relatively inactive at the undergraduate level. Undergraduate groups such as the CS club exist, but we heard from some students that they see this as a domain of hackers, not a place to make friends. A group or club that aims to provide more social (non-technical) events would be helpful to both genders.

To counter-balance the co-op effect, especially in first year, it would help to modify the system of M-sections. Currently, incoming students do not enroll in their core courses individually; instead they choose an M-section which determines all core courses. Hence students in the same M-section see the same students in all their core courses, and these are likely the ones they become friends with. The co-op streaming system is currently being changed, and with it the M-section system will likely have to change as well. We suggest that these changes are done such that students in the same M-section are also in the same co-op stream, so that students do not lose the friends they have just made after a few months. All-female M-sections could also be considered.

Recommendation General-3: *Consider ways to foster community within CS.*

Responsibility: *Commons committee, Mathematics Undergraduate Office (for M-sections).*

- Provide support for the Women-in-CS committee.

To help build community especially among women in computer science, in parallel with the work of the task force the school established a Women-in-CS committee (WICS). Many similar societies exist at other universities (e.g. [2, 12]), and the size of the CS program here at UW makes such a society relevant even though the Women in Mathematics (WIM) committee exists and includes women in CS in their mandate.

This committee needs to be supported. A sufficient budget must be given, and the WICS chair must receive teaching relief and/or strong personnel support, e.g. in the form of a co-op student.

The ordinal mandate of WICS was to build community among female CS students, especially at the graduate level. Many of our recommendations fall naturally into the domain of WICS, and as such, we suggest that the mandate of WICS be expanded to include the following items:

- Organize activities to build community among women in CS here at UW.
Activities could range from the purely social (e.g. coffee/tea chats) to research related (e.g. female invited speakers), and should be coordinated with WIM activities.
- Support activities that connect women in CS here at UW with women in CS elsewhere.
One specific suggestion would be to provide scholarships for women to attend conferences for women in CS (see Appendix B for some possibilities.) WICS should also be in charge of deciding whether UW should underwrite any of these conferences, as done this year for the Grace Hopper Conference (see also Appendix C). If so, then WICS should decide how UW should present itself at these conferences and be in charge of organizing this presence.
A few years ago, a Women in Mathematics conference (for women from across Canada) was organized here at UW. Many participants that we spoke to have very fond memories of it, and WICS should consider whether doing a similar Women in CS conference would be feasible.
- Communicate important events and information for women in CS.
WICS is already working on designing a web page. We suggest to add to the web page a list of scholarships possibilities for women in CS (see also Appendix B) and alert students (e.g. via email) about upcoming deadlines. The WICS web page should also contain information about women in CS, both at UW-CS and in general (see Recommendation General-9).
- Communicate with other committees and groups at UW-CS whenever issues relevant to female participation in CS is discussed.
- Collect data on female participation in CS and maintain it in an organized way. (See Recommendation General-1.)

Recommendation General-4: *Maintain the WICS committee. Provide it with monetary and personnel support, and consider teaching relief for the chair.*

Responsibility: *Director.*

- Sexual harassment training.

Sexual harassment is an issue at UW-CS; it has been mentioned by undergraduate students both in our cs240 survey (see Section D) and during a survey among students taking cs125 vs. cs133 done in 2006. We have also heard (informally) of incidences of sexual harassment and bullying among female graduate students (both from peers and from faculty members), and among faculty in CS. We need to prevent such incidences as far as possible, and deal with them harshly whenever they occur.

It needs to be made very clear what constitutes bullying and sexual harassment (and that “sexual” refers to “gender-biased”, not to “intercourse-related”.) This may be especially important for international students with different cultural backgrounds and a language barrier. Also, the pathways for reporting incidences, and people to contact for guidance should be published well. A zero-tolerance policy should

be instituted, and consequences for the aggressor should be made very clear. All members of the school need to be informed of these issues, including faculty, who need to ensure a female-friendly atmosphere in the labs, and avoid any inappropriate comments towards students during advising or in class. Places where such information could be given include:

- During an Ethics section to be included in our undergraduate curriculum, as was requested during the recent CS program review.
- During the professional development courses that co-op students are required to take. (This would not reach all undergraduate students unless we require regular students to take them as well.)
- During TA orientation for graduate students, where the topic is briefly mentioned already (but mostly only to advise students not to date anyone who is being TAed by them.)
- On the Twiki page for new faculty and staff members.

Special training should be given to likely first points of contacts (CS advisors, graduate student advocates and CSGSA officer), so that they can deal with complaints well.

Note that sexual harassment is not topic-specific, and training sessions on sexual harassment could be done for many departments and faculties together. It would be worth exploring what other departments do with respect to this, and whether resources could be pooled.

For graduate students, in parallel with the task force, the office of a female graduate student advocate was created, starting September 2007. In the short time since its creation, this advocate already reported multiple cases of advising (compared to very little traffic to the (male) existing graduate advocate in previous terms). It is possible that women are seen as “more caring” among the student population and hence students prefer going to her. This office should be kept and supported. We would also suggest to keep this person different from the WICS chair, so that there is another natural female point of contact for female students. For even more outlets for female graduate students, one could also consider having two CSGSA officers, one man and one woman.

Recommendation General-5: *Ensure that all members of the school know about sexual harassment, ways to recognize and report it, and our policies about it. Give special training to the likely first points of contact.*

Responsibility: *UAPC, Graduate committee, Commons committee.*

Recommendation General-6: *Maintain and support the office of female graduate student advocate.*

Responsibility: *Director.*

- Offer scholarships to female CS students.

One commonly seen suggestion to increase female participation in CS is to offer scholarships exclusively for women, or even positions exclusively for female faculty. Anecdotal evidence (see for example [22]) shows that a scholarship may make a big difference to whether a student chooses a program or not. At UW-CS, such scholarships currently exist at the Ph.D. level (in form of Prov-Doc scholarships funded by the provost), but to our knowledge not at other levels. Our cs240 survey (see Appendix D) suggests that male students seem to think that females are preferred generally in receiving scholarships.

One disadvantage of such scholarships is that the net-effect may be not to entice more women into CS, but only poaching from other universities. Also, a women who accepts such a scholarship might well have come even without a scholarship; this may be a complete waste of money. (But the same could be said about all other scholarships, yet many scholarships exist to entice the best candidates to choose UW over other universities.)

We feel that in some situations the advantages of scholarships are high enough to make up for possible disadvantages. One of the reasons women choose not to study CS is that they have the wrong idea of what CS is (see also Recommendation General-2.) If a scholarship gets them to come to UW-CS as undergraduate students, then we have a chance to correct wrong impressions; especially if we take great care to expose students to CS as more than programming early. Similarly, if a student chooses not to

do graduate studies because they have misconceptions of what that is, then a scholarship (e.g. for an undergraduate research assistantship) would help them to try it out, and get a correct picture. For this reason, we feel that scholarships for female students should get offered, especially entrance scholarships for undergraduate CS students, and funding for undergraduate research (such as NSERC-USRA's, which are fairly expensive to the faculty members otherwise.)

In order to maximize the potential of scholarships, they need to be advertised well. The undergraduate recruiting material needs to inform about it, and presenters at recruiting fairs should be instructed to mention it to interested female high-school students. Scholarships for undergraduate research should be advertised to all female upper-year undergraduate students. We should also alert these students to some external scholarships for undergraduate research (see e.g. [29]).

Recommendation General-7: *Offer scholarships to female CS students at the undergraduate level, as well as on other levels where students may be deterred by misinformation about CS due to lack of exposure. Advertise these scholarships well.*

Responsibility: *Director and higher UW administration.*

- Provide role models for female students.

One of the reasons that few women choose CS is that they believe that there are few (if any) women in CS. As such, providing female role models is very important and has been shown to keep women in the program [15].

One possible approach is to offer mentoring, which many studies have shown to be especially effective (see e.g. [19, 20]). A few years ago efforts were made within the Faculty of Mathematics to build our own mentoring program, but this was abandoned since it was very time-consuming for the organizers. While a local mentor program would probably be best, this should not be attempted again unless the school is ready to provide substantial teaching relief and other means of support to the organizers. It may be better to use existing external mentor programs, such as mentorNet (<http://www.mentornet.net>), to which the Faculty of Mathematics is currently already subscribed. The main problem here is to find people willing to mentor; mentorNet offers much help for mentees, but pressure/incentives to become a mentor must come from within UW-CS. This is especially vital for faculty; studies have shown that faculty time devoted to mentoring makes a statistically significant difference to the success at retaining women in the program [7].

To provide role models, we should publicize information about women here at UW-CS. We should especially highlight achievements by women in CS, e.g., research chairs for faculty, scholarships for graduate students, Fryer medal for undergraduate students, etc. Stories about successful female alumni would be good, too, especially if they work in jobs that are about much more than programming. Another form of role modeling comes from the history of computing, where there is wealth of women role models [14]. The web page of WICS would be a natural place for this information, but the general CS web site should feature successful stories about women in CS prominently (see also Recommendation Outreach-3.)

Recommendation General-8: *Support existing mentoring activities and/or implement local mentoring programs. Encourage graduate students and faculty members (of both genders) to get involved and clarify what credit is given for this.*

Responsibility: *Director.*

Recommendation General-9: *Provide information about women in CS and highlight their achievements.*

Responsibility: *WICS.*

- Increase incentive for faculty to get involved.

Many of the activities that we suggest throughout this document require people to get involved, e.g. by participating in fairs, giving presentations outside the lecture room, helping to organize, etc. For many of them, the bottleneck will be finding people to do this, especially faculty members (of both genders.) Currently, participants for such activities are found by sending a pleading email and hoping that the

personal reward or free food is enough to attract volunteers. Some faculty seem to be very active, while others ignore calls for participation entirely.

There should be a more structured way of rewarding faculty for participation. It should be clarified how much participation in non-research, non-lecturing, non-committee work is expected as part of the work load of every faculty member, and faculty members who do not participate must compensate in some other way. The faculty evaluation form should have a section specifically for listing activities, for example those related to outreach and community-building within CS. The director should clarify to the faculty how much service and/or teaching credit can be received for them.

Recommendation General-10: *Clarify how much participation in activities is expected from faculty members, and what credit is received for it. Consider ways to increase the incentive for faculty to be involved.*

Responsibility: *Director, Advisory committee on evaluations.*

- Provide women with opportunities for feedback.

There is no systematic way at UW-CS to ask for feedback regarding our success or shortcomings in providing a female-friendly environment. Many people viewed this task force as a welcome opportunity to make their thoughts known, but we did not have the resources to interview all members of the school. We should create a systematic way to offer everyone (and especially women) a way to voice their thoughts.

For undergraduate students, one could insert a question about gender issues into student course evaluations, or administer questionnaires in selected CS classes, similar to our cs240 survey. For graduate students and faculty, no regularly applied feedback-mechanism seems to exist. One could consider sending an email inviting feedback regularly (for example yearly), this would then most naturally fall into the domain of WICS and/or the female graduate advocate.

Recommendation General-11: *Consider systematic ways to invite feedback about any gender issues (from both genders, but especially from women) in UW-CS at all levels.*

Responsibility: *Commons Committee, WICS, Female graduate advocate.*

- Monitor service load of women in CS, and compensate appropriately.

Many of the recommendations (in the literature and by ourselves in this report) can be summarized as “provide role models by asking female members of CS to participate especially often.” Examples include recommendations such as putting women into administrative positions frequently [38, 36], ensuring committees always have at least one female faculty member on them (as currently done in UW-CS), match female students with female mentors, etc. While all these are laudable policies, they have the net effect that women in CS seem to do proportionally more service work than men.

While we would not want to change any of the above policies or recommendations, we need to do our best to keep the service load of women comparable to that of men, or if this is not possible, explicitly reward women that have a higher service load. The director should monitor the service load of female faculty members carefully. In case of imbalance, female faculty members should not serve on committees or be involved in events, unless this is needed to have female representation, or they explicitly express the wish to do so. In exceptional years (such as the year 2007/2008, when 5 out of 9 female research faculty members are on leave for part of the year), it may be necessary to leave some committees without female faculty members, at least for part of the year. Sometimes it may be possible to provide female representations by drawing on lecturers or graduate students, thereby increasing the pool of women.

The graduate committee should consider ways to monitor service loads for graduate students (of both genders), and consider ways to compensate those with especially high involvement. One possibility would be to count such involvement towards teaching assistantship (TA) duties, similarly as done for the officer of the Computer Science Graduate Students Association (CSGSA).

Recommendation General-12: *Monitor service loads of women in CS carefully. Consider ways to compensate for service given beyond normal expectations.*

Responsibility: *Director, Graduate committee.*

- Create a physical environment that is welcoming to women.

Many aspects of the physical environment can contribute to the sense of women as being welcomed. Women tend to enjoy attractive rooms and computer labs, whereas men are commonly indifferent to this [15]. Baby change tables (of which currently none exist anywhere in DC) are seen as a sign of welcoming mothers; breastfeeding areas (or at least comfortable places to sit in washrooms) even more so. Wide, and preferably automatic, doors are convenient for mothers with strollers (as well as for wheelchair users or anyone with mobility issues.) Safety issues are important as well: Are there enough lights at night, are there clear sight lines?

While some of these items are quite expensive to install, we should keep such positive changes in the environment in mind whenever renovations are scheduled for any part of the facilities of computer science.

Recommendation General-13: *With every renovation, keep attractiveness and safety of the physical environment to women in mind.*

Responsibility: *Director, space committee.*

3 Recommendations for outreach

Much of the problem with the lack of women in CS is the general perception of CS in the wider society. While we cannot hope to change society single-handedly, we should do our best to influence it whenever we have a chance. For this reason, outreach may be one of the most important factors in attracting more women into CS.

Outreach concerns two specific areas: the population in general, for which media is the only effective way to reach them, and students early in the pipeline, such as in middle school or even earlier. This is especially important to women since girls lose interest in computing by the time they reach high school [32, 36].

Currently, CS related outreach activities are done by many different UW organizations. The Centre of Education in Mathematics and Computing (CEMC) organizes various outreach activities; of special interest is the “Imperial Oil Seminar” for young women in computing (see <http://www.cs.uwaterloo.ca/prospect/liaison/imperialoil/>). The undergraduate recruiting committee hosts CS4U, which aims at high school students in grade 8-11 (see <http://www.cs.uwaterloo.ca/prospect/cs4u/>.) Other CS activities, aimed at even younger children, exist within the Engineering Science Quest camps (<http://esq.uwaterloo.ca/>), and the Arts and Computer experience camps (<http://www.arts.uwaterloo.ca/ACE/>.)

We recommend the following:

- Outreach committee:

We recommend to create and support an “Outreach committee” (possibly in the form of just one person responsible for coordinating outreach activities). This committee should have as mandate to communication with people not directly connected to computer science or a related program at UW. In particular to be mentioned are monitoring the picture we present of ourselves and of CS on our web page and in communication with the media, and CS outreach activities, especially for middle school and earlier.

Recommendation Outreach-1: *Establish an outreach committee.*

Responsibility: *Director.*

- Develop a strategic plan for outreach.

The outreach committee should be in contact with, and provide material to, existing outreach initiatives to see that CS is presented as more than programming, and problem solving and social good is emphasized. The outreach committee should develop a clear plan for what outreach should be

done on each level, and verify whether the current activities are sufficient. If they are not, or if some of them cannot continue for whatever reason, or if the CS exposure is deemed unsuitable, the outreach committee should consider starting our own initiatives. We would like to mention that there is support for outreach in K-12 available from outside sources, e.g. through the IBM K-12 program (<http://www.ibm.com/ibm/ibmgives/downloads/IBMandEducation.pdf>) which has been used successfully by the Engineering faculty (see also [38]). Examples of possible new initiatives would include:

- A problem-solving competition. Currently, a computing competition is organized by CEMC (<http://cemc.uwaterloo.ca/ccc/>), but female participation is quite low. This competition is programming based, which is both a deterrent in itself to girls (fewer of them have the necessary background), and helps to spread the myth that CS equals programming. It would be helpful to have another competition that focuses on problem-solving. One should consider making it team-based as well, which appears to increase the appeal to girls due to its more social aspect.
- Offer CS circles, or present more CS aspects during Math circles. CEMC offers Math circles, a weekly night enrichment session for local secondary students (<http://cemc.math.uwaterloo.ca/english/mathcircles/>.) Female participation among these is comparatively high, estimated at 25%. A similar session for CS topics should be considered, or, if not enough instructors can be found, stronger involvement in the existing Math circles by CS faculty and graduate students should be encouraged.

Note that if we choose to offer a separate such program for CS, the name “CS circles” may not be an optimal choice; girls might well self-select against it on the (false) assumption that it involves only programming. A title that stresses problem solving should be sought.

Recommendation Outreach-2: *Develop a strategic plan for outreach activities, especially for middle school and earlier. Monitor how CS is presented.*

Responsibility: *Outreach committee.*

- Media-exposure for women in CS.

Media plays an important role in how girls perceive computer science. The presentation of CS in the media is the only way of reaching girls (and their parents) that do not have an interest in CS already, but too many inaccurate reports from media sources still present CS as males-only, programming-only, geeks-only domain (see [15] and the references therein.)

We should monitor the way we present CS to the media, and especially use every opportunity to present women in CS in the media. Some possible examples for doing so are included below:

- Some of the girls that have been invited to the Imperial Oil seminar are mentioned in their local newspapers. We should build on that, and pro-actively contact those newspapers.
- The UW-CS home page should include a special section about women in CS (likely cross-linked to/from the WICS web-page.) Any achievements by women in the school, as well as visits from notable women in CS, should be made prominent in the news section.
- Articles about activities for or achievements by women in CS should be suggested to the media whenever feasible.

Recommendation Outreach-3: *Give especially high priority to attain media exposure for news or events concerning women in CS.*

Responsibility: *Outreach committee.*

In the area of outreach would also fall the question of CS high school courses. Many people expressed the sentiment that current CS high school courses are not helpful in attracting students to the CS program, both in terms of quality and in the way CS is presented (predominantly as programming.) The task force chose not to make specific recommendations for how to improve high school courses, since this is not in the domain of the school. However, whenever we have an opportunity to influence the way CS courses are structured or CS teachers are trained, we should monitor how CS is presented, and whether any aspects of it may be deterring to girls.

4 Recommendations for the undergraduate program

4.1 Data

- The enrollment of women in CS at UW has dropped sharply over the last years. Overall enrollment in CS, according to IAP was 18.6% female in 2001/2002, 17.8% in 2002/2003, 16.1% in 2003/2004, 14.3% in 2004/2005, 13.7% in 2005/2006 and 12.7% in 2006/2007.

In comparison, Canada-wide enrollment in CS was 20.8% female in 2001/2002, 15.4% in 2003/2004, and 13.9% in 2004/2005 [25].³ Somewhat conflicting with this, data obtained from Statistics Canada [33] indicates the following female participation rates in CS within Canada: 23.9% in 2001, 21.3% in 2002, 18.3% in 2003 and 17.8% in 2004.

These percentages will likely get worse in the next few years: First-year registered students in CS (including bioinformatics, but excluding SE and CFM) were 10.3% female in 2004, 12.7% in 2005, 9.2% in 2006, and 11.7% in 2007. In comparison, the percentage of first-year registered women in the Faculty of Mathematics excluding CS has been fairly stable between 38.6% and 43.9% over the same years.

- A good part of the problem is in attracting applications from high-school students, and in convincing them to accept offers. The female percentages among applications received to CS dropped quite steadily, from 20.9% female in 2001 to 12.9% in 2007. The percentages of offers made to women are consistent with (and in fact, usually somewhat higher than) the percentages of women that applied. But proportionally more women than men choose not to actually come to UW after an offer has been made; the difference (for both the co-op and regular program) is statistically significant at the 95% confidence level.⁴
- Retaining female students is also a large problem. Data obtained from IAP indicates that retention is worse among women than among men. For students starting in 1998-2001, retention rates were 49-63% for women vs. 66-71% for men; the differences were statistically significant at the 95% confidence level.

The difference in retention rates are especially pronounced for students in the regular program (as opposed to the co-op program.) For students starting in 2000-2002, the retention rates for women in regular CS were 27-32%, vs. 56-65% for males. While there are not many female undergraduate students in regular CS (for most years it is 20-30), the multi-year trend makes it likely that this is not just a case of outliers.

- The above enrollment data is for women whose first major is in CS. However, an interesting picture emerges when breaking the numbers down by exactly what else CS students are studying. It is already well-known that bioinformatics attracts significantly higher percentages of women than other CS fields. (The average of 1st year registered students over 2001-2007 together is 43.5% female; numbers for individual years are quite small and hence prone to outliers.) The Computational Finance and Management program was 24% female. We were surprised to discover that many more women than men choose an additional non-mathematics area (e.g. as minor, joint, or double-degree); in the graduating class in Winter 2007, 30.3% of the women did this vs. only 15.3% of the men.⁵

4.2 Attracting High School Applications

UW-CS currently takes part in many activities to attract high school students to apply to CS, such as the Ontario University Fair and UW Day. The Faculty of Mathematics also does many high-school visits to mathematics courses (usually including a CS presenter), especially in the greater Toronto area and in Alberta.

³We obtained these numbers from the CAUT Almanacs from 2002-2007, but these did not cover all years.

⁴The application and offer numbers count students repeatedly if they apply to multiple programs, whereas the acceptance numbers count students only once. We doubt, however, that this was cause for gender differences in acceptance rates.

⁵This data appears to be not available electronically; we hand-extracted it from a list of graduating students. More studies of which other fields are the most popular, and trends over multiple years, would be interesting.

At these activities, we try to have female faculty members and/or graduate students present. The material that is handed out (the “golden brochure”) has been checked carefully to ensure that women are well-represented in the pictures.

Recently the listing of high-school CS courses in this brochure has been changed: whereas before they were listed as “recommended”, they are now not being listed at all. We think that this is a good thing. Participation of girls in CS high school courses is generally low (we did not obtain precise data), and CS high school computing courses seldom prepare students to be successful in a university setting [15].

We have some recommendations how to improve attracting high school applications, and especially how to make it more inviting to women.

- Communication with high-school counselors.

We already mentioned training of high-school counselors in Recommendation General-2 of “CS vs. programming”. Another aspect is to ensure that counselors do not contribute to the myth that CS is an all-male domain (see also [7]). We heard at least two female students mention that they were actively discouraged from applying for CS by their high-school counselors. We should provide high-school counselors with information about women in CS (for example from our web site; see also Recommendation General-9) to be distributed to high-school students.

Recommendation Undergraduate-1: *Provide information about women in CS to high-school counselors.*

Responsibility: *Outreach committee.*

- Advertise possibilities of combining CS with other fields better.

As our data indicated, women prefer combining CS with other fields. We should therefore strive to advertise as much as possible that this is feasible, and specifically, what special options and programs are available here at UW. The recruiting material already has most needed information in it; the emphasis here should be on getting the word out and training the presenters.

Recommendation Undergraduate-2: *Emphasize that CS may easily be combined with other areas of study (both within mathematics and outside of mathematics).*

Responsibility: *Undergraduate recruiting committee.*

- Consider paths to allow students with backgrounds from other disciplines into CS.

The University of British Columbia instituted a program where alternative routes to an undergraduate degree in computing were allowed for those with degrees from other disciplines. This program has maintained an enrollment of over 50% female in all cohorts, and continues to attract a high number of female applicants [16, 18]. Likely because of this, data from Statistics Canada [33] indicates that female participation in CS in British Columbia increased from 19.3% in 1999 to 28.4% in 2004, whereas Canada-wide it decreased from 24.4% to 17.8% in the same time period.

We should consider whether similar programs could be instituted here at Waterloo. Waterloo already has some programs that are tailored to generally academically interested students, and have some CS component [26, 27]. Can we build similar programs with specific focus to lead students to a CS degree eventually? Or at least ensure that the CS component that these programs have exposes true CS and not just programming?

Recommendation Undergraduate-3: *Explore ways to allow students with degrees from other disciplines to obtain a degree in (or at least much university exposure related to) CS.*

Responsibility: *Undergraduate recruiting committee, UAPC.*

As another area of concern, we would also like to mention that there appears to be no list of local high school teachers in CS kept anywhere in the school. Communication (e.g. about outreach and recruiting activities) is usually sent to the head of the Mathematics department at high schools, and from there it may or may not reach the CS teachers (we know of cases where it didn't.) While this is not directly relevant to recruiting more women, we would still recommend that such a list be created (likely by the chair of the outreach committee or the recruiting coordinator).

4.3 Attracting High School Acceptances

We currently have many activities to encourage students to come to UW. Among them are the Campus Day (March), the phonathons (March-May), and U@UW day (May). Care is taken to provide future female students with female role models wherever possible; for example during the phonathon female applicants are called by female professors/students as far as resources allow.

We do not have specific recommendations for these activities, beyond a broad recommendation that for all of them, women should be given priority whenever resources are limited. For example, during the phonathon we should try to reach all applicants, but if this is impossible due to lack of participants, we should make sure that at least all female applicants have been called. We should also carefully monitor how we present ourselves during recruiting activities; do we present CS as competitive, or do we emphasize social aspects? (See also Recommendation General-2.)

Attracting undergraduate acceptances by women is an area where we are sorely lacking, which is one of the reasons why we recommend entrance scholarships for female students in CS (see Recommendation General-7.) Beyond this, we have one more recommendation:

- Tailor letters to accepted students.

Currently, the director writes letters to all accepted CS students, telling them more about UW-CS and inviting them to join us. The same letter is sent to both male and female students. It would be better to draft a letter specifically tailored to female students. In particular, such a letter should include information about WIM and WICS committees, and typical activities that they organize for female undergraduate students. It should also list some achievements by women in CS, both from students and from faculty. For further inspiration, see a similar letter from the president that was sent to accepted students in Engineering ([38], Appendix 5).

Recommendation Undergraduate-4: *Tailor the letter to accepted CS students specifically to female CS students.*

Responsibility: *Director.*

We would like to share one more insight that we gained during our information gathering that is not specifically relevant to women, but that we found interesting. From informal responses during the phonathon, we heard that many students declined coming to Waterloo because they were not accepted in their first-choice program (even if they were offered a lower-ranked program at UW.) For example, students preferred Software Engineering at another university over UW-CS, even though the CS program offers a software engineering option that gives much of the same course content.

As much as politically possible, we should emphasize in recruiting material that the difference between the various programs is not as tremendous as it may seem. It would also be good to include in the training of phonathon volunteers some information about the various program and about the difference (or absence thereof) in terms of the material learned.

4.4 Retaining Undergraduate Students

As mentioned in the data section, retention of female undergraduate students is of special concern. A lengthy attrition report [35] was created by a subcommittee of UAPC that looked into possible reasons for attrition and made recommendations (some of which are now being implemented.) Sadly, this report did not distinguish the gender of students in their questionnaires, and so it is hard to draw any conclusion as to which reasons for attrition especially pertain to women.

Partially to counter-balance this, we performed a survey among those CS students that took cs240 in the Spring 2007 term (see also Appendix D). Many of the resulting insights have led to recommendations elsewhere (e.g., increase communication, sexual harassment, CS high school counselor training.) Based both on this survey and on literature published elsewhere, we would like to make the following recommendations:

- Choose programming assignments carefully.

Care has already been taken in the last years to make programming assignments gender-neutral. It is vital to continue this. In particular, implementing computer games, as much appeal as it sometimes

may have, should be avoided. (None of the women in our cs240 survey quoted “games and web surfing” as reason for choosing CS, whereas 15% of men did.)

Recommendation Undergraduate-5: *Continue to monitor carefully the programming assignments given to students, especially in the first year courses.*

Responsibility: *Course instructors and coordinators.*

- Consider attractiveness to women whenever re-designing undergraduate courses.

Contrary to the fact that CS is more than programming, much of our CS exposure to undergraduate students is in fact about programming, and CS for the machine’s sake; especially in the first year. In designing new courses, or fixing course outlines, care should be taken to present CS as problem solving as early as possible.

The recent change of first-year programming language to Scheme should help; the people in charge of developing the new first-year courses should strive to make best use of this. Likely the switch to Scheme is a good thing for female students in general, as it serves as an equalizer among incoming students, and especially gives women with less computing background a higher chance of succeeding. Good experiences (especially for women) with Scheme have been reported elsewhere [4]; we should monitor whether this holds here as well.

As mentioned earlier, computer science courses which offered a more interdisciplinary approach and discussed connections of computer science with other disciplines appear to attract more women. We should keep courses like this in mind whenever we re-design parts of the curriculum.

UAPC is currently studying how to present both ethics and history in our CS curriculum. Both of these aspects of CS are important for women. History offers many examples of women in computing; care should be taken to stress those. Ethics provides a sense of interconnectedness of computing and society, and tends to be of particular interest to female students [34].

Another suggestion frequently seen in the literature is to use pair programming, especially in the first year. This has been shown to be especially helpful to female students (see e.g. [39, 37].) Pair programming has been tried in UW-CS on a small scale, but not shown enough promise to have been continued. With the new first-year courses, and the younger students that we have now, should pair-programming be tried again?

We would also like to stress the importance of recent efforts by UAPC to address courses with heavy workload, which often have a competitive “show-off” component to them. Separating competitive aspects from courses that otherwise contain interesting and relevant CS material would help more women choose these courses.

Recommendation Undergraduate-6: *Keep attractiveness to women in mind whenever re-designing courses in the undergraduate curriculum.*

Responsibility: *UAPC*

- Consider ways to ease adding other fields of study to CS.

The data indicates that women are more attracted than men into combining their CS studies with other academic plans (e.g. a minor, double major or joint option), especially in areas that are not in the Faculty of Mathematics. We should consider ways to make this as easy as possible. While the web page offers good information about what courses need to be taken for which combination with other plans, it offers little information about how to actually go about adding another plan. The process appears to be especially complicated when adding a second major not in the Faculty of Mathematics. Communication between the different faculties should be streamlined.

Recommendation Undergraduate-7: *Provide more help for students wanting to add another academic plan to their CS studies, by informing students better about the process, and communicating better with other faculties.*

Responsibility: *UAPC, CS advisors.*

- Continue work based on the attrition report.

It is highly regrettable that the attrition report did not include gender information, as the attrition rate among women is significantly higher than among men. If such an attrition report were ever to be repeated, gender information definitely should be included. Until then, all we can do is guess (based on our general assumptions and the cs240 survey) which of the student comments and subsequent recommendations may be especially relevant to women. We re-iterate some of them here; others have been integrated in recommendations elsewhere.

- “Many [students] complained of busy-work or mechanical work; they wanted more scope to be creative.” ([35], p. 9).
- “We must continue to [...] keep the members of a larger School involved and concerned with undergraduate teaching.” ([35], p. 11). Enthusiastic professors are too few. Motivation and involvement by professors is key for women being engaged and for being retained in the program [7].

We would also like to pass on a recommendation recently made at the 2007 Grace Hopper Conference, which suggested to monitor first assignments (ideally for all students, but especially for women), especially in the first year. Students who fail these assignments should be forced to talk to a CS advisor, to see whether they are placed in the appropriate course, and to see what needs to be done to help them succeed in the program.

Recommendation Undergraduate-8: *Continue to monitor attrition rates, especially among women, and consider ways to address possible causes.*

Responsibility: *UAPC*

Finally, we would like to mention that communication with female undergraduate students (e.g. for posting activities or alerting to deadlines for scholarships) is easily achieved. The CS data base of students maintained by the Undergraduate Operations Coordinator contains gender information, and one can easily extract the email addresses of all female undergraduates in CS from it. This data base is updated automatically, so no manual maintenance of an email list is required.

5 Recommendations for the graduate program

5.1 Data

- Overall enrollment in the Master’s program in CS, according to IAP, was 23.1% female in 2001/2002, 23.8% in 2002/2003, 24.0% in 2003/2004, 22.5% in 2004/2005, 20.9% in 2005/2006 and 14.5% in 2006/2007.

In comparison, Canada-wide, the Master’s students in CS were 29.6% female in 2001/2002, 26.3% in 2003/2004, and 22.1% in 2004/2005 [25].

- For outlook for future years, the Master’s students who accepted an offer from UW-CS were 12.5% female in 2005, 17.0% in 2006 and 17.0% in 2007. Hopefully the year 2005 was an outlier (which now depresses the average in overall enrollment), and the number of female Master’s students will return to slightly higher numbers in the near future.

- Overall enrollment in the Ph.D. program in CS, according to IAP, was 18.4% female in 2001/2002, 18.2% in 2002/2003, 21.3% in 2003/2004, 21.5% in 2004/2005, 22.5% in 2005/2006 and 22.0% in 2006/2007.

In comparison, Canada-wide, the Ph.D. students in CS were 24.5% female in 2001/2002, 24.8% in 2003/2004, and 22.5% in 2004/2005 [25].

The Ph.D. students who accepted an offer from UW-CS were 29.0% female in 2005, 25.9% in 2006 and 20% in 2007.

- We did statistical analysis on the gender-ratios for offers vs. applications and acceptances vs. offers; as opposed to the undergraduate program there were no statistically significant differences.
- An interesting picture emerges if we break the data down by visa status. In the years 2001-2003, the percentage of women among Canadian/PR Master's students at UW were slightly below, but mostly in line with, the female percentages overall. This has changed dramatically in the last three years; the Canadian/PR Master's students at UW were 9.5% female in 2004/2005, 15.0% female in 2005/2006 and 7.0% female in 2006/2007. Only an increase in the female participation among international students has prevented us from having even worse female percentages for Master's students.

For Ph.D. students on the other hand, female percentages among international students were mostly consistent (and in fact, somewhat below) the overall female percentages.

- No data about retention rates of female graduate students (or graduate students in general) was available.
- Female graduate students at UW-CS receive proportionally about as many scholarships (such as NSERC, OGS, Cheriton etc.) as male graduate students. The so-called Prov-Doc scholarship is specifically for attracting female Ph.D. students into CS; since 1998 approximately 22 students have received this funding, which is \$5000 per year for 2 (sometimes 3) years.

5.2 Attracting Graduate Applications

UW-CS sponsors many activities to attract students into our graduate program; some of them will be commented upon below. Most of these are geared towards our own undergraduate students. Relatively few initiatives can be done for international students, mostly due to lack of funds and contacts. This is a pity, since the female percentages among international students are generally higher both in our own graduate program and North America wide [13].

We hope that the graduate recruiting committee will continue to work on attracting international students better, but do not have specific recommendations for this, or for how to attract female international students in particular. However, we offer some recommendations to attract more female students from Canada.

- Increase contact with faculty, post-docs and graduate students.

Studies show (e.g. [31]) that contact with faculty outside class is one of the most influential factors in undergraduates' decision to pursue graduate studies, especially for women. It helps to show that graduate school is different from undergraduate studies, and gives student a better idea of what to expect.

Unfortunately, here at UW the contact between students and faculty is limited outside the classroom. Many of the reasons for this are immutable: the school is very large, students rarely have the same professor in more than one class, and many classes before 4th year are too large for professors to get to know all students well. The physical separation between DC where professor's offices are, and MC where undergraduate students spend most of their time, surely does not help.

Various tools already exist for outside-class contact between undergraduate students and faculty and introduction to research, for example undergraduate research assistantships, the honours thesis, and the cs497 (research topics) course. The problem, as for many other outreach activities, is how to find faculty that are willing and have the time to take on students in these projects. In terms of pure research output, faculty members likely feel that their time and/or money is probably better spent on graduate students; research with undergraduate students might be more popular if rewarded with explicit teaching credit. Scholarships specifically for women to do undergraduate research should also be considered, see Recommendation General-7.

Recommendation Graduate-1: *Increase the incentive for faculty members to offer research opportunity to undergraduate students.*

Responsibility: *Director, Advisory committee on evaluations.*

- Make research visible to undergraduate students as early as possible.

In the spirit of the previous recommendation, we should strive to make research visible to undergraduate students, preferably much earlier than 4th year. One approach is to ask faculty to put some time aside in each course and try to relate it to their research. Obviously, not all faculty teach courses closely related to their research, but for many courses in 3rd and even 2nd year, some connections can be found and should be presented.

Another largely untapped resource are graduate students and their research. Graduate students that have significant contact with undergraduate students (e.g. when holding tutorials) should be strongly encouraged to spend a few minutes on talking about what their research is; especially if the research can be related to the course content. This is especially important if the graduate student is female, to give undergraduate students a female role model to look up to. For this reason, instructors might also consider giving women preference (assuming same qualification level and interest on part of the graduate student) when selecting which of the TAs will have increased contact with undergraduate students, e.g., by holding tutorials or being chosen as IA.

Recommendation Graduate-2: *Encourage faculty members to relate topics in 2nd and 3rd year courses to current research topics. Update course outlines to specifically allot time for this.*

Responsibility: *Director, UAPC.*

Recommendation Graduate-3: *Encourage graduate students to use a few minutes of tutorial/office hour time to talk about their research to undergraduate students.*

Responsibility: *TA supervisors (usually the instructor.)*

Recommendation Graduate-4: *Give a preference to women (assuming same qualification level and interest on part of the graduate student) when selecting which TAs are put into contact with undergraduate students.*

Responsibility: *ISG, TA supervisors (usually the instructor.)*

- Provide more guidance during the application process.

The size of the undergraduate program makes it unlikely that students who are applying for graduate school and scholarships such as NSERC/OGS know each other and can support each other. We need to help them find information. This is especially important for women, whose lack of self-confidence may prevent them from applying to graduate school in the first place unless they are encouraged.

There are many resources available already that provide the necessary information. However, some of these could be improved. Most of the resources are about the technical details of when and how to apply; but we should also try to contact students that are not at all sure yet whether graduate school is for them (or whether they are good enough for graduate school.) In September 2007, the Graduate Student Association's Women's Issues Committee held such an event for all UW faculties together, which was well-attended in general, but (as far as we could tell) had only very few women from CS. Could such an event, tailored to CS, be held specifically for women in CS, ideally in conjunction with a social event? Or could at least experiences from UW-wide events be used to make our own information sessions more welcoming to women?

We also think improvements could be made to the NSERC/OGS information session. This has a broad audience: from undergraduate students who barely know what research is to Ph.D. students who apply for a renewal and have a clear research plan. Some undergraduate students reported walking out of this information session with the feeling that in order to qualify for a scholarship one must have a very detailed research plan already, and since they only had a vague idea what they wanted to do, they had no chance at such a scholarship and "maybe graduate school isn't for me." This may be especially relevant to women due to lack of self-confidence. We should make sure that the information session does not prevent undergraduate students from applying for scholarships just because their research ideas are still somewhat vague. Alternative, one could consider having separate sessions for each pool of applicants.

As one more aspect relevant to both genders, we would like to point out that the deadlines for NSERC/OGS scholarships are very inconvenient. Students need to prepare their applications and approach professors for references at the same time as the fall term starts and both students and faculty are very busy otherwise. Many of the students do not know their professors well yet, since they have taken few if any 4th year courses yet. The situation is even worse for students who are on co-op in the fall term. While the deadlines themselves are likely immutable, the graduate recruiting committee should consider ways to make it easier for co-op students to participate. Could information sessions be held in the Spring term as well?

On the topic of applications, we should offer undergraduate students one-on-one mentoring in writing applications, especially if they are not otherwise involved in a mentoring program. We could offer them a proofreading of their application by someone who is familiar with the process, such as a Ph.D. student or a faculty member. Many faculty members already do this for students that they are writing letters of recommendation for and where they hope to attract the student themselves. We should make sure that this service is offered in a systematic, not haphazard, way. Since resources are probably too limited to offer it to all our undergraduate students, preference should be given to female undergraduate students. Note that we can reach all female 4th year undergraduate students quite easily via email.

Recommendation Graduate-5: *Offer information sessions on graduate studies that focus on “is graduate school for me?” more so than the details of how to apply for graduate school. Ensure the information sessions are not deterring to undergraduate students whose research plans are still somewhat vague.*

Responsibility: *Graduate recruiting committee.*

Recommendation Graduate-6: *Offer proofreading of applications by a faculty or Ph.D. student mentor, with preference (in case of limited resources) given to female applicants.*

Responsibility: *Graduate recruiting committee.*

- Recruit students with non-standard background for graduate studies in CS.

Since women become interested in computer science later than men, [16, 24], women may have already chosen other subjects for undergraduate studies when they become more interested in CS. Interdisciplinary research can greatly benefit from such students (and vice versa, the number of women that combine CS with other areas seems to indicate that interdisciplinary research is more appealing to women; see also [16])

We should explicitly work on attracting students with non-CS background into the CS graduate program, e.g. students from psychology for Human Computer Interaction, biology for Bioinformatics, mathematics for Algorithms and Complexity, and fine arts for Computer Graphics. Special promotional material for these departments would be useful. The message should be aimed not only at 4th year students, but also students in earlier years, while they still have a chance to take undergraduate courses in CS.

Related to this, we should consider making it more feasible for non-CS students to aim for a graduate career in CS. Currently, 3rd year CS core courses are closed to non-CS students, and no minor-version exists. Hence we make it impossible for non-CS students to satisfy core requirements, and they cannot be taken into the graduate program without taking at least two, likely more, remedial courses.

Remedial courses required of graduate applicants with non-CS background are also a major disincentive to them being accepted. Students with non-CS background will necessarily have to take many remedial courses, and even with the very recent changes that allows supervisors to remove remedial courses, such students will not be able to get by without taking at least a few. With the current funding model, the future supervisor would have to pay for funding for the first year during which the student is tied down with remedial courses and has little time for research. Also, the student will likely take longer to finish the graduate program, hence exceed the limits of TA support and be especially expensive to his/her supervisor.

We should consider ways to either remove this disincentive or provide other means of students to enter the graduate program. One possibility is to expand the program that accepts students without

supervisors to explicitly include students with possibly weak CS background, but much promise due to excellent background from other disciplines. Another option would be to ease the burden on the supervisor by extending the limit of TA support for such students.

Recommendation Graduate-7: *Actively recruit students from other departments with material that emphasizes interdisciplinary programs within CS.*

Responsibility: *Graduate recruiting committee.*

Recommendation Graduate-8: *Reconsider the funding model for graduate students, especially for students with strong background in a non-CS discipline.*

Responsibility: *Director, Graduate committee.*

Finally, we noticed during our investigations that the current CS home page has (on the front page) an immediate link to faculty recruitment and to undergraduate recruitment, but not to graduate recruitment. While finding the graduate recruitment material is quite easy (it is two clicks away), this sends the message that graduate studies are less important to the school; the web page should be changed to give equal importance to recruiting at all levels.

5.3 Attracting Graduate Acceptances

The most important aspect for whether a graduate student accepts our offer is likely contact with the future supervisor. The school already encourages all supervisors to contact accepted students, and sends suggestions for emails; it is hard to come up with ideas of what else the school in general could do, since each contact is different depending on the supervisor and student. We make here a few recommendations relating to other aspects of attracting graduate students acceptances:

- Tailor package sent to accepted students to women.

Currently, the package from the school that is sent to accepted graduate students is the same for all students. Similarly as for undergraduate students, it would be a good idea to write a letter specifically tailored to female students, highlighting achievements by women in CS, especially women at UW. Alternatively, one could include a letter from WICS (similarly to the letter from the CSGSA officer currently included).

Recommendation Graduate-9: *Tailor the acceptance package to graduate students specifically for women.*

Responsibility: *Graduate recruiting committee.*

In studying the acceptance package, we also noted that it is fairly full of material already, some of the material feels irrelevant or redundant (especially since it is all available on the web), and the copy of the material ranges from bad photocopy to nice glossy brochure. We would recommend to the graduate recruiting committee to review this package in general.

- Invite female accepted students for a visit.

In March 2007, for the first time, the school invited some graduate students from Canada to come to a visit to UW-CS, all expenses paid. Invitations were sent to students that received an NSERC scholarship, as well as accepted Canadian/PR students for which the supervisor expressed interest in having them come for a visit. Based on personal feedback this event seems to have been a success.

We should repeat these visits in general. In an ideal world, we would invite all accepted graduate students, but in the reality of limited funds, we recommend that preference be given to women. The female percentage among Canadian/PR Master's students is of special concern, so we should invite all accepted Canadian/PR female students, as well as outstanding international women.

We should also consider whether the visit program could possibly be expanded to students that are not accepted yet (such as for example done at University of Toronto.) Having a potential student visit should have a positive effect on the offer rate (the supervisor can be more certain that the student

is a good match) and the retention rate (the student is less likely to come in the first place if it is a bad match, so funds will be used primarily for students that will actually stay). Financing such visits would be expensive, so yet again preference should be given to women.

Any visits should also contain events to help the students bond with each other. (This would also ease the burden on the host of each student by filling more of the open “slots” for them.) For female students especially, a meeting with WICS representatives would be suitable; maybe the visit could be timed with a WICS social event? For all visiting students, it would be a good idea to combine the visits with an open house for some labs, or a speaker in the distinguished speaker series.

Recommendation Graduate-10: *Make the visit by accepted graduate students a regular event, not just a one-time trial. Routinely invite all female Canadian/PR students. Consider expanding it to students that are not yet accepted.*

Responsibility: *Graduate recruiting committee, Director (for funding).*

Recommendation Graduate-11: *Use the recruiting visits to help visiting students (and especially females) bond with each other.*

Responsibility: *Graduate recruiting committee, WICS.*

5.4 Retaining Graduate Students

Many issues related to retaining graduate students have already been mentioned elsewhere (in particular see Recommendation General-5 on sexual harassment.) We would like to add some more here:

- Increase communication among female graduate students.

An important aspect of retaining female students is to help them build community and peer-support among themselves. Recommendation General-4 about WICS and social events for female students applies strongly here, but for graduate students, we have two more specific recommendations to add.

When the task force was formed, communication meant for female graduate students was sent to the general graduate student population, prefaced with a disclaimer such as “males, please disregard”. It does not take much work, and would help foster community among female graduate students, to have a separate email list for females instead. We have instituted such a mailing list (cs-female-grads) for now, and it has already proved useful for advertising the Grace Hopper conference and other communication. This mailing list should be maintained on a regular basis, likely by the maintainer of the cs-grads mailing list (currently this is the CSGSA officer), or by WICS.

The second recommendation is to put female graduate students into offices together whenever possible. While all-female offices may be seen as too restrictive and/or become a reason for mockery, it would be advisable to pair female graduate students in offices or labs whenever possible. This is especially important for newly arrived female graduate students. We should also allow women to switch offices easily if they report feeling uncomfortable due to inappropriate comments from their office mates.

Recommendation Graduate-12: *Maintain a separate email list for female graduate students.*

Responsibility: *CSGSA officer or WICS.*

Recommendation Graduate-13: *Assign new female students to offices that have other female students.*

Responsibility: *Graduate office.*

- Offer support for part-time studies for students with family obligations.

Studies showed (see [21] and the references therein) that women’s participation is greater in graduate CS programs with flexible timetables for degree progress, and women placed more importance on flexibility than men. Likely this flexibility is desired due to obligations related to raising a family.

We should consider how to support students that want to combine graduate studies with raising a family. Parental leave policies only cover the first year after birth; afterwards students might need to study part-time if they wanted to devote time to their family.

Currently, no assistantships are offered to part-time students. Should such funds be provided if the student does not earn income from other sources (i.e., the part-time status is desired for raising a family, as opposed to doing graduate work while doing a full-time job elsewhere?) Should special funds be made available to single parents? More information would be useful about how leaves or part-time status affects international students; is this feasible with visa restrictions and what are implications on funding?

We would also like to point out that some of the information relevant to graduate students raising a family is hard to find. The Graduate student association has assembled a very helpful web page (<http://www.grad.uwaterloo.ca/students/gsomatguide.asp>); links to this web page should be added from CS pages for graduate students.

Recommendation Graduate-14: *Consider support for graduate students in need of reduced workload to raise a family. Advertise such possibilities well.*

Responsibility: *Graduate committee.*

Recommendation Graduate-15: *Increase the visibility of UW's policies on leaves for CS graduate students.*

Responsibility: *Graduate committee.*

- Publish possible non-CS courses.

Since women appear to be generally more interested in interdisciplinary studies, they will, more often than men, be interested in graduate courses that are outside CS. It is possible for graduate students to take such courses and count them towards their requirements, but students have to apply for each course individually, and have no guidance whether the course is likely to be accepted, and if so, under which CS area it is going to be counted in.

The possibility of taking non-CS courses should be published better in general. It would also help tremendously if a list of courses that have been approved (and possibly some that have not) could be made public, including information under which CS area they were counted for the requirements.

Recommendation Graduate-16: *Publish a list of non-CS courses that have been approved for credit in lieu of CS graduate courses in the past. Advertise it well.*

Responsibility: *Graduate committee.*

6 Recommendations for faculty

6.1 Data

- In July 2007, we had 4/7 female lectures (57%), 0/7 female postdoctoral fellows (0%), 1/14 female assistant professors (7%), 5/34 female associate professors (15%), 3/23 female full professors (13%), and overall, 9/71 female research faculty members (12.6%)
- In comparison, Canada-wide in 2004-2005 (the latest year from which data was available from CAUT) full professors were 8.4% female, associate professors 19.0% female, assistant professors 18.7% female, and other (presumably primarily lecturers) 29% female. All ranks together were 16.6% female, and all professorial ranks were 15.4% female [25].
- We felt that the sample size is too small to gather meaningful statistics about attracting acceptances or retention at the faculty level.

6.2 Attracting Faculty Applications

The University of Waterloo strives for gender balance in its faculty [36], and has instituted various policies (especially UW Policy 76) to ensure the underrepresented gender is given due consideration during the hiring process. UW-CS already follows these policies; in particular the hiring committee (SACA) always has at least

one woman on it, and for every male faculty appointment submitted for approval to higher administration, information about the the top female candidate is also supplied.

UW-CS appears to be doing quite well with respect to spousal opportunities (i.e., how to resolve 2-body problems): 7 out of 9 female research faculty in UW-CS also have their spouse working at UW. This is helpful both for recruiting and for retention of female faculty members, and might be considered as something worth advertising more.

Nevertheless, our percentages on the whole are lower than the North American averages, and as such, we still need to work harder to attract more faculty applications from women. We offer some recommendations below.

- Work on increasing the numbers of female postdoctoral fellows.

Postdoctoral positions are especially useful for attracting good graduate students to stay in academia until such a time that a suitable faculty position becomes available. Such positions could also be useful for bridging purposes or 2-body problems, and have been especially recommended by previous task forces here at UW [36, 38].

The current model of hiring postdocs is that the supervising faculty member needs to find the money, which is a significant hurdle especially for younger faculty members with smaller grants. The school should help increase the number of female postdocs by providing funds (in addition to money provided via teaching) that a faculty member can apply for if he or she is in contact with a qualified female candidate for a postdoctoral position. The funds could more generally be made available to all underrepresented minorities.

Currently no information is given about whether postdoctoral fellowships are available from UW-CS; recruiting postdocs is usually done by word-of-mouth via the future supervisor. Some mentioning of availability of postdoctoral positions, especially if special funds for women are available, should be made on the CS faculty recruiting web page.

Recommendation Faculty-1: *Create funds to be applied for to fund postdoctoral positions for underrepresented minorities. Advertise them well.*

Responsibility: *Director, SACA.*

- Consider ways to make the faculty recruiting advertisement text and web page more attractive to female applicants.

The current advertisement text is all about life in academia. Since we are trying to attract people that are establishing a permanent home and possibly wanting to raise a family, we should also include some information about life in Waterloo outside academia. Waterloo has many attractive features (these include the communities in blooms award, short commuting times, lots of parks, and good public transportation for a town this small.) Space permitting, it would also be helpful to include information on parental leave⁶ policies (which are quite good, especially in comparison to the United States).

The printed advertisement text also list “UW encourages applications from all qualified individuals, including women, members of visible minorities, [...]”. While this is in line with how other universities advertise, it would not hurt to use stronger wording. One possible suggestion would be “The University of Waterloo strives to achieve equity among its faculty, and hence strongly encourages applications from women, members of visible minorities, [...]”

The CS faculty recruiting page (<http://www.cs.uwaterloo.ca/about/facultyRecruiting/>) contains some information about life outside academia, but this should be expanded and have more positive spin to it. Since space/advertisement cost here is not an issue, it would also help to provide more information about other aspects of faculty positions. Examples include teaching (teaching terms, co-op system, class sizes, typical teaching load, 40/40/20 split, typical number of graduate students, etc.), tenure-system (typical time frame until renewal and tenure, implications of parental leave on tenure, etc.) and service expectations. Much of this information is already available from the CS web site (e.g. <https://www.cs.uwaterloo.ca/faculty/guide/> and <https://www.cs.uwaterloo.ca/>).

⁶For this report, for simplicity we use “parental leave” to mean “pregnancy/maternity/parental leave”.

ca/twiki/view/CSEveryBody/SchoolGuide), but adding links and supplementing some information would be useful. Alternatively, the guide for new faculty could be expanded; this would then be the domain of the Commons committee.

The CS faculty recruiting page also lists lots of achievements by faculty members, but the list is not necessarily up to date (and hard to keep up to date.) Installing one central “bragging” list on the CS web page, and linking to it with some suitable text (such as “The university has an excellent reputation and its outstanding faculty has won many prestigious awards, see ...”) may make maintenance easier. In any such bragging list, we should always include awards to at least one female faculty member.

Recommendation Faculty-2: *Rework recruiting advertisement texts and web pages in the light of making it more attractive to women.*

Responsibility: SACA

- Pro-actively invite women to apply to UW-CS.

This year, as a pilot, we initiated sponsorship by UW-CS of the Grace Hopper conference (see also Appendix C.) As part of this sponsorship, we gained access to a resume database of female students. The resumes in it range from undergraduates seeking internships to Ph.D.s seeking employment in academia. We should use this database to identify women that would possibly qualify for a faculty position here at UW, and pro-actively invite them to apply to our school. Other avenues to reach female graduating Ph.D. students across North America should be explored as well.

Conferences for female students in CS should be considered not only for sending students (to build community, see Recommendation General-4), but also as a recruiting tool. The way UW presents itself at such conferences, and personal contact of our students or faculty with female Ph.D. students from elsewhere will help increase the profile of UW as inviting to women.

Recommendation Faculty-3: *Pro-actively invite suitable female Ph.D. students to apply to UW-CS. Make use of all opportunities to reach such students, and monitor how UW presents itself to them.*

Responsibility: SACA chair, WICS (for conferences).

6.3 Attracting Faculty Acceptances

Many factors that determine whether an offer for a faculty position is accepted are immutable, such as offers from other universities, research fit, and friendships with faculty already at UW. The only aspect that we can work on is how we present UW-CS to the candidate during the faculty interview (or any follow-up visits.) Care is already taken that female interviewing candidates meet many female faculty members and graduate students during their visit; this should be continued (and possibly strengthened by involving WICS into such visits.) We offer here one more suggestion:

- Ensure information relevant to women is given during faculty interviews.

We should make sure that we give precise and helpful information to the candidates. Of particular concern to female faculty candidates would be information about parental leave and reduced work load, day cares and schools in town, and experiences of resolving 2-body problems. Information about WICS and activities for women in CS would also be useful.

While usually someone brings up these topics during some interview slot, there is no mechanism in place to ensure that all information is given (and vice versa, that it is not given too often.) Such a mechanism could be a fact sheet to be included in the recruiting package, or a link to a suitable web page (see the text near Recommendation Faculty-2), but probably the best way is to have this be told in person. During the interview, one of the interviewing faculty members should be specifically instructed to be in charge of making this information available to the candidate. This may be the host of the visit, or the director of the school, but ideally it would be someone who is matched as closely as possible with the candidate in terms of age, family status and cultural background (for non-Canadians). We may not always have this information about the candidate (and are not allowed to ask), but we should try to match as far as feasible.

To advertise life outside Waterloo, we should also include a tour for all visiting non-local faculty candidates, showing off nicer housing areas, parks, maybe the farmer’s market, etc. This was done in the past, usually by the director or by the host, but appears to have fallen by the wayside. Doing a tour seems a very attractive thing, and would naturally involve conversations about life in Waterloo as recommended above.

Recommendation Faculty-4: *Ensure relevant information about life in Waterloo is given to all recruiting candidates, and especially to women. Include a tour of Waterloo outside university in the recruiting visit.*

Responsibility: *SACA, host of recruiting visit.*

While not female-specific, we would also like to mention that the recruiting package given to visiting candidates could be improved. Currently it contains much information that would be useful more for visiting tourists than for someone who considers making Waterloo his/her permanent home. Including an accurate town map, a real-estate brochure, and cultural attractions in general (in more concise form than a visitor’s guide) would be useful. Links to web-pages as mentioned in the text for Recommendation Faculty-2 could also be included, to ensure candidates can follow up easily on information received orally during the interview. We suggest that SACA spend some time reviewing the current package.

6.4 Retaining faculty

While few female faculty members have left the school, it is important that the school work hard on keeping it this way, and pro-actively work on situations where females may experience bias or feel disadvantaged. Most of the recommendations we had in this area (create community, sexual harassment, service load) have already been mentioned in Section 2, but we have quite a few more recommendations which are concerned with parental leave.

Generally, UW’s policies on parental leave and part-time work are good for faculty. Faculty are entitled to a year of leave with employment insurance benefits by Canadian laws; UW provides supplementary benefits that amount to 95-100% of the salary for the first 23 weeks. Faculty wanting to spend more time with family can easily request a temporarily reduced work load (as long as it is at least 50%) for normally two years, and possibly extended to four years. Faculty can also change their appointment to a fractional appointment if reduced work load is required even longer.

However, the realities of going on parental leave are still far from ideal. The nature of a faculty appointment makes it difficult to be truly “on leave” for an extended amount of time: Research cannot be stopped, literature to be read continues to pile up, and most importantly, graduate students still require supervision. The school needs to do whatever possible to support being truly on leave better, and to give credit for work done while on leave.

- Consider implications for graduate students of faculty that are on parental leave.⁷

Currently, nothing is provided for graduate students whose supervisor is going on parental leave, not even the appointment of a delegate supervisor (as done during sabbatical leaves.) The usual approach seems to be for graduate students to try to get by with rare (and often distracted) meetings with their advisors. In consequence, these graduate students are hampered in their progress and therefore likely finish later than they otherwise would have. In consequence, the supervisor then has to bear additional financial burden to support the student longer, especially if the student exceeds the time limits for TA support. Since faculty on parental leave tend to be early in their career, this financial burden is a significant problem.

We should consider better ways to provide for these graduate students. The ideal solution would be to find a co-supervisor that truly interacts with the student on research issues, but this may not always be possible due to research interests and/or lack of time from other faculty members. Another option would be to help students to go on an extended leave of absence themselves (e.g., to work in industry)

⁷We developed these recommendations with parental leave in mind, but similar issues exist for sick leave or unpaid leaves of absences.

while their supervisor is gone; if so then we need to minimize the paperwork involved for this, waive the re-application fee, and use a term less deterring than “voluntary withdrawal” for a leave of more than two terms. If students cannot or do not want to take such a leave, we should at least consider easing the financial consequences on the supervisor: TA support and increased support for international students to make up for higher tuition should be extended by some length of time proportional to the length of parental leave.

Recommendation Faculty-5: *Help faculty manage implications of a faculty parental leave relating to their graduate students.*

Responsibility: *Graduate recruiting committee.*

- Consider implications of parental leave during faculty evaluations.

When a faculty member is on parental leave, the current policy (based on the Memorandum of Agreement) is to apply the average of previous years’ ratings to all components that cannot be evaluated. While this is principally a good idea, it should not be applied blindly. Faculty members may feel obliged to put in work during the leave, for example if they have committed to some work long before they knew about their leave (e.g. conference committees, refereeing, graduate student supervision.) Any such work is essentially unpaid work for the benefit of the school, and often done at great cost to the faculty member during a period of general upheaval in their lives. The Memorandum of Agreement gives no advice on how such work should be credited, whether it should improve the ratings for the current year, or be carried forward to future years. This should be clarified and communicated to faculty members on parental leave; preferably before they even go on leave.

Another area of concern is the time lag between when research is done and when it can get credited during evaluations due to it being published. The research record during the year with parental leave may well be quite outstanding, due to research that was in the pipeline already. Parental leave needs to be taken into account when considering research output during the year following the leave, and (for journal publications) even the year after. Currently the research component is evaluated with a three-year rolling average. We suggest that the period of this average be extended if it includes time of parental leave, and that the policy on this be communicated to faculty going on leave.

Finally, care should also be taken how pregnancy is taken into account during faculty evaluations. While some pregnancies are uneventful, others may significantly impede the ability of the mother to work, yet not be “bad enough” to apply officially for sick leave. Can a system that takes this into account be devised?

Recommendation Faculty-6: *Consider implications of pregnancy and parental leave during faculty evaluations, for the year itself and also in subsequent years. Clarify policies and communicate them.*

Responsibility: *Director, Advisory committee on evaluations.*

- Ensure information about implications of parental leave is available.

The university’s web sites are very informative as far as what the parental leave benefits are and how to apply for them (see Policy 14). Other implications, for example the above-mentioned implications relating to graduate students, may be less apparent to the faculty member going on parental leave. Especially important here is the ability to extend the probationary period (i.e., the time to apply for tenure); while this is explicitly mentioned in Policy 14, it may be easily overlooked.

For graduate students, the graduate studies office has instituted the position of a parental leave advisor. A similar office would be very helpful for faculty members as well. During a meeting with such an advisor, it would help to cover a range of topics on the realities of going on leave, from how long to plan on being to able to teach while pregnant, to what to do best with graduate students, to what work can realistically be expected to be done while on leave, to timing of grant applications, and last but not least how this will affect tenure considerations. If no support can be found for instituting such an office university-wide, then the director should initiate a meeting with every faculty member that announces plans of going on leave.

For pre-tenure faculty members, the director might even consider bringing up the implications of a leave on tenure at every post-evaluation-meeting (regardless of gender and whether a leave is currently planned); since tenure-preparation is such a long-term process the timing may be too late by the time the leave is being applied for.

Recommendation Faculty-7: *Ensure faculty applying for parental leaves receive adequate information on the impact such a leave may have on various aspects of their career.*

Responsibility: *Director and higher UW administration.*

One final recommendation concerns all female faculty members, not only those on leave.

- Consider possible bias against women during evaluations.

Some literature suggests that evaluations are biased against women, especially by male students towards female instructors [10]. The results are not clearcut, but enough to warrant a reminder that UW's Policy 77 explicitly states that "Student course evaluations are an important source of information, but they should be supplemented with peer evaluation of teaching skills, course content and course materials.". We recommend to implement such peer evaluations more frequently, especially for female faculty. Even peer evaluation may be biased (see e.g. [17] for general bias against females in evaluations); the possibility of such bias should be kept in mind whenever studying evaluations of women.

Recommendation Faculty-8: *Consider possible bias against women during evaluations, especially on the teaching component.*

Responsibility: *Director, Advisory committee on evaluations*

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A Acronyms used in this report

- ACM: Association of Computing Machinery. <http://www.acm.org>.
- CAUT: Canadian Association of University Teachers. <http://www.caut.ca>.
- CEMC: Centre for Education in Mathematics and Computing in the Faculty of Mathematics at UW. <http://cemc.math.uwaterloo.ca>.
- CFM: Computing and Financial Management, undergraduate program at UW. <http://cfm.uwaterloo.ca>.
- cs240: CS 240, Data Structures and Data Management. An undergraduate CS course typically taken by students in their fourth term.
- CRA-W: Computing Research Association, Committee on the Status of Women in Computing Research. <http://www.cra.org/Activities/craw/>.
- CSGSA: Computer Science Graduate Students Association at UW. <http://www.cs.uwaterloo.ca/~csgsa/>.
- DC: William G. Davis Computer Research Centre; the building that houses UW-CS.
- GHC: Grace Hopper Conference. <http://www.gracehopper.org>
- IA: Instructional assistant. Similar to a teaching assistant, but with higher emphasis on instruction and contact with students.
- IAP: Institute for Analysis and Planning at UW; http://www.analysis.uwaterloo.ca/stats/ext_cubes/index.html.
- MC: Mathematics and Computer; the building in which the majority of undergraduate courses in UW-CS are being taught.
- NSERC: National Sciences and Engineering Research Council of Canada. Offers scholarships to Canadian graduate students. Also offers Undergraduate Student Research Awards (USRA). <http://www.nserc.ca>.
- OGS: Ontario Graduate Scholarships, available to graduate students at a university in Ontario. http://osap.gov.on.ca/eng/not_secure/OGS.htm.
- PR: Permanent resident in Canada. These are not Canadian citizens, but were approved to reside in Canada permanently. For purposes of tuition fees and scholarships, they are treated the same as Canadian citizens.
- RA: Research assistant. Almost all full-time graduate students that are not supported via a scholarship receive a research assistantship, usually paid for by the student's supervisor.
- SACA: School Advisory Committee on Appointments at UW-CS. Responsible for recruiting new faculty members who will hold regular appointments.
- SE: Software Engineering, undergraduate program at UW.
- TA: Teaching assistant. Almost all graduate students that are not supported via a scholarship receive a teaching assistantship. Master's students receive this support for 5 terms, Ph.D. students for 12 terms.
- UAPC: Undergraduate Academic Plans Committee at UW-CS. Responsible for policies regarding undergraduate courses, programs, and requirements, and approval of individual undergraduate courses. <http://www.cs.uwaterloo.ca/admin/curric/>.

- UW-CS: The David R. Cheriton School of Computer Science at University of Waterloo. <http://www.cs.uwaterloo.ca>.
- WICS: Women in Computer Science, a newly established committee at UW-CS.
- WIM: Women in Mathematics, a committee in the Faculty of Mathematics at UW. <http://www.math.uwaterloo.ca/navigation/WIM/index.shtml>.

B Links to conferences and scholarships for women

During the investigations of the task force, we often stumbled across conferences and/or scholarships that are specifically designed for women in CS. Maintaining a list of those would fall into the domain of WICS, who should publish them and advertise them well to the appropriate audience. We provide here a list of a few links that we found (especially of local activities); the list is far from complete and WICS should search for others. Many more useful links can also be found at other web sites for women in CS, see for example <http://women.acm.org> or <http://www.cra.org/Activities/craw/> or <http://cms.math.ca/women>.

- <http://gracehopper.org>: Grace Hopper Conference. See Appendix C for more on this.
- <http://www.cra.org/Activities/craw/gradcohort/index.php>. CRA-W Grad Cohort.
- <http://www.cs.cmu.edu/ourcs/>. OurCS, Opportunities for Undergraduate Research in Computer Science. Carnegie Mellon University.
- <http://www.fields.utoronto.ca/programs/scientific/06-07/cwimac06/>: Connecting Women in Mathematics. Toronto.
- <http://www.ccwestt2008.ca/>: CCWESTT 2008 Conference. Guelph.
- <http://impact.org/wil/technight/>: Infusion Angel's Women in Technology Night. Local.

Some scholarships specifically for women in CS include:

- <http://www.google.ca/anitaborg/>. Scholarship for female students enrolled in full-time studies in Computer Science or related fields.
- <http://women.acm.org/scholarships.html>. Scholarship for female students wanting to attend a research conference.
- <http://www.cra.org/Activities/craw/gradcohort/index.php>. Scholarships to attend the CRA-W Grad Cohort workshop.
- <http://gracehopper.org/2007/participate/scholarships-student/>. Scholarships to attend the Grace Hopper Conference.

C Grace Hopper Conference

In parallel with the establishment of this task force, the school also decided to underwrite the Grace Hopper Conference (GHC) (see <http://www.gracehopper.org>), and to provide some funds to send graduate students to this conference. Since WICS did not exist yet at the time, the task of choosing students to send, and organizing the participation of UW at the conference was left to the task force as well. Due to lack of time, we did not use all possibilities open to underwriters of Grace Hopper; this was also partly motivated that we wanted to find out what other universities did there first.

The following provides some information on and experiences with underwriting GHC and sending students there, as well as feedback from the attendees that were sent. We hope that this will be useful in deciding whether the school should underwrite and send students again next year.

C.1 Underwriting

- There are various level of sponsorship, from Affiliate to Gold. This year, we underwrote at the Bronze level. The main benefit to us is visibility of Waterloo (logo on web page, name in conference program, the ability to put one flyer and trinket into conference bags, shared space in the exhibition hall,) as well as two scholarships for attendees (all costs paid.) This level of sponsorship costs \$3,000.

Other levels vary from \$1,500 to \$15,000 in cost, and buy proportionally less/more visibility and scholarships. See http://gracehopper.org/2007/assets/GHC07_Academic_Benefits.pdf for a detailed list.

- Additional costs would arise from making full use of the visibility available to us. This year we only used the logo and the name in the conference program, but not flyers, trinkets, or booth due to lack of time and money.

Single-page flyers for conference bags cost approximately \$1 each to print. Trinkets for the conference bags are allowed up to \$3 per trinket. (This is for the bronze level sponsorship; more costly material is allowed at higher levels of sponsorship.) This material would be needed for 1500 conference bags. Display tables would cost both for the actual equipment of the table, as well as for gifts to be given away. To all of these, shipping costs to the location would have to be added.

- Underwriting GHC at any level also provides access to a database of resumes. The entries in the database range from undergraduate students searching for internships to Ph.D. candidates seeking a position in academia. In October 2007, 137 resumes were available; we did not analyze carefully yet how many of them fell into which category.

For purposes of comparison, 5 universities underwrote at the Gold level, 5 at the Silver level, 8 (including UW) at the Bronze level and 9 at the Affiliate level. None of the other underwriting universities were from Canada, and only one other (University of Southampton) was from outside the US.

C.2 Sending students

We decided to spend \$3,000 on partial scholarships to send students to GHC. Two additional full scholarships were available due to underwriting GHC.

We advertised the possibility of scholarships to the cs-female-grads email list. Interest level was very high. 13 students specifically applied to go to receive scholarships; a few others mentioned later to us that they did not see the email, but would have applied if they had.

Selecting students to receive scholarships was difficult and done somewhat ad-hoc. In the end, we considered commitment of the students to issues regarding women in CS as one main determining factor (e.g., have they ever volunteered in outreach activities?) We also considered whether the student may be able to receive funding from elsewhere (e.g. the supervisor), and whether they would likely still be at UW next year and might get a chance to go to GHC then. In the end, we selected 6 students.

To make the best of the experience for the students, it would have been helpful to have both pre-conference and post-conference meetings with them. Due to lack of resources (mostly time), we did not hold actual meetings, and most communication with the attendees was done by email.

The cost for one student to attend GHC (including travel, hotel and meals) appears to be around US\$1,100 on average.

C.3 Feedback from the attendees

We asked the students that attended to provide us with feedback about their experiences at GHC, and also to evaluate how they perceived the promotional material given by other institutions. The following is a summary (and some quotes) from their responses.

Experiences

- All attending students raved about the experience of having been at GHC. They were happy to meet women in CS and make friends, both from Waterloo and from elsewhere.

It was a rather unique experience to be surrounded by so many women and girls that have similar interests.

I felt much more at ease there than I do at most academic or networking events.

I was able to get to know many girls from Waterloo [...] Before we were only colleagues, but now I can truly say we are friends and supporters.

Students felt that for once that they belonged to CS.

Women are so outnumbered at other CS conferences, but GHC changes that. [...] For a day you feel like you belong there.

As a women in CS I often question if I chose the right career path. More often than not I feel out of place, I feel as if I do not belong. For the first time in my life I felt like I belong in CS. I wasn't alone. There were other women out there just like me dealing with very similar issues.

A few men attended GHC as well, and they felt out of place surrounded by so many women. One of them said as a joke "I guess this is how you guys feel all the time". The sad thing is, he was probably right.

Students recommended GHC highly, for women at all levels of CS (undergraduate, graduate, faculty.)

- Students found many other women to connect to. This was especially appreciated by those who do not have many such opportunities otherwise.

I also feel great that I found some women whose research area is close to mine. I'm really excited about this since I'm the only woman in my lab.

Usually, CS conferences are dominated by men, and running into another female graduate student/professors is difficult. [...] GHC is dominated by women from academia and industry.

There were so many role models and contacts I made. [...] I found many contacts in [my research area.]

- GHC offers panels on a wide range of topics relating to women in CS, e.g. talks regarding women in technology, recruiting and retaining women in CS, and methods for monitoring the number of women. The panels were seen as very inspiring.

There was a talk on how to become a full professor, and I felt that the women presenting offered great insights into the world of academia as well as great advice.

[I felt good about] seeing quite a lot of female professors who were stressing that they combined career and having family at the same time (which is my personal big "phobia").

- GHC also offers technical talks and a poster session. Responses to this were mixed; some attendees found interesting research contacts and felt it would have been useful to submit a poster, but others felt the technical talks weren't relevant to them and they didn't have enough time to look at the posters.

Promotional material

- Many trinkets were given in the conference bags. Sadly, the (promised) coordination from GHC to avoid duplication of trinkets appears not to work well; students complained of too many pens. Gifts that were seen as useful included a notebook, a pack of gum, an SPF lipstick, a mirror, and hand cleaner. Students appreciated gifts especially tailored to women. However, a tampon holder generated much attention, but not necessarily in a positive way.
- Most flyers included in the conference bags were seen as a waste of paper, since they mostly aimed at recruiting graduate students, which did not apply to the students that we sent.
The few flyers that are mentioned as being worth looking at were from industry; the Google flyer was mentioned especially as showing strong support for women globally.
- The booths by corporate sponsors were quite aggressive in handing out gifts and flyers; the booths by universities were more passive. Generally university booths were quite basic and consisted of flyers and poster boards; one exception was CMU. Some universities left their booths unattended, others had students and/or faculty there at all times. The booths of the Bronze sponsors apparently were in a corner tucked away, and not prominent.
- At the booths, many nice gifts (such as bottles, key chains, T-shirts) came from corporate sponsors. Gifts from universities (which included pins and magnets) were deemed mostly useless.

Publicity

- The Bronze level sponsorship buys comparably little publicity. The logo is displayed at the web page, but not in the program (as opposed to silver level and higher.) Higher level sponsors are mentioned orally at panels; Bronze sponsors are not.
- Students were surprised by how many people (especially from industry) already knew about Waterloo.
- Some universities made themselves quite visible by providing their attending students with T-Shirts imprinted with the university's logo.
- The attendees felt that none of the universities' displays gave the feeling that they were any better or worse for women than average. Such impressions came from casual conversations with other students or through talks and panels featuring faculty.

GHC as recruiting tool

- Industrial sponsors (such as Google, Microsoft, Cisco, Yahoo) were very prominent and clearly worked hard at recruiting students. GHC would be an ideal place to establish contacts with company representatives, and turn in resumes. This is somewhat detrimental to the objective of encouraging women to pursue a career in CS in academia.
- There were a number of universities that were advertising faculty positions or looking for graduate students, usually through flyers handed out at the booths.
- The attendees thought that GHC was a great place for upper-year undergraduate students to inform themselves about graduate schools.

C.4 Suggestions for future years

Based on feedback from the students that attended GHC, the conference was a great success. Clearly students profited from the bonding experience and the presentations. The gain in publicity or for recruiting is more debatable.

We strongly feel that money should be made available from the school to help students attend GHC (or similar conferences). We leave it to WICS and the director to decide whether GHC is the best possible place for students to connect to each other, or whether other conferences might be more suitable.

As for underwriting, the cost of it (once one deducts the money gained back in form of scholarships) is quite small, and the publicity gained by it cannot hurt. Underwriting at the Silver Level might make more sense; this buys a lot more publicity, would cost \$7,500 and gain 5 full scholarships, compared to \$6,000 and 2 full and 4 partial scholarships this year.

If we decide to continue underwriting GHC, then we would have to decide whether to make use of the opportunity for flyers/trinkets/booth and gifts.

- Flyers would have to be well-designed. Simply using the graduate recruiting flyer will not gather significant attention. Especially worth mentioning may be differences between Canada and the US, for example concerning universal health care, better parental leave policies, etc. We collected many flyers that were handed out this year; these should be studied.
- Trinkets and gifts make an impression, but only if chosen carefully. A useless standard trinket such as a pen, pin or a magnet will cost us lots and gain us little. Making the gift somewhat female-specific (e.g. mirror, lipstick) seems appreciated, but avoid inappropriate gifts such as the tampon holder. Consider gifts that are different, even if only a little, for example highlighters instead of pens.
- Enthusiastic and well-informed personnel is vital at booths. A passive approach is a waste of resources. Generally, booths and gifts seem very expensive and did not seem to have a large impact, especially at Bronze level.

D The cs240 survey

In Spring 2007, we did a survey among 2nd year CS students and SE students, to gain more insights both into why they chose UW as their place of study (i.e., undergraduate recruiting), and how they view their program now (i.e., undergraduate retention.) Our survey went through ethical clearance procedures from the Office of Research Ethics at the University of Waterloo.

Our survey was administered to all students attending cs240 on one day, both women and men. We thank Alejandro López-Ortiz and Arne Storjohann for letting us use their class time. The following lists the questions that we asked, summarizes the answers, and adds information on insights we gained.

Background Information

1. What is your gender? [Male/Female]

73 men and 15 women responded to the questionnaire.

2. What year and term are you currently in? (Please Circle)

	2A	2B	3A	3B	3N
Female	0%	87%	13%	0%	0%
Male	4%	78%	15%	1%	1%

3. What program are you in, including major, joint honours, minors and options (e.g. BCS/Bioinformatics with a minor in Music)?

	CS only	CS with option	CS with math	CS with non-math	SE	Other
Female	27%	7%	20%	33%	13%	0%
Male	39%	13%	8%	10%	27%	3%

We grouped the results by whether the students studied “Vanilla CS” (i.e., Bachelor of CS or Bachelor of Mathematics (CS)), used one of the CS options, combined CS with another area of study (through a minor, joint, or double-degree), and whether that area was within the Faculty of Mathematics or not. “Other” refers to students whose major was neither CS nor SE (they were Mathematics students with a CS minor.)

The noticeable gender-difference in combining CS with other areas prompted us to investigate data whether this trend holds in general. It does, at least for areas outside mathematics. In the survey-responses, the non-mathematics area for men was frequently physics, whereas for women it was a wide range of programs.

Making the decision for university studies

- What was the main reason you chose UW? (Check one.)

- Overall reputation of UW
- Reputation of CS at UW
- Close to home
- Higher ranked choices did not accept me
- Other (please specify):

	<i>Overall reputation</i>	<i>CS reputation</i>	<i>Close to home</i>	<i>No Higher offer</i>	<i>Other</i>
<i>Female</i>	<i>33%</i>	<i>73%</i>	<i>0%</i>	<i>0%</i>	<i>7%</i>
<i>Male</i>	<i>23%</i>	<i>67%</i>	<i>3%</i>	<i>3%</i>	<i>15%</i>

The “other” reason frequently was the existence and/or reputation of the co-op program.⁸

- In retrospect, how justified was that reason? (Circle answer)

	<i>Strongly justified</i>	<i>Somewhat justified</i>	<i>Neutral</i>	<i>Somewhat unjustified</i>	<i>Strongly unjustified</i>
<i>Female</i>	<i>53%</i>	<i>33%</i>	<i>7%</i>	<i>0%</i>	<i>0%</i>
<i>Male</i>	<i>36%</i>	<i>52%</i>	<i>8%</i>	<i>1%</i>	<i>3%</i>

- What was the main reason you chose CS? (Check one.)

- Enjoyed programming
- Enjoyed playing computer games and surfing the web
- Attracted to the idea using computers to address real world problems
- Other (please specify):

	<i>Programming</i>	<i>Games/surfing</i>	<i>Real world</i>	<i>Other</i>
<i>Female</i>	<i>57%</i>	<i>0%</i>	<i>43%</i>	<i>0%</i>
<i>Male</i>	<i>59%</i>	<i>15%</i>	<i>33%</i>	<i>15%</i>

Given other literature on the subject, we were surprised to see the high percentage of women that chose CS because of their love of programming.

- In retrospect, how justified was that reason? (Circle answer)

	<i>Strongly justified</i>	<i>Somewhat justified</i>	<i>Neutral</i>	<i>Somewhat unjustified</i>	<i>Strongly unjustified</i>
<i>Female</i>	<i>53%</i>	<i>47%</i>	<i>0%</i>	<i>0%</i>	<i>0%</i>
<i>Male</i>	<i>48%</i>	<i>36%</i>	<i>11%</i>	<i>0%</i>	<i>1%</i>

- What, in your mind, are the main reasons that only few females choose CS as their major?

The most popular response to this question was that girls are intimidated by an already male-dominated industry. This is in line with the literature that suggests the image of the typical CS student is a deterrent to girls. Some comments (by men) reiterated stereotypes, such as “Come on, girls don’t like math, that’s nature!”, and “They are not good at logically thinking in a CS way.”

⁸Some students chose to check more than one answer or left answers blank; hence percentages do not always add up to 100.

The Computer Science Program at Waterloo

- What are the most satisfying aspects of your studies here? (Check all that apply to you.)
 - Course work is intellectually challenging and interesting
 - Course work relevant to my long-term goals
 - Ability to combine my CS studies with other areas
 - Co-op system
 - Student environment
 - Other (please specify):
 - No satisfying aspects

	<i>Challenging</i>	<i>Relevant</i>	<i>Other areas</i>	<i>Coop</i>	<i>Environment</i>	<i>Other</i>	<i>None</i>
<i>Female</i>	63%	31%	50%	63%	25%	0%	0%
<i>Male</i>	55%	40%	26%	74%	15%	5%	0%

The most noticeable gender-difference (not surprising, considering the results previously discussed) is in the ability of combining studies in CS with another area. Coop is strongly valued by both women and men.

- What are the most troubling aspects of your studies here? (Check all that apply to you.)
 - Not interested in nor motivated by course material
 - Course work irrelevant to my long-term goals
 - Assignments involve too much busy-work and are too removed from course content
 - Too much time spent on core courses
 - Feel isolated from other students
 - Performance in courses not up to expectation
 - Other (please specify):
 - No major sources of concern

	<i>Not motivated</i>	<i>Irrelevant</i>	<i>Busywork</i>	<i>Core</i>	<i>Isolated</i>	<i>Performance</i>	<i>Other</i>	<i>None</i>
<i>Female</i>	19%	19%	50%	44%	13%	44%	6%	6%
<i>Male</i>	16%	15%	34%	16%	21%	33%	18%	11%

The biggest gender-difference occurs in complaints about busy work and the time spent on core courses. A significant number of students are disappointed with their academic performances to date, with a higher percentage of women feeling that way. These findings seem consistent with the previous attrition study that was completed in the past.

- How happy are you with your decision to study CS? (Circle one.)

	<i>Very happy</i>	<i>Somewhat happy</i>	<i>Neutral</i>	<i>Somewhat unhappy</i>	<i>Strongly unhappy</i>
<i>Female</i>	60%	13%	27%	0%	0%
<i>Male</i>	50%	46%	4%	0%	0%

- How happy are you with your decision to study CS at UW? (Circle one.)

	<i>Very happy</i>	<i>Somewhat happy</i>	<i>Neutral</i>	<i>Somewhat unhappy</i>	<i>Strongly unhappy</i>
<i>Female</i>	60%	27%	0%	7%	7%
<i>Male</i>	56%	37%	4%	3%	0%

- Do you think you will graduate with a degree in your current plan of study?

	<i>Definitely</i>	<i>Probably</i>	<i>Not sure</i>	<i>Probably not</i>	<i>Definitely not</i>
<i>Female</i>	50%	29%	21%	0%	0%
<i>Male</i>	70%	24%	6%	0%	0%

Consistently with the literature, women were less confident of finishing their program.

- Why or why not?

No unusual responses were made here.

- Do you know of any situations (for you or your friends) in which being a female has made a difference (positive or negative) as a CS student at UW? Please consider course work, awards, lab environments, co-op terms, etc.

The most popular response to this question was that women are given an advantage in the co-op selection process or when receiving scholarships. Two responses mentioned sexual harassment as an issue UW-CS, both in the classroom and in co-op employment situations.

Suggestions/Advice

- What advice would you give to students about to start their first year in CS at UW?

Most of the advice given by these second year students related to being prepared for the work, and not falling behind.

- What changes would you suggest to improve the quality and/or experience of studying CS at UW? Your suggestions may relate to courses, the overall program, lab environments, etc.

Most student comments related to improving the quality of instruction, and course organization (there were several comments about cs246 explicitly), and some low level changes. One female CS student suggested to include some discussion of sexual harassment in the discussion of ethics.