Graduate School Guide for Women and Minorities in Computer Science and Engineering

Carla Ellis, Lori Pollock, and Patty Lopez
(CRA Committee on the Status of Women in Computer Science (CRA-W))
and
Manuel Perez-Quinones (Coalition to Diversify Computing (CDC))

1 Introduction and Motivation to Pursue an Advanced Degree

Computer & Information Science and Engineering (CISE) research has fueled numerous innovative and technological advances, resulting in the improvement of the quality of life for many. While women and minorities have made major contributions to these advances, they are still underrepresented in the field.

The annual CRA Taulbee Survey tracks the number and percentage of women and minority professors at Ph.D.-granting CISE departments in North America. The trends over several years in the proportion of women in academia are summarized in a report that shows very slow improvements in the percentage of female tenure-track faculty (from 8% to 11% of full professors, 12% to 13% of associate professors, and 16% to 20% of assistant professors over the 10 years 1998-2007). The most recent Taulbee data (as of this writing, the 2008/09 academic year), show women holding 11.7% full, 15.4% associate, and 21.7 assistant professorships. The percentage of full time, minority faculty of all ranks remains very low (under 5%).

The objective of this Graduate School Information Guide is to encourage more women and minorities to pursue an advanced degree in CISE. It is also intended to help potential graduate students (whether current undergraduates or those returning to school from the workplace) better understand the graduate school experience so that they will be more likely to succeed.

The remainder of this section discusses the opportunities and challenges of completing an advanced degree in CISE. **Section 2** offers advice on preparing oneself to become a competitive graduate school applicant and deciding whether graduate school is something you want to pursue**. Section 3** describes the application process, including choosing the right graduate schools to which to apply, the timeline, and preparing the various components of the application. **Section 4** presents information on graduate financial aid. **Section 5** discusses how to evaluate the offers of admission that you receive. **Section 6** addresses making the transition to graduate school and how it differs from the undergraduate experience. It also deals with topics to help students be more successful as they transition through later stages of graduate school. **Section 7** discusses how to avoid some of the most common pitfalls that many women and minority students may uniquely face while in graduate school. Finally, **Section 8** provides links to other resources about graduate study in CISE.

1.1 Pros and Cons of Obtaining an Advanced Degree

There are many factors to consider when deciding whether or not to attend graduate school. Naturally, the reasons vary from individual to individual and are based on many considerations including, but not limited to, career goals, lifestyles, family commitments, personality, and financial resources.

One of the advantages of graduate school is that it opens up career paths that might not otherwise be accessible. Some jobs absolutely require an advanced degree. For example, if you plan to teach or do research at an academic institution, a Ph.D. is required. There is a broad range of academic positions requiring a Ph.D., from research-intensive faculty positions at universities offering Ph.D. degrees to faculty positions dedicated to teaching at colleges and universities focusing on undergraduate education. Many industrial and government research labs also hire Ph.D. researchers for basic and applied research. Master's degrees are important in advanced development and applied research in the computer industry as well as project leadership of development teams. Even if not a strict requirement, an advanced degree is often viewed as a distinguishing criterion for separating job seekers in the applicant pool.

Many of the advantages of an advanced degree are qualitative and involve greater job satisfaction. With an advanced degree, you are likely to encounter more challenging problems and exciting projects that might not be open to you without one. Graduate school provides training in research and facilitates your ability to advance the state-of-the-art in your chosen CISE area through cutting edge research. An advanced degree is also likely to give you more flexibility in choosing or initiating projects.

An advanced degree develops the skills and expertise that often make the critical difference in career advancement. It provides research and writing expertise vital for launching one's career onto the fast track. It adds depth and breadth to one's technical background that not only improves your chances of obtaining an interesting job, but can also enhance your job performance if you already are employed. A graduate degree gives you more credibility among peers that can propel you into leadership positions and increased levels of responsibility. Finally, participation in a research project as a graduate student can provide valuable exposure to project management and experience working with a team.

The financial considerations of obtaining an advanced degree are complex. The decision to attend graduate school should not be based *solely* on the expectation of monetary benefits. It is true that having an advanced degree will generally result in earning a higher starting salary at the very beginning of your career. According to a 2006 National Science Foundation report, recent graduates holding bachelor of science degrees in computer science reported a median salary of $45,000 and those holding master's degrees reported a median salary of $65,000. The 2007-08 Taulbee Survey gives average nine–month salaries for assistant professors (primarily recent Ph.D.s) at $89,000, though the average may be significantly lower for non-PhD granting institutions. As you progress in your career, you may supplement your salary with grants, consulting, and by teaching additional courses or workshops during the summer months.

However, one of the tradeoffs of attending graduate school is the fact that a gain in starting salary with an advanced degree may not offset the income you might earn if you do not attend graduate school, start working right out of college, and wisely invest the money you earn. It typically takes 1 to 3 years to obtain a M.S. and 5 to 8 years to obtain a Ph.D. in CISE. The longer you stay in graduate school, the greater the monetary difference resulting from attending graduate school and delaying the beginning of your career may be. For example, according to one source that tracks salary by years of experience, a bachelor's degree after 5-9 years can earn a median of $72,500 (data as of Sept. 2009) while a master's degree 1-4 years out is earning a median of $55,000 after several years spent as a grad student instead of gaining work experience. As the job market changes over time, it is hard to estimate the future impact of these tradeoffs. This difference can be offset somewhat by obtaining summer internships that provide both income and work experience.

The good news (as explained in Section 4) is that students are often adequately supported (via tuition and a stipend) while attending graduate school in CISE; however, the amount of money you earn for a living as a graduate student is considerably less than the amount you might earn while working on a job. This may be a serious consideration if you have others to support.

Graduate school can be an extremely rewarding experience and an exciting time of both personal and intellectual challenge and growth. It is also very demanding and it requires discipline and focus. It can be a humbling experience and it is also very stressful. It is important to develop the personal characteristics (e.g., coping mechanisms, persistence, and resilience) and adequate support systems (e.g., effective mentors, supportive family and/or friends) to rely on through the inevitably stressful times. Graduate school isn't for everyone, so it is wise to be aware of and prepared for the challenges you will face. You should conduct a realistic assessment of your likelihood to enjoy and successfully complete a degree program. This involves not only your personal and social resources and your academic ability, but also the likelihood that you will enjoy research, since that is the primary focus of graduate school.

Many women and minorities tend to underestimate their abilities. Since you may be identified or self-identify as "different" from the majority, you may tend to separate yourself from the group as a way to explain your struggles. All students struggle in graduate school at one point or another. It is a difficult time. You should ask your trusted undergraduate professors and other colleagues with advanced degrees to help you in making a good assessment of your chances to succeed.

2 Working Towards Graduate School

Now that you are seriously interested in attending graduate school, how do you prepare for the next steps of choosing an appropriate pathway and becoming the most competitive applicant you can be?

Your current professors, colleagues, and employers are important sources of advice, professional contacts, and the letters of recommendation that you will need when you apply. Get to know as many of your undergraduate course professors as possible, particularly in the technical areas that interest you. A good way to interact with professors is

to take advanced undergraduate courses and, if possible, introductory graduate courses. Independent study is an excellent way to form a working relationship with a professor. This will also add depth and breadth to your background. Also, get to know the graduate students, particularly the teaching and research assistants (if they are present at your school) as they can explain the transition from undergraduate to graduate school that you are about to make. Go to these professors and graduate students and discuss your desire to attend graduate school and ask for their perspectives. Employers who provide CS internship opportunities often have technical experts who can also write letters of support that give insight into your ability to come up to speed quickly in a new technical area, to collaborate in a team setting, to problem solve, and to be self-motivated. Letters from employers outside of CS will not be particularly helpful.

One of the most important questions to ask yourself is whether you will enjoy doing research. Undergraduates often have had little exposure to research which, rather than classwork, is the central focus of the graduate school experience. However, there are an increasing number of opportunities to gain this experience while still an undergraduate. By starting to think about graduate school as early as possible, you have time to explore these opportunities. NSF Research Experiences for Undergraduates (REU's), the CRA-W/CDC Distributed Research Experience for Undergraduates (DREU), and the CRA-W/CDC Collaborative Research Experiences for Undergraduates (CREU) are examples of programs that sponsor this type of activity. Look into these programs and take advantage of the opportunities they offer. The supervising professor will be committed to working with undergrads and introducing them to the methods of doing research in their sub-discipline. Also, ask your professors in your department if they have any research opportunities for undergraduates. As Section 3 will explain, experience gained from this type of activity can also be a major selling point when applying to graduate school. Your research supervisor may get to know you well enough to provide a good recommendation letter and provide excellent guidance about the programs you are considering. Since research, by definition, doesn't always yield positive results, do not get discouraged if your undergraduate research project isn't deemed a success. It is more important that you learn about the research process and believe you'll love doing more of it.

There are several non-traditional routes to graduate school in CISE. These include returning to school after several years working in the computer industry (or another break after earning a bachelor's degree in a CISE-related field), changing disciplines from a non-CISE undergraduate major, returning to school after military service, or taking time off for personal reasons. Each has its own challenges. It is likely that you have lost contact with professors at your undergraduate institution or those professors were in an unrelated discipline. It is often a good idea to establish a current academic relationship with a professor in CISE, perhaps by taking courses as a part-time student at a local university. This has the added benefit of updating your knowledge base and skill sets to reflect recent developments in the fast-changing computing field. If it has been a long time since you have taken exams, it is a good idea to prepare and practice for the Graduate Record Exam (GRE), as GRE scores are a key factor in determining graduate admission acceptance.

After making the decision to go to graduate school, the next question to be answered is what degree you are going to pursue. This may influence how you prepare for the application process. If you are thinking of first completing a Master's degree and then (possibly) your Ph.D. degree, you should be aware that there are usually advantages in applying directly to a Ph.D. program (and receiving your Master's degree along the way) rather than presenting your plans in the more natural chronological order. Students applying for a Master's degree often are not considered for the same level of financial aid. Some Ph.D. programs require a Master's degree as an explicit step in continuing on to the Ph.D. degree. In other departments, the M.S. may be awarded as a milestone of clearing the initial hurdles in the Ph.D. process.

If you are certain that you are not interested in continuing for the Ph.D., then you should consider a "terminal" Master's program. There are basically two kinds of Master's programs available: coursework only and those with a thesis requirement. Some institutions offer a choice between the two. Your decision to pursue graduate work with or without the thesis option depends upon your career goals. If you plan to obtain an M.S. degree and then work in industry, the coursework option may work best for you, as if offers more breadth. But, if you plan to eventually obtain a Ph.D. (even if you plan to take a break between completing your M.S. degree and starting in a Ph.D. program, perhaps at another university) then you should choose the thesis option to develop your research skills. This often determines the emphasis you place on gaining research experience prior to applying.

3 The Application Process

3.1 Deciding Where to Apply

Once you decide to attend graduate school, there are many factors to consider when determining which school is right for you. The goal should be to find the right match between your goals and the program you choose. In this section, we discuss some of the questions you might want to ask and how to find those answers.

One of the first questions to consider is what areas of CISE interest you the most and then to determine which schools offer quality programs in those fields. Some students at this stage seem certain of the specific area in which they want to specialize and possibly even the professor they want as a mentor. Other students have not narrowed down their interests to this extent. This may make a big difference in your evaluation of programs. Some universities offer top-ranked programs in one area (e.g., graphics) and are relatively weak in other areas; whereas other universities are highly ranked, in general, and offer a breadth of areas, but do not have depth or a critical mass of faculty in the one area of interest to you. Since it is not uncommon for students to change interests or advisors during graduate school, some breadth is desirable in the department you choose. The "right" balance between depth in one area and overall breadth is something you should try to determine. Exercise caution in choosing a university based on working with a specific faculty member, as they may leave the institution before you finish and jeopardize your funding, research, and graduation date.

Where you do graduate work is important, since the reputation of the institution can add to or subtract from the value of your credentials upon completion. For graduate school, the national reputation of a particular department is more important than the ranking of the university as a whole. This is determined by the quality of its faculty, research facilities, research funding, and the success of its graduates.

Two sources to consult for comparative rankings of programs are the regularly published surveys by U.S. News and World Report and periodic surveys by the National Research Council. While rankings convey important information, they do not necessarily reflect centers of excellence in particular areas or new opportunities that have developed at an institution since the last survey.

Professors and graduate students at your undergraduate institution can make recommendations regarding what schools you should apply to, based on your abilities and interests as well as the latest news about departments on the academic grapevine. Professors know a great deal about the other strong schools in their area of research and have probably visited a number of them. They will know about newly hired faculty or faculty that have left and about new research directions at that university that have yet to influence the periodic rankings. If you are working, then you can seek advice from co-workers or others in your company who have earned graduate degrees in CISE. Also, many human resource departments classify and rank CISE graduate programs for recruitment purposes.

For descriptive information on degree offerings, enrollment, number of graduates, admission requirements, academic calendar, faculty size, etc., the Directory of Graduate Programs, published by the Educational Testing Service, Princeton, NJ 08541, is a good source, available in your college library. One can also search for facts about various graduate programs at the Princeton Review website. Another good resource is each academic department's website. The NSF REU program and the CRA-W/CDC DREU program (both mentioned in Section 2) are also good ways to learn about other universities, the programs they offer, and the campus life. Often you get to spend 8-10 weeks in the summer at another institution; there is no better way to get a sense if you belong in that community than living there for a short period of time.

There are many considerations that go beyond the reputation of the program. Graduate programs vary widely in size, cost, supportive environments (see Section 7), reputation, and education and research styles. You should seriously consider the type of program in which you can excel, weighing all of your options. Some questions you should ask yourself include the following:

- In what type of academic climate do I wish to study?
- What type of degree am I seeking?
- What are my academic credentials - research abilities, writing skills, GPA, test scores?
- What are my financial needs?

After you have made a personal assessment, based on advice from professors, graduate students, and/or co-workers, and based on your own knowledge of your abilities, begin compiling a list of schools that seem right for you. This

list may include schools in one of three categories: 1) highly selective dream schools, offering both depth and breadth, 2) schools that are especially strong in your narrow area of interest, and 3) schools in which you have a good chance of acceptance. This should improve the probability of acceptance into at least one graduate program and, if you tend to underestimate your ability, a better one than you may have expected.

Once you have a list of schools, gather as much information about them as possible. This involves visiting their websites to access information for prospective graduate students. For each department, list its location, size, type (major state or private university), the cultural, social, and academic environment of the campus, the percentage and number of women or minority students in the CISE graduate program, the percentage and number of female faculty members, the academic calendar (semester or quarter), and the financial aid packages available.

Prerequisites for entering specific programs and requirements for graduation are major determinants of expectations and length of time for completion. With this in mind, a careful review should be made of what is required, recommended, or optional in terms of: 1) course hours, 2) Ph.D. exams, 3) thesis/dissertation, and 4) residency.

The campus environment - the place where a student lives, studies, and gains intellectual prowess - must be conducive to self-determination and self-fulfillment, and it must allow for personal and academic growth. Thus, areas such as living accommodations for graduate students, cultural and social outlets, and collegiality of association are all critical factors in the assessment of each institution.

One important feature of graduate education - a feature that makes it uniquely different from undergraduate studies - is the close working relationship formed between the student and the thesis/dissertation advisor. The uniqueness of this relationship is such that it is imperative that: 1) the graduate program have a positive history of advising, mentoring, and graduating female and minority graduate students; and 2) the department be recognized as a place known for its appreciation and support of the intellectual capabilities of female and minority students.

Other questions to ask about the graduate program you are considering include the following:

- Does the faculty exhibit special strengths and research qualities through their graduate advisees, published works, and funded research?
- Are the libraries, laboratories, computers and other research facilities adequate for your educational needs?
- Are the graduates of the program sought by recruiters?
- Does the department of interest offer sufficiently large and varied curriculum to allow you a broad offering of courses and options?
- How senior are the professors in your area, what are their interests and what will their availability be? Do they already have a large number of students? Are they heavily involved in outside activities (e.g., startups)?
- What are the degree requirements? Number of hours of coursework required? Major exams? What are the expectations for a thesis/dissertation?
- What is the completion rate of the general graduate population? Of the female or minority graduate population?
- How long will it take to complete my program?
- Is office space available for graduate students?
- Is there a chapter of a formal association (e.g., Society of Women Engineers), a chapter of ACM-W, or an informal group (e.g., monthly luncheon) for women in the department or college?
- Similarly, is there similar support for minority students (e.g., local chapters of the National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), or American Indian Science and Engineering Society (AISES))?
- Have women students been supported to attend the Grace Hopper Celebration of Women in Computing? Are minority students supported to attend the Tapia Celebration of Diversity in Computing Conference?
- Does the faculty participate in activities organized by CRA-W or CDC? Do they serve as mentors to underrepresented groups? Are there any faculty members that belong to CRA-W or CDC?
- Does the department participate in any NSF Broadening Participation in Computing Alliance or other multi-institutional group like National Center for Women in Information Technology (NCWIT)?
- Does the department or college have a diversity committee? Does the university have a statement of diversity or an office of Diversity or Multicultural Affairs?

Once you have collected as much information as you can about the schools on your list, you should narrow the list down to a handful of schools and then start the application process. One of the best ways to get answers to many of your questions is to take the time to visit several CISE departments. Many prospective students do this in the Summer or Fall when considering where to apply. Be sure to ask to meet with graduate students and faculty in your research interest areas when you visit.

Finally, you may have personal considerations (family, health, religious, or physical) that further constrain your decision-making process. Find out as much as you can about community resources to determine how you can best accommodate these additional constraints at your chosen institutions. See Section 7 for more information.

3.2 Components of the Application and Timeline

The application process consists of requesting or locating application materials, taking the required exams, completing and submitting the application materials prior to the deadline (usually December or January), asking for letters of recommendation to be sent on your behalf, and sending letters of acceptance or rejection once you are admitted to a program.

You can begin gathering application materials as early as the summer before the last academic year before you plan to matriculate as a graduate student but no later than September. Most schools are making applications available on the web, but you should still start early to ensure you have time to gather all the materials you will need. You may choose to write a letter or email to a particular department including a statement about your interest in applying to their graduate program, a request for detailed information about the department, a request for all application materials, including financial aid, and an appointment for a pre-application campus visit.

Start organizing a file of information about this process. We recommend one folder for each school to which you are applying and a folder for your transcript(s) GRE scores, requests for letters of recommendation, and copies of your personal statement.

The graduate school application generally includes an application form, your personal statement, transcript(s), GRE scores, and letters of recommendation. The objective of the graduate admissions committee reviewing these applications is to assess and quantify your ability to conduct a successful research program within the department. Therefore, your application preparation and presentation should show a professional set of credentials that make the case for your research potential. This includes using a clear, concise, and coherent writing style and the completion of all parts of the application as directed.

The Application

Before you complete the actual application, read it thoroughly and make sure you understand everything that is requested of you. Make an off-line copy of the application and think about each item before completing the actual form. Make sure your responses reflect your interest, qualifications, and motivation to pursue an advanced degree. Once you have formulated the answers to items on the application, look it over carefully to make sure you are satisfied with the expression of your ideas. Then, complete the actual application, using your copy as a guide. When the actual application is complete, review it for content, grammar, and spelling before submitting it. Enlist a friend, faculty advisor, or colleague to help, especially if you are not a native English speaker.

Transcripts

Official transcripts are usually required when submitting an application. Your undergraduate institution will usually send the official transcript directly to graduate admissions. However, before this occurs, obtain an unofficial copy of your transcript and make sure it is correct. Request the transcripts well in advance of the application deadline so you have time to correct any problems you may encounter before the deadline for receipt of the official transcripts.

Test Scores

Results for the Graduate Record Examination (GRE) are required by many, but not all, CISE graduate admissions programs. Many schools require the general GREs (verbal, quantitative, and analytical tests) and an advanced GRE. Advanced GREs are offered in eight disciplines: biochemistry, cell and molecular biology, biology, chemistry, computer science, literature in English, mathematics, physics, and psychology. The GRE office will send you information about these advanced tests with sample exam questions. The GRE can be taken late in your junior year

but no later than the fall of your senior year. Make sure that the schools to which you are applying that require GRE scores are included in the list of schools, agencies, etc., that will receive your scores. The GREs are now given in a computerized format. It is a good idea to do a bit of preparation both for the new format and because you probably have gotten out of practice for taking standardized tests since your SATs. There are three scores reported on the GRE® General Test:

1. •a Verbal Reasoning score reported on a 200 – 800 score scale, in 10-point increments
2. •a Quantitative Reasoning score reported on a 200 – 800 score scale, in 10-point increments
3. •an Analytical Writing score reported on a 0 – 6 score scale, in half-point increments

You may want to understand what scores are considered acceptable by most institutions, especially for the advanced subject area.

If you are not a native English speaker (or come from a country where English is not the primary language), there may also be a requirement for the Test of English as a Foreign Language (TOEFL) exam. A new exam, the Test of English for International Communications® (TOEIC) was developed to measure the ability to listen and read in English, using a variety of contexts from real world settings in response to the need by multinational corporations for employees with high-level speaking and writing skills. It involves computer-delivered TOEIC speaking and writing measures that require test takers to produce responses that are subjectively scored by highly trained human raters. It is not clear if institutions are requiring the TOEIC exam, but it is helpful to be aware that it exists and what it measures.

Statement of Purpose

A very important component of the application is the personal statement, ideally tailored to each institution. This statement gives you the opportunity to elaborate on your motivation for wanting to pursue an advanced degree, your interests in the graduate program at the specific school, your technical area of interest, and your professional goals. This gives the graduate admissions committee information to assess your ability to conduct a successful research project in the environment present at the school. Research should be the central theme in this statement. Whereas good academic performance in an undergraduate program usually means getting good grades in coursework, the admissions committee will be looking for evidence of originality, creativity, problem-solving ability, inquisitiveness, independence the ability to collaborate, and good writing skills as predictors of future research success. Include in your personal statement any background work that indicates you can successfully complete a graduate research program. If you had any research experiences as an undergraduate in CISE, describe them and what was compelling to you about the experience. If you did any independent study in your technical area of interest under a professor, or had a work experience that motivated you to explore it, describe this and how it contributed to your research potential. Explain why you are interested in the given technical area, and why you think you should be admitted. Describe any relevant accomplishments. *This is not the time to be modest!* Doing your homework on each department may allow you to add a sentence or two tailored specifically to that department. For example, you may consider mentioning the research of a professor in your area of interest. The length of your personal statement should be reasonable. Many schools limit the length to a maximum number of words. In these cases, make sure you work within these guidelines. It is wise to write a rough draft of this statement and have several of your professors or co-workers critique it. Take their advice seriously and rewrite it according to their suggestions. Once you are satisfied with its contents, proofread it thoroughly (using a spell and grammar checker if at all possible) before submitting it. Be especially careful when cutting and pasting one set of information into another, as you may inadvertently put the name of the wrong institution or faculty member in your application materials, which will be a sure signal to the receiving institution to reject your application.

Letters of Recommendation

Another important component of the application is the set of letters of recommendation written for you. Many graduate admissions programs require at least three letters of recommendation. Approach professors who know you and your abilities. It is very important that all of your letters of recommendation are positive. Ask potential letter writers if they feel they are able to give you a positive recommendation. Although this may be awkward and difficult, it is imperative that you know that positive letters of recommendation are included in your total application. Otherwise, you may have excellent credentials, stellar GPA and GRE scores, a concise and well-written personal statement, but a negative or lukewarm letter of recommendation from a well-known and respected researcher in your area of interest. If that is the case, you will probably not be admitted to the graduate program. A

good letter has to say more than the fact that you received an "A" in some class you took from them. *Give the letter writers all the pertinent information needed to write an effective positive recommendation such as a resume, your personal statement, and the schools' instructions for letter writers with criteria they are using for admission.*

There is some evidence that letter writers sometimes subconsciously write a different kind of letter for women than for men, emphasizing their positive "feminine" qualities (e.g., cooperation) instead of other qualities they have which may be perceived by some readers as more important for graduate success (e.g., ambition). Ideally, you may know your letter writers well enough to have a conversation about this issue. Describe yourself in the documentation you give to your letter writers in the same way you would like them to describe you in their letters. If you set the tone, they may follow suit.

It is often the case that employers do not provide the kinds of letters expected by academics. Again, if possible, have a conversation about what elements you would like them to incorporate into their letters. For example, discussions of your creative contributions to a project are more compelling to admissions committees than many performance metrics that may be quite important for your current job but do not suggest research potential.

The writer should be given a list containing the name and address of each school to which you are applying, your technical area of interest, and the application deadline. Many letters are now submitted on-line and the letter writer will be provided the URL of a secure website at which to submit the letter. If that is not the case, supply the letter writer with a correctly addressed, stamped envelope to send the letter as well as any forms required. Make your request known to the letter writer well in advance of the application deadline (at least a month). Approximately two weeks before the deadline, follow-up with each letter writer with a reminder to make sure the recommendation has been or will be sent on time.

Once you have completed the entire application, review it thoroughly and make copies of everything before submitting it. Having a copy of the application will expedite the re-application process if needed for any reason. Make sure you receive the acknowledgements you expect. *If you do not receive a timely notification of successful receipt of your application materials, contact the department to verify that the entire application package has been received.* The Educational Testing Service will inform you when your GRE test scores are sent to the schools you have chosen. Make a copy of the application and place it in the file folder you have for the specific school. When you receive acknowledgements, also store them in this folder.

5 Financing Graduate Study

Funds for graduate study are available. Most departments support their Ph.D. students with both tuition and a stipend to live on. Master's students may not be offered such support. However, there are numerous sponsorship, scholarship, and fellowship programs available. Even if you expect funding from the Ph.D. program that admits you, there are good reasons to seek out and apply for various fellowship programs. Independent funding gives you flexibility and more freedom in choosing research advisors. If granted prior to admission decisions, an outside fellowship can also make you more attractive to admissions committees.

Make a list of all the graduate funding programs available. Seek advice from the graduate financial aid office at your undergraduate institution. You can also seek advice from the graduate financial aid offices of the schools to which you apply. Read graduate study announcements and department bulletin boards. Talk to faculty. Go to the reference section of your school's library or of your local public library. There is generally a plethora of information available in these reference sections on graduate financial aid.

See the resources in Section 8 for a list of organizations and programs offering financial aid in CISE.

There are two basic types of graduate school aid available; fellowships and assistantships. A fellowship is a form of financial aid that is similar to a scholarship. It is a grant of money for which no work is required. A fellowship can cover all or part of tuition and it may include an additional stipend for living expenses. Fellowships are awarded based on merit and they may be offered by universities, but most are through organizations outside the university such as private industry, foundations, and the government. Many corporations that sponsor fellowships also provide paid summer internships. There is usually no requirement to work for the company or organization after graduation; however, a successful internship may result in an offer of permanent employment.

An assistantship is a form of financial aid in which the student is required to work. The work is often related to the student's studies or areas of interest. There are two types of assistantships; research (RA) and teaching (TA). RAs

pay the student to assist a professor in a research project. To be chosen as a RA is prestigious and an RA has several advantages. You are directly associated with an ongoing research project and you may be able to formulate your thesis or dissertation topic as a result of the work. You may also be able to conduct some of the research for your thesis. Another advantage is the fact that you are working with someone who may be well respected in the field. Published papers that result from the work will include your name associated with this respected individual. If these papers are presented at a conference, you may have the opportunity to present the work and make contact with others working in the field.

TAs pay the student to assist in a professor's course or to teach low-level undergraduate courses. Assisting a professor may require grading problem sets or examinations, overseeing laboratory courses, teaching tutorial sessions related to the course, and/or providing office hours to explain problems relating to the course. Many graduate students in CISE are supported by assistantships available through the department. They are usually awarded based on merit (academic potential and performance as assessed from your application). Many schools require all students to teach at some point as training for academic positions they may apply for upon graduation. Academic teaching institutions will be especially interested in seeing this experience in your application. Gather information about graduate aid during your junior year or the summer preceding your senior year. Many programs have early deadlines (November or December of your senior year) so you should locate or request application materials during the summer and no later than September of your senior year.

Funding can only be awarded to those who apply. Many programs do not have an effective program for finding you, so you must be diligent in finding them. In fact, many funding programs do not award as much aid as they would like to because students do not apply. Apply to as many programs for which you are eligible to apply as possible, taking care to keep the quality of each application high. Once again, make copies of everything before submission and add the copies to your files.

5 Evaluating your Offers

Graduate admissions usually notify you of their decision by March or April of the academic year prior to your matriculation. Once offers of admission and financial aid go out, it is time to make the final choice of the one program you will attend. When you are accepted into a graduate program (especially more than one program), a primary factor to consider is the financial aid package offered to you. This is also the time to think seriously about the offers. You may want to go to your professors or co-workers again and ask for their advice. They will be pleased that you have been accepted into a graduate program and more likely than not, will be happy to offer advice on the reputations of the specific programs. Try to find someone who has graduated from the graduate program of that department and seek their advice and discuss with them their experiences.

Many departments now host visits for prospective graduate students who have already been offered admission into their programs in March or April prior to the deadline for making their decision (which is traditionally April 15). Schools may even offer to reimburse travel expenses for such visits. Visit if possible, even if you visited before when you were trying to decide where to apply. You will see the department with a new perspective now knowing that you have been accepted.

Some schools will encourage all the accepted students to visit on one or two designated dates. On those days, the professors have arranged their schedules to have more time to meet with prospective students. It also allows you to meet the other students who might become your new classmates.

Visiting and talking with faculty and current students is one of the best ways to assess the academic climate for women and minorities at that school. There is no better way to judge the qualitative aspects of the program that do not show up well on paper. Are the students, especially the women and minority students, happy, and making good progress in their research and path to graduation? Are the faculty members in your area people that you think you could form a working relationship with? Are the women in the department visible and respected members of the community? Do you sense camaraderie and collaboration, or do you sense antagonism and competition? Trust your gut feelings -- do you think you will feel comfortable and be productive in that department?

If you can't visit, make sure to find out everything you can about the graduate community and the individual professors in the department. You can call or correspond by email with professors you think you might want to work with. Ask questions of current graduate students in the department by email or phone. It's often the graduate students who will tell you what really matters in the program. They can tell you what it is like to work with certain

professors. Don't be afraid to ask about the things that are important to you about the environment and the people in the department.

You should make your decision in a timely manner. It is great to have multiple offers, but it may not be easy to narrow the choices down to just one. It's helpful to realize that there isn't one "right" answer and that you will probably do well at any of your top choices.

Once you have made your decision, you should notify your school of choice of your decision to accept and of your intention to enroll. Notify the institutions you did not choose and thank them for considering your application. A timely response is important because the schools you do not choose may quickly offer this slot to someone else. And finally, write thank-you letters to all the people who contributed to your success, and aided you in your job search, especially those who supported you from afar. It’s a treat to get a letter from a student thanking you for the time and effort you devoted to them.

6 Transitioning to and within Graduate School

6.1 What, More Coursework?

Most students enter graduate school as very accomplished coursetakers, with a small amount of undergraduate research experience. Especially with the Ph.D. degree, the goal is to leave as an independent researcher and an expert in your topic. While different schools and degree programs vary a great deal in the formal academic hurdles for obtaining your advanced degree, the series of transitions to go from a student to a researcher follow a common path.

Often the first couple of years of a Ph.D. program and a Master's degree program are similar. This period is likely to involve coursework to acquire breadth in the field and depth in some area. The structure of the curriculum and coursework requirements reflect the balance between breadth and depth for that program.

In a sense, the student coming straight from their undergraduate degree may feel in familiar territory with classes, course projects, and final exams (along with familiar habits like cramming for exams and a focus on high grades). A necessary aspect of the transition into grad school is to recognize that the purpose of the coursework is to prepare the foundation for research (i.e., gaining the background for depth in your area) and for membership in the scholarly community (i.e., a broad awareness of the other areas in the field). Achieving straight-A grades is usually considered less important.

This phase is often culminates in an exam, called the qualifying, preliminary, or comprehensive exam, to demonstrate that the student has acquired breadth in the field. This exam may be written, oral, or both and each student prepares for it independently. The exam is usually taken after the completion of formal coursework; however, many graduate programs require that you initially take this exam during the first year of your graduate program. Some schools offer these exams in pieces with sub-exams taken at the end of the semester when the relevant courses are taught. Students who ultimately successfully complete their Ph.D. degrees may fail on the first try.

One danger of the comfort zone of coursework is that some students lose sight of the need to move toward research. During this early phase, many programs have explicit requirements to push this transition forward. There may be an early research requirement or a master's thesis to demonstrate research ability. This requirement may take the form of a project that need not have anything to do with the eventual dissertation topic or a rotation through several research groups. Actually earning a master's degree may be an explicit requirement for continuing on to the Ph.D. (even if the student entered the program with an M.S. completed elsewhere). Alternatively, a master's may be awarded as a milestone of clearing the initial hurdles in the Ph.D. process.

To obtain a "terminal" Master's degree, schools may require coursework only or coursework with a master's thesis. In M.S. programs that only require course work, there is usually a requirement to take a number of in-depth courses in your area of interest, as well as courses outside your area for breadth. You may also take a few additional courses, including an option to do independent study or complete a minor. There may also be an exam covering some core curriculum in this option. M.S. programs that require a thesis also typically require both depth and breadth courses.

6.2 Time Management, Organization, and Planning Skills

Developing excellent time management, organization, and planning skills during graduate school is imperative. You've already gotten a taste of this in putting together your applications materials, managing all the deadlines, and keeping track of the status of each application. A good practice is to use a calendar for every event that important to your success and balance. Many electronic calendar tools sync with your phone or handheld device and can be invaluable in reminding you of important dates and deadlines. Procrastination is a sign that you are struggling with a task or activity that will inevitably need to be addressed, and may be defocusing and demotivating until it is completed. Introspect on the areas where you tend to procrastinate and develop some good practices for self-motivation and support to help you get through them with the minimum of stress.

Note that teaching assistantships may be more time intensive than research assistantships – you may run into students in the grocery store or as you are working on your own research and be torn between the two responsibilities. Keep the conversations focused and encourage them to seek you out during office hours. You may also be asked to serve in leadership roles on graduate committees or student organizations that are time intensive. While these activities will build your skills and help you grow your network, define clear roles and responsibilities and take on only as much as you can commit to delivering. Learning to say no is difficult to do, but letting others down by taking on too much responsibility that you cannot deliver with quality will sap your self-confidence and damage your credibility. Work on small successes that build upon each other and you will demonstrate your ability to handle the larger ones while establishing a reputation as reliable and responsible.

6.3 Choosing a Research Advisor and Topic

Identifying the Research Topic

The next step is to choose an advisor and find an area that will lead to a promising dissertation topic. This phase culminates in a thesis proposal that will convince your research committee that it is a project worth doing and that you are ready to do it. A Ph.D. student is usually required to present a written dissertation proposal to their research committee and defend it in an oral exam. The committee generally includes your research advisor, other professors in your chosen research area, and some outside your area. Different schools have different procedures for selecting members of this committee. They range from permitting you to select all of the members of your committee, following certain guidelines, to having the members of the department and the graduate school appoint members of your committee. Often, one member must be from outside your department, and is often from outside your university.

This can be a stressful transition period for several reasons. First, you are entering a period that lacks the structure of coursework. You have to manage your own time without the due dates and scheduling of classes. You have to avoid distractions or allowing other "required" activities (e.g., your TA duties) to expand into distractions from your research.

Second, there is a lot of uncertainty in identifying a topic and scope. You are venturing into the unknown in many respects. A dissertation seems to be a huge, daunting project. The usual definition is that a dissertation is an independent project that makes an original contribution to the field. But, it may not yet be clear to you exactly what the scope of that original work should be. Since you are still learning how to do research, you may not feel like you know how to proceed. There is much survey work to understand, and tracing the origin of the research without knowing where to prune the search may result in an ever expanding list of reading. Further, research does not always work out as expected. Other researchers may be working on the same problem elsewhere and "scoop" you (i.e., solve the problem you had carved out as yours to solve). This uncertainty looms large while choosing a Ph.D. topic.

During this phase, the student engages in a number of concrete activities that can lead toward a topic idea. You will be reading many papers in the literature to familiarize yourself with the field and, later, to stay current with new work. In reading these papers, read critically and pay attention to all aspects of the work, not just the results. How do the authors pose the problem? What are their assumptions? What methods are used in the solution and in the evaluation of the idea? Is the proof or evaluation valid? Do the assumptions still hold? You should also read a couple dissertations to understand what is required. What is the "size" of the problem the author is trying to solve and of the contribution finally given (the solution is often just a part of the grand vision initially given)? The future work section may be a good starting point for unsolved problems. You may be tempted to work in an area that has already received a lot of research attention, and avoid areas that are fertile, but lacking in published research; each

approach has advantages and disadvantages. Keep a good annotated bibliography of everything you read so you can remember and refer to each paper later. You should also interact with researchers doing related work and stay aware of what they are doing. Keep track of such "private correspondence" in your bibliography along with their papers.

A good Ph.D. problem is timely and important, unsolved, feasible to tackle, and interesting to your chosen advisor. Some advisors will have an on-going research project and expect you to work on pieces of it. This may lead directly to a Ph.D.-level topic that builds on their previous work or the experience may inspire a different direction. There are some advisors that will hand a student a topic and others who will encourage the student to go through the process of identifying a topic on their own (with guidance). The challenge is to stay actively engaged working on manageable sub-problems and trying things out. It is unlikely that you will think of a good dissertation-scale topic by sitting alone and waiting for inspiration to strike.

The master's thesis presents a scaled down version of the process described above. The project is usually smaller in scope and the problem to be addressed is usually more well-defined. There is usually less uncertainty surrounding the master's research project. The thesis itself is a research document that is presented as one of the final fulfillments for obtaining a Master's degree. You may also be required to have a research committee that oversees your research. You may be required to present a proposal to this committee. The proposal is generally a description of the type of research you wish to pursue and a presentation of some details about how the work will be conducted and the results you hope to achieve. Once you have completed your research work and you have completed or are near the completion of the writing of your thesis, you may be required to defend your work. The defense may take one of several forms, such as a lecture on the thesis topic, a formal oral examination of your work or some combination of the two. Once you have passed this defense and completed the required coursework, you have completed all the requirements to obtain the M.S. degree.

The Advisor-Student Relationship

A major figure in the life of the graduate student is the research advisor. The relationship you establish with your advisor is vital to successful completion of your graduate program. Therefore, it is of utmost importance that you do your homework when selecting an advisor. There are basic questions that should serve as a guide to you in selecting your advisor.

- Is the faculty member in a position to share her or his time and advice? Graduate level faculty are expected to accept new doctoral students; however, because of tenure status, research or resource constraints, and other factors, they may not be willing to take on additional students at this time. You may not want an advisor with too little available time to give you the attention you need. If your potential advisor does not have tenure but is up for tenure review in one or two years, there is the possibility that the individual may not get tenure and leave while you are in the middle of your research program. It may be possible to assess the faculty member's tenure prospects by talking with various faculty members within the department. You may want to seek their advice and opinions before making your decision.
- Does the faculty member have a reputation for producing high quality research? A part of the thesis process and a major part of the doctoral process is the development and completion of an original research project that is worthy of publication in conference proceedings or journals in your technical area. Your advisor's research expertise and laboratory output will be crucial to your research productivity. Having an advisor with a good reputation in the field will be beneficial to you when completing your studies (particularly for those in Ph.D. programs). A well known advisor will result in an increased marketability for academic and other research positions upon graduation.
- Is the faculty member's current research area of interest to you and in keeping with your graduate study goals? If your research interests are totally opposite from those of the faculty member, then this is probably not a good choice. An effective research alliance requires commonality of interest. If you find that you have a good rapport with a faculty member who is not conducting research in your area of interest, then you may want to establish another form of mentoring relationship with that faculty member. For example, you may be able to obtain professional advice from this faculty member.
- Is the faculty member known to be a good mentor to graduate students? Talk to current students of the faculty member to learn about their mentoring. What does this advisor do to ensure graduate student success? Are students progressing in their degree programs and writing publications, ideally as first or

second author? Do they have opportunities to attend professional conferences to present their work? Is research funding consistent year to year? Does the faculty member maintain good working relationships with other members in the department, outside of the department, and outside of the university?

- Do you and the faculty member communicate effectively? This is important in forming a good working relationship with your advisor. Are your communication and working styles compatible?
- Is the faculty member sensitive to the concerns and problems many women and/or minorities face as a graduate student? The small number of underrepresented graduate students in CISE sometimes results in feelings of isolation. Women also encounter a number of other problems which fall disproportionately within a woman's domain. Ideally, you may wish to have an advisor who is aware of the unique problems you may encounter and who will provide a supportive environment. If this is not the case, you will have to seek supportive mechanisms elsewhere.

6.4 Completing the Dissertation Research and Writing

Research Proposal and Research Completion. Once the topic is defined and the research approach is understood, the next phase is to complete the dissertation research and write the final dissertation document. Along the way, you will write and defend a written research proposal in which you outline your research plan. This is typically written after you have some preliminary research and evaluation to establish your expertise and demonstrate the feasibility and promise of your research strategies. The timing of the research proposal varies with different advisors and research areas. For some, they are written early in the research process to obtain early feedback from your dissertation committee, while for others, they are written after considerable research has been completed. This document serves as a guiding plan for completing your research. At this point in your graduate studies, the uncertainty and anxiety levels may go down to be replaced by the problem of maintaining motivation, momentum, and focus of working on a single problem for an extended period of time.

Dissertation Document. In some projects, the research is performed before the writing starts. In others, the two activities overlap, with written sections clarifying the remaining work to be done and new results providing improved text for sections already written. The actual process rarely reflects the linear nature of the resulting document.

The dissertation document varies in form and length, depending on the technical area and the type of research involved. It is designed to show a mastery of the subject matter and of research tools. It should contribute something new to the field. The entire process can take 3 to 5 years to complete.

Final Oral Defense. Once the research is completed and a draft of the dissertation is written, the student is usually required to conduct a defense (or oral exam) of the work. In most instances, you will be required to discuss your work, including your methodology, results, and conclusions. You must defend the methodology and accuracy of these results as well as their significance and original contribution to the field. After passing this exam and polishing the final document, the student usually has completed all the requirements to receive the Ph.D. degree.

6.5 Joining the Research Community

The official degree requirements as listed in the university catalog are not the whole story involved in earning a Ph.D. degree. You will be writing workshop and conference papers for submission and presenting talks or posters at those conferences. You may also be writing journal papers on your dissertation research while still in graduate school. It is important that you begin to build a professional network within your research area. These are people who will know you and your research contributions, potentially collaborate with you, mentor you, and possibly write letters of recommendation for you. Networking can occur within your university and particularly at conferences and workshops that you attend. Be sure to ask your advisor to introduce you to researchers in your area and mingle with researchers at all levels in your research area -- graduate students through senior researchers. You will be collaborating with your research group and networking to form relationships with colleagues elsewhere. It is likely that you will be interviewing for jobs before your thesis is done.

7 Avoiding the Pitfalls

7.1 Common Pitfalls

At some point in your academic career, you may find yourself struggling with self-doubt and questioning your competence. Early successes may come too easy and are difficult to reproduce, and periods of unproductiveness may cause you to question whether you belong in graduate school. The imposter syndrome is characterized by feelings of inadequacy that persist in the face of evidence to the contrary, and is prevalent among women and minorities who are in fact, high achievers. With the imposter syndrome, success is often attributed to luck rather than hard work, and there is a tendency to over-internalize failure. This may result in the constant fear that at some point, a student will be "found out" and exposed as an imposter. There is great effort expended by the student to compensate for this perceived deficit by preparing for every possible question or outcome. The anxiety that results can put a strain on interpersonal and work relationships. For those without strong parental support or role models, it can be crippling, and cause an otherwise talented researcher to drop out of graduate school altogether.

It is critically important to have a strong support system so that you can get a reality check to maintain perspective and balance. The inner critic in all of us may take several forms – the perfectionist (nothing is ever right), do-it-all-yourself driver (no one can do it quite like you can), fake/fraud/imposter (you'll be exposed at any instant), pleaser (allow self worth to be defined by others), comparer (never as good as the others are), and worst of all, the committee of critics that all chime in together. Work to increase your awareness of which critic you are facing, and name them. Listen for what is useful in the critic's message, and why this information is important to you. Give yourself some room to succeed by setting realistic and achievable goals, instead of setting yourself up for failure by choosing impossible ones. At some point in your study, you will be pushed to admit that you don't know something, but you do know how to find it out. It is a good practice to prepare for meetings, but there is no need to anticipate every possible question, nor overanalyze every response. Sometimes, the best defense is a good offense, and you can turn the question into a larger reflection on the topic, and an opportunity for others to contribute further exploration and collaboration.

Finally, there is life outside of work, and striking a balance between your private time and your research time is critical to managing stress, maintaining a healthy lifestyle and a positive perspective. Taking time to socialize and network helps you relate to and connect with your colleagues and faculty in a way that builds trust, rapport, and reciprocity in your research efforts. Savor your successes and the successes of those closest to you. The bonds that you build in graduate school will likely sustain you through your early career and beyond.

The period of transition from the familiarity of coursework to the unstructured nature of research is a stressful time for most graduate students. It may help to realize that almost all students experience the doldrums sometime during the middle years of the program. Unfortunately, many of the men will not talk about it and many women may still feel they are alone with these feelings.

7.2 Gender Specific Issues and Support

As stated above, women may encounter challenges in graduate school in CISE that are unique to their gender. Women sometimes are more deeply affected by any of lack confidence and react differently to the common problems that all graduate students experience (e.g., transition to graduate school). If you do not find a support mechanism, it may be very difficult for you to complete your degree requirements. Remember that you are there to be trained and not expected to have all the answers and nor to be aware of the research process initially.

As discussed in the previous section, the transition period can be challenging. The nature of this period can undermine anyone's identity, and women often have lower self-esteem to begin with. Add to these emotional challenges a sense of isolation and lack of role models, family responsibilities that fall more directly upon women, including harassment and blatant discrimination.

While all graduate students deserve a positive environment, women are often more attuned to this need and should be proactive in seeking a support structure to deal with such issues. Before you begin the program, you should do some research to determine if the department or the graduate school provides some means of support and encouragement. For example, there may be a formal Women-in-CS program that pairs female faculty, other sensitive faculty members, or more advanced graduate students with new women graduate students for mentoring or other support. There may also be informal programs where female graduate students and/or faculty meet on a

regular basis (for example, lunch once a month) to discuss problems and other issues they encounter, and also to discuss their technical work. Some CISE departments provide some kind of support for the special needs of female graduate students such as child care. If you are not aware of these programs when you arrive, ask about them. If they do not exist in your department, you may want to start an informal group. If there are few women in your department, you may try getting together with women in other technical disciplines such as engineering or the physical sciences. To get more exposure to women role models, you might propose women speakers be invited for your departmental colloquia or you may ask to be supported to attend conferences such as the Grace Hopper Celebration of Women in Computing or the CRA-W Grad Cohort Workshop where you can meet many other women in the field.

7.3 Minority Issues and Support

Many minority students complete their undergraduate degrees in minority serving institutions (MSI), also known as Historically Black Colleges and Universities (HBCUs) and Hispanic serving institutions (HSIs). However, there are few of these institutions with PhD programs in computing. As a result, many minority students continuing to graduate school in computing face a culture shock when moving from an MSI to what is typically referred as a predominantly White institution (PWI). Research has evidenced transitional difficulties for minority students who attend graduate school at a PWI. Among the many reasons that have been cited for these transitional difficulties, personal, academic and social adjustments have been targeted as areas in which most problems may arise if minority students are not prepared for the change.

Support systems are very important for minority students entering graduate school at a PWI. In general, the absence of social, academic and personal support systems has led to high attrition rates for minority students attending school at a PWI.

All students experience some form of personal adjustment when entering graduate school. Minority students being immersed into a majority culture may be more prone to experience transitional difficulties that may cause personal distress due to issues of acculturation and assimilation. On a personal level, manifestations may include symptom associated with depressive and adjustment disorders (e.g. feelings of isolation, periods of sadness, lack of interest to engage, feeling anxious, depressed moods). It is vital that minority students considering a PWI for graduate studies have and continue to develop a strong personal support system involving people who are close to them (e.g. family members, romantic partner, friends, religious leaders) who can objectively help with personal adjustment issues as the arise. As well, they should make themselves aware of campus resources (e.g. counseling center, mentors, and advisor) that could be accessed in the event of personal maladjustment during graduate studies at a PWI. Seeking out other resources (e.g. ethnic stylists and barbers, restaurants, groceries, and stores) prior to arrival at a PWI may be helpful as well.

Academic adjustments are typically not as problematic as personal adjustments for minority students attending a PWI for graduate school. However, African American and Hispanic graduate students at a PWI for graduate school who attended an HBCU or HIS may have some difficulty due to differences between the two institutions of higher learning. Most African American students who complete their undergraduate studies at an HBCU or HIS may be accustomed to close personal relationships with students, faculty and administration. Because the atmosphere at an HBCU or HIS fosters community and collaboration, some difficulty may arise at a PWI due to the individualistic nature of the academic environment. African American and Hispanic students considering graduate studies at a PWI should prepare themselves for an independent academic experience, though there are many opportunities for collaboration on these campuses. Unfortunately, African American and Hispanic students may experience prejudice in seeking such opportunities just as women may experience gender discrimination. Though the policies of most PWIs reject prejudice and discriminatory practices, the reality is that they still exist amongst students, faculty and administration. Awareness is vital as well as knowledge of procedures to address this issue.

Though graduate school is academically focused, there will be the need to have a social life. Many minority students attending a PWI for graduate school find social life challenging due to a lack of social networking opportunities or social experiences solely based upon the interests of the majority culture. Because races, ethnicities and cultures socialize in various/different patterns, it is vital that minority students considering attending a PWI in a predominantly White geographical region establish a strong social support system while there. Outlets for socialization are important for personal balance to relieve stress and to take care of the need for human social interaction. Before deciding where to attend graduate school, it is advised that minority students research social opportunities (e.g. ethnic clubs/lounges, festivals, hangouts, religious organizations). This will allow for some

immediate social adjustment opportunity upon arrival instead of having to seek out these opportunities blindly. Sometimes obtaining basic services is a challenge. For example, African American women at a PWI might experience difficulty finding make-up that matches their skin color. African American and Latino women might find it hard to find a hair stylist that knows the type of style they prefer. Latinos will find it hard obtaining spices used in cooking traditional Latino cuisine.

Overall, minority students considering attending a PWI for graduate studies need to be prepared to face some adversity. This adversity can be overcome by researching and seeking out opportunities prior to arriving at the PWI. More importantly, establishing personal, academic and social support systems is paramount in helping to adjust positively to their new environment.

7.4 Conclusion

Earning a graduate degree in CISE can be a very empowering process. It is possible that the intense intellectual enlightenment associated with this process may not be repeated at any other point in your life. It can be a very exciting time. However, it is also a humbling experience that can be very stressful. This guide outlined the graduate school process for women and minorities in CISE. The overview presented here is designed to educate you on this process, and to highlight some of the advantages and disadvantages of pursuing a graduate degree. Also discussed were some of the formal and informal programs you can use to provide a supportive environment that is conducive to conducting a successful independent research program while enjoying your life.

8 Additional Resources and References

Below is a partial resource list of organizations and programs offering financial aid in CISE, as the list changes frequently. See http://www.finaid.org/scholarships/prestigious.phtml for a more extensive and up-to-date list.

1. The Alliance for Graduate Education and the Professoriate (AGEP) seeks to join together universities and colleges in the common mission of increasing the number of underrepresented minority students earning PhDs and positioning minority students to become leaders in science, technology, engineering and mathematics (STEM) fields. See http://www.agep.us/.
2. The National Science Foundation's Graduate Research Fellowship Program (GRFP) helps ensure the vitality of the human resource base of science and engineering in the United States and reinforces its diversity. The program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based master's and doctoral degrees at accredited US institutions. The NSF welcomes applications from all qualified students and strongly encourages under-represented populations, including women, under-represented racial and ethnic minorities, and persons with disabilities, to apply for this fellowship. See http://www.nsfgrfp.org.
3. The mission of The National GEM Consortium is to enhance the value of the nation's human capital by increasing the participation of underrepresented groups (African Americans, American Indians, and Hispanic Americans) at the master's and doctoral levels in engineering and science. See http://www.gemfellowship.org.
4. Through its Fellowship Programs, the Ford Foundation seeks to increase the diversity of the nation's college and university faculties by increasing their ethnic and racial diversity, to maximize the educational benefits of diversity, and to increase the number of professors who can and will use diversity as a resource for enriching the education of all students. See http://sites.nationalacademies.org/pga/fordfellowships.
5. The Hispanic Scholarship Fund's (HSF) mission is to strengthen America by advancing the college education of Hispanic Americans. The organization delivers a range of programs to Hispanic families and students through community outreach and education, affordability via scholarships, college retention and career opportunities. See http://www.hsf.net.
6. The AT&T Labs Fellowship Program (ALFP) offers three-year fellowships to outstanding under-represented minority and women students pursuing PhD studies in computing and communications-related fields. AFLP fellows are partnered with a technical staff member to serve as their mentor for the duration of the program. The program emphasizes personal interaction between the ALFP fellow and their mentor. For the typical recipient, this personal interaction with a mentor is often the most important component of the program. See http://www.research.att.com/evergreen/working_with_us/internships.html.

7. The Hertz Foundation Graduate Fellowship empowers outstanding young people pursuing a PhD degree in the applied physical, biological, and engineering sciences with the freedom to innovate and explore their genius in collaboration with leading professors in the field. See http://www.hertzfoundation.org/.
8. The IBM Ph.D. Fellowship Awards Program is an intensely competitive worldwide program, which honors exceptional Ph.D. students who have an interest in solving problems that are important to IBM and fundamental to innovation in many academic disciplines and areas of study. These include: computer science and engineering, electrical and mechanical engineering, physical sciences (including chemistry, material sciences, and physics), mathematical sciences (including analytics, statistics, operations research, and optimization), business sciences (including financial services, risk management, marketing, communications, and learning/knowledge management), and service science, management, and engineering (SSME). See https://www.ibm.com/developerworks/university/phdfellowship.
9. As future leaders, with a lasting understanding of British society, Marshall Scholars strengthen the enduring relationship between the British and American peoples, their governments and their institutions. Marshall Scholars are talented, independent and wide-ranging, and their time as Scholars enhances their intellectual and personal growth. Their direct engagement with Britain through its best academic programs contributes to their ultimate personal success. See http://www.marshallscholarship.org.
10. The NASA Graduate Student Researchers Program (GSRP) is an Agency-wide fellowship program (also called GSRP Training Grants in what follows) for graduate study leading to masters or doctoral degrees in the fields of science, mathematics, and engineering related to NASA research and development. In 2011, NASA is expanding GSRP to include students that are interested in becoming teachers or education administrators. This twelve month award requires students to participate in a 10 week NASA Center or HQ-based research experience at the NASA Center/HQ extending the GSRP Fellowship award. See http://fellowships.hq.nasa.gov/gsrp/nav.
11. As a means of increasing the number of U.S. citizens and nationals trained in science and engineering disciplines of military importance, the Department of Defense (DoD) plans to award approximately 200 new three-year graduate fellowships in April 2011, subject to the availability of funds. The DoD will offer these fellowships to individuals who have demonstrated the ability and special aptitude for advanced training in science and engineering. See http://ndseg.asee.org.
12. The National Physical Science Consortium is a partnership between government agencies and laboratories, industry, and higher education. NPSC's goal is to increase the number of American citizens with graduate degrees in the physical sciences and related engineering fields, emphasizing recruitment of a diverse applicant pool including women and minorities. See http://www.npsc.org.
13. The Rhodes Scholarships, the oldest international fellowships, were initiated after the death of Cecil Rhodes in 1902, and bring outstanding students from many countries around the world to the University of Oxford. The first American Scholars entered Oxford in 1904. See http://www.rhodesscholar.org/home.
14. The Sloan Research Fellowships seek to stimulate fundamental research by early-career scientists and scholars of outstanding promise. These two-year fellowships are awarded yearly to 118 researchers in recognition of distinguished performance and a unique potential to make substantial contributions to their field. See http://www.sloan.org/fellowships.
15. Xerox Minority Scholarships - Xerox is committed to the academic success of all minority students. That's why we offer a Technical Minority Scholarship that awards between $1,000 and $10,000 to qualified minorities enrolled in a technical degree program at the bachelor level or above. See http://www.xeroxstudentcareers.com/why-xerox/scholarship.aspx.

Useful Publications:

1. R. Azuma, "So long and thanks for the Ph.D.! Everything I wanted to know about C.S. graduate school at the beginning but didn't learn until later."
2. A set of articles that have been published in the ACM *Crossroads* magazine about graduate school including:
   P. Arge, "Advice for Undergraduates Considering Graduate School"
   M. desJardins, "How to Succeed in Graduate School" Part 1 and Part 2.
   R. Pottinger, "Choosing a Ph.D. Program in Computer Science"
3. Graduate Educational Resources from ACM *Crossroads.* Robert L. Peters, *Getting What You Came For* (Noonday Press, 1992)

Acknowledgements

This guide is based on an early document written by Sandra Johnson Baylor and revised in 2000 by Carla Ellis and Ann Redelfs. This new version adds material that has been created for the CRA-W Grad Cohort workshops, a program created by Mary Lou Soffa and Mary Jane Irwin along with the contributions of many presenters over the years. Quentin Alexander (a graduate student at Virginia Tech) contributed material specific to minorities. We thank Jan Cuny for encouraging and supporting the updating of this guide.