

Diversifying the Images of Computer Science: Carnegie Mellon Students Take on the Challenge!¹

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Abstract -- This paper tells the story of two student initiatives, driven by a desire to diversify the images that surround computing-related disciplines and those who work in them. We believe it may hold some useful pointers for those interested in showing that computer science is so much more than “coding”. It offers easily adaptable models for those interested in launching outreach programs to encourage more girls and women (and boys and men) to participate in computing-related fields.²

Women@SCS³ students, at Carnegie Mellon, were particularly concerned that so few images of computer science showed the breadth and excitement of the field and its potential for diverse participants. They saw this as a challenge --and an opportunity --to develop new outreach endeavors aimed at changing how computing-related fields are perceived in the public consciousness.

Their first initiative generated an outreach presentation, the Women@SCS Roadshow, which tackles two important questions: “Who can be computer scientists?” and “What can you do with computer science?” The second initiative set in motion a weekly series of technology skills workshops called “Creative Technology Nights for Girls”. These initiatives are planned and presented by women students who share their enthusiasm and technology know-how with their audiences. In this way they challenge stereotypes and promote new images of computer science and related disciplines.

Introduction

Over the past few years we have become well aware of the declining numbers of girls and women entering the computer science (CS) major. The problem has been well researched and documented, and disseminated in such well known articles as Tracy Camp’s “The Incredible Shrinking Pipeline” [Camp, 1997] and “The Incredible Shrinking Pipeline Unlikely to Reverse”

¹ A much shorter version of this paper, with a similar title, was presented at the 2005 SIGCSE conference

² While the focus of this paper is computer science we are also using the term “computing-related fields” as we believe these

outreach initiatives lend themselves to other areas and especially to engineering.

³ For more information about the organization, Women@SCS, please browse the web site:
<http://women.cs.cmu.edu/>

[Camp, 2000]. In 2005, Computing Research News reported that this downward trend has continued at an alarming rate: “the proportion of women who thought that they might major in CS has fallen to levels unseen since the early 1970s.” [Vesgo, 2005]

More recently the issue of declining numbers of students has been felt across the board, as fewer men, as well as women, make the decision to enter the CS major. The 2002-2003 CRA Taulbee Survey shows that enrollment in undergraduate CS programs in the US has dropped by more than a quarter since 2001.[CRA 2002-3] The situation has triggered debates and discussions within CS communities across the nation. In “The Incredibly Shrinking Pipeline Is Not Just for Women Anymore”, CS professors James Morris and Peter Lee⁴ suggest that declining numbers “are merely symptoms of deeper problems in how we educate our students. In a nutshell, our current approaches to computer science education fail to teach the science of computing. As a result, they fail to inspire the very best and brightest young minds to enter the field.”[Morris and Lee, 2004] Arguably, concern for women’s enrollment preempted what is now an overall concern for the field.

But the issue of declining numbers may actually be a much needed wake-up call for those of us in the field to re-evaluate, re-think, and re-shape what CS really means, and how it is perceived in the public consciousness. We may find that some of those aspects of the field that have been deterring many women from entering are also deterring all students, and strategies for change may well result in increasing enrollment overall, and a more balanced and diverse environment.

We suggest that *images* surrounding CS are fundamental to an understanding of the field. Public perceptions still seem to be dominated by stereotypes showing the field as populated largely by geeky⁵ guys doing little more than coding. The image of CS as a broad and exciting field with the potential for diverse participants is, for the most part, missing from the big picture. Changing the big picture will be no easy task. Nevertheless, council members from our student organization, Women@SCS, at Carnegie Mellon University, decided to take on the challenge!

The Women@SCS Advisory Council

The Women@SCS advisory council is made up of graduate and undergraduate students (not all women), and faculty, in the School of Computer Science. The council represents a thriving and well represented body of women students⁶. Our mission is to create, encourage, and support women's academic, social and professional opportunities in computing-related areas, and to promote the breadth of the field and its diverse community. It is important to note that *Women@SCS has evolved, not as a “handholding” support group, but rather as an action oriented organization in which women have taken leadership roles that have enhanced the entire*

⁴ James Morris is Professor of Computer Science and Dean of the Carnegie Mellon West Coast campus and Peter Lee is Professor of Computer Science in the Computer Science department at Carnegie Mellon.

⁵ The word “geek” seems to have entered the vernacular in the 1990s as a label for computer obsessed individuals. For an interesting discussion of the term see: <http://dictionary.reference.com/search?q=geek>

⁶ For the full story of how Carnegie Mellon reversed the trend with regards to numbers of women at the undergraduate level see: Blum, L. *Women in Computer Science: The Carnegie Mellon Experience*. <http://www.cs.cmu.edu/~women/>

CS community.[Frieze et al, 2006] The Roadshow and Creative Technology Nights for Girls (Tech Nights) programs exemplify this development.

Lenore Blum, Distinguished Career Professor of Computer Science and faculty advisor to Women@SCS has noted “there is no dearth of ideas generated by the Council and, indeed, the level of energy expended is extraordinary”. [Blum, 2001] The council organizes numerous networking, social and professional events on campus and a busy program of outreach activities. [Frieze and Blum, 2002] It is with this commitment and energy that council members took on the challenge of trying to diversify the images of CS, based on a vision of how the field, and the people in it, should be represented. And since many strategies that work well for women have been found to work well for all, we may find this contribution can reach out beyond the initial goals and expectations.

The Roadshow Story

The majority of this paper describes the Roadshow because this has been our major outreach program for several years. It also formed the springboard for Tech Nights, a relatively new program, which we describe in less detail but anticipate will be equally as popular and dynamic.

A few years ago a small group of our undergraduate women returned from the Richard Tapia Celebration of Diversity in Computing Conference⁷ full of enthusiasm and energy for transforming the view of the computer science field. Even at Carnegie Mellon, where we have made progress towards gender balance, we still struggle to diversify our CS student body in terms of race and ethnicity. The group reported their experiences to the Women@SCS advisory council and summed up their experiences by unanimously declaring (we paraphrase): “We must do more Outreach! ...especially to younger girls! We have to let them know there are women and minorities in the field and that it’s not just about coding!” The council concurred with a resounding “Okay let’s do it!”

The following weekend, a group of students worked together to produce a power point slideshow which tackled two “image” topics head-on: “Who can be computer scientists?” and “What can you do with computer science?” At subsequent meetings, we talked more about our goals (see below), and the logistics (see below) of putting plans into action; we improved and revised the content and added new slides, and finally began giving presentations of what soon became known as the Outreach Roadshow, a title suggested by our faculty advisor, and soon claimed.

Since then the Roadshow has become a very popular program within our organization. It continues to capture the imagination of our undergraduate and graduate students alike. We present the show on campus, and at middle and high schools. We also present to middle and high school teachers. Our website visitors can find an online downloadable version and we welcome requests from students and teachers to use it as their model. We continually improve the Roadshow as we collect, and respond to, feedback from students and teachers. When Bill Gates,

⁷ *The Richard Tapia Celebration of Diversity in Computing:*
<http://www.ncsa.uiuc.edu/Conferences/Tapia2003/index.html#PROGRAM>

Chairman and Chief Software Architect of the Microsoft Corporation, came to campus our group was called upon to give a demonstration of the “show”.

More recently we produced, and continue to develop, a “research focused” version that is presented by our graduate women to undergraduates. This is a more sophisticated version of the Roadshow in which Carnegie Mellon’s graduate women present at other campuses to undergraduate students –men and women. The research focused version of the Roadshow is one part of our Women@IT⁸ enterprise which places special emphasis on encouraging students from fields outside of CS, to consider applying to doctoral level studies in computing-related disciplines.

Perhaps the most meaningful and exciting moment for us, in terms of the Roadshow story, was going back to the Richard Tapia conference in 2003 and *presenting our Roadshow at the site of its inspiration!*

What is the Roadshow?

The Roadshow is presented by undergraduates and graduates from the School of Computer Science at Carnegie Mellon. They share their thoughts on CS, why and how they began studying the field, their early and current experiences, what CS means to them now, and their future hopes and expectations. The presentation includes a slide show to illustrate the breadth of the field of CS and computing related areas, lots of question and answer interaction, a guessing game, and a robot demonstration.

Currently, three versions of the Roadshow separately target middle school, high school, and undergraduate students. They share the goals of bringing women’s personal experiences in computing related fields to various audiences, and of getting students *excited* about the science of these fields and their possibilities. Students do not address “gender issues” explicitly unless specific questions arise. Nevertheless, the presentation shows (implicitly) that women can occupy technology leadership roles, have great technical skills, and have tremendous enthusiasm for computing-related fields.

Student presenters make the Roadshow effective. Their energy, visibility, technical know-how, and interaction with the audiences in combination with slideshow images challenge stereotypes and offer new images of the field and the people in the CS community. Below is a brief description of what the middle and high school level Roadshows usually include:

- Images of the students to illustrate their personal stories as they introduce themselves (these include their baby pictures or photos from outside of the work situation.)
- An interactive guessing game to show many diverse images of real computer scientists interspersed with occasional images of actors/non-computer scientists

⁸ For more information about Women@IT see: <http://women.cs.cmu.edu/womenIT/>

- An interactive discussion on “what is computer science?” that stresses the *science* in computer science and what you can do with it (children are asked about their use of the internet, instant messenger, etc.)
- A step by step math puzzle, sometimes acted out, and introduction of the term algorithm, to show the problem solving aspects of computer science (answers and more puzzles are provided)
- The breadth of the field is illustrated with such slides as a “talking heads” synthetic speech demo, a robotics video, the CAPTCHA project (which serves to identify humans from robots as they log on, for example, to Yahoo), web site building, video graphics, speech recognition, computer science and biology, and more
- Depending on the age of the audience the students will add information about the classes they take, job opportunities, the companies they can work for, and graduate school options
- After the slideshow the students introduce simple robot demos such as a “lego robot bug” and, our most recent addition, a Sony Aibo Robot dog
- The students conclude with a question and answer session (they also encourage questions throughout). They leave handouts –pins, brochures and flyers with contact addresses-- in case members of the audience want more information or have further questions.

In the graduate level presentation the students discuss the variety of programs in computing related fields available at the graduate level. They give suggestions on how to pay for graduate school and recommendations on becoming a good graduate applicant. Students tell their personal stories, give overviews of their particular fields, and provide short talks on their individual research. At Carnegie Mellon we have the advantage of having the School of Computer Science which is comprised of 7 departments representing a diverse range of research areas. Thus, in the graduate Roadshow students are able to represent such diverse areas as Robotics and Robot Soccer, Computational Neuroscience, Privacy and Security, Language Technologies, Theory, and Computer Science.

Goals

The Roadshow serves a variety of goals, in fact we deliberately aim to make the most of all such presentations!

- to increase the visibility of young women in computing-related fields
- to *challenge* traditional stereotypes and images of computing-related fields and those in them
- to *diversify* current images of computing-related fields and those in them
- to *show the breadth* of fields that computer science and related areas can encompass
- to *spark interest in the science* of computing and the challenges of problem solving
- to provide an interesting and enjoyable learning experience
- to provide leadership, role modeling and mentoring opportunities
- to expose undergraduates to the breadth of possibilities of research in computing-related fields

- to provide opportunities for graduate women to network with faculty and students from other schools

Audiences⁹

The content of the Roadshow changes to suit audiences. The presentation for younger students is fast paced and fun with a guessing game and puzzles that can be acted out, and more time spent on the robot demonstrations. The undergraduate audience gets a taste of real research areas and advice on funding and applying to graduate school. While targeting girls and women, *we nevertheless are inclusive of boys and men*, because our primary goals include showing women in leadership and teaching roles and illustrating the breadth of the field to all audiences. Our audiences include:

- middle and high school girls and boys
- parents, teachers, and representatives from industry
- undergraduates from CS and non-CS fields e.g. math, linguistics, biology
- all who are interested in gender equity in fields where girls and women are under-represented e.g. engineering and computer science

We have presented our middle school level Roadshow at science fairs, indeed our most recent Roadshow was held in St Louis at the invitation of the 2006 American Association for the Advancement of Science (AAAS) family science days. Our presentation for undergraduates has been given at several universities including Georgia Institute of Technology (Georgia Tech), George Washington University, D.C., Princeton University, University of Pennsylvania, Columbia University, University of Texas at Austin, and at Harvey Mudd College. As well as presenting at the Richard Tapia Celebration of Diversity in Computing Conference we have also presented the graduate level Roadshow at the 2004 Grace Hopper conference¹⁰ and a fast paced multi-level Roadshow at the 2005 SIGCSE conference.

Logistics

Our current motto is “Be prepared for anything!” Although our Roadshows are carefully arranged we never quite know the make-up of the audience and the setting until we arrive on the scene. The range has been surprisingly wide. We have presented to entire student bodies in splendid auditoriums. We have presented to individual classes, sometimes in school cafeterias, having struggled in with our own screen, laptop, robots, and projector. In all cases, however, we have found the audiences to be wonderfully responsive! Perhaps the most meticulously and diligently arranged Roadshow, a university level event, with numerous emails going back and forth, turned out to be the most disappointing because the session was set for a time when, unfortunately, undergraduate students were busy with classes and unable to attend. Good timing, as we found out, is crucial to a successful presentation. The rest of the day, however, was carefully thought out, with productive meetings, and our graduate women were able to network

⁹ For a complete list of presentation sites visit: <http://women.cs.cmu.edu/What/Outreach/#presentations>

¹⁰ The Grace Hopper Celebration of Women in Computing 2004 <http://www.gracehopper.org>

with faculty and other graduates, so that overall it became a worthwhile experience and many of the objectives were met.

Funds for the Roadshow come from several sources, but most are provided by the School of Computer Science at our own university. The Graduate Outreach Roadshow --one of the programs that comes under the umbrella of Women@IT-- is funded by a grant from the Sloan Foundation. Small industry grants have proved invaluable. A recent grant from Microsoft, for example, allowed us to purchase our own Aibo robot dog.

The Latest Initiative: “Creative Technology Nights for Girls”

While the Roadshow *aims to spark excitement about the field* of CS, its spin-off, “Creative Technology Nights for Girls” (Tech Nights), provides *hands-on technology skills and practice*. The workshops are the inspiration of one of our graduate women who saw the potential for expanding the Roadshow. Our student organizer, now the Tech Nights Program Director, designed a series of workshops hosted by volunteer graduate and undergraduate women from the School of Computer Science who teach technology skills to girls ages 9 to 16 and provide mentoring/networking opportunities in the process.

The Tech Nights Program Gets off the Ground

Tech Nights is a relatively new program with student efforts centered on action, collaboration and exploration. We have already moved forward in increasing the numbers of girls attending and we have received requests to replicate the program at other venues. Here we describe the steps taken, and the lessons learned, in getting the program up and running.

The first step in coordinating the workshops was finding a suitable venue. We began by meeting with the owners of a local gaming facility, CyberConXion¹¹, to discuss the program and explain our goals. The owners recognized that exposing more girls to the facility, and to games in general, could be a good business move as well as showing community spirit. They agreed to let us use the facility space, which includes two networked classroom spaces complete with internet access and projector, on a weekly basis *free of charge*.

Once the venue was fixed, local schools were targeted for the workshop attendees, and Carnegie Mellon was targeted for volunteers to lead individual sessions. Local school administrators and teachers were solicited for support and rapidly joined in the effort to engage their female students. The primary sources for getting the word out included a Tech Nights web page on the CyberConXion website¹² and announcements on the Women@SCS website.

Graduate and undergraduate volunteers were invited to teach a class in their field resulting in a variety of classes embracing many areas of CS (see program description below). In the spring of

¹¹ Pittsburgh Cyberconxion: <http://www.pghcyberconxion.com/>

¹² Tech Nights for Girls: http://www.pghcyberconxion.com/pages/training/technight_girls.shtml

2005 “Creative Technology Nights for Girls” was launched and the free weekly workshops have continued through the 2005 -2006 academic year. From the volunteers perspective the workshops serve to strengthen the local community of women in computing-related fields. Workshops also offer graduate and undergraduate instructors an opportunity to hone their teaching and curriculum development skills by allowing them to present in an informal environment.

Each week, a different instructor leads the session, sharing skills and knowledge in an informal demo or hands on exercise, while other volunteers assist on a one-on-one basis as needed. The system works well for volunteers and young participants alike. The variety of topics and instructors thoroughly engages the girls without placing an unmanageable time commitment on student volunteers. Girls are encouraged to attend the free classes each week; however, registration and attendance are not required on the basis that the girls should attend because they want to --and not because they feel they have to.

Weekly workshops are casual to allow instructors to adapt content according to the interest level of attendees and to avoid replicating the more formal classroom experience. Girls are encouraged to progress on topics they are more familiar with, and all subjects are presented to allow for self-pacing for less qualified students. Indeed, self-paced activities and demos allow students of all skill levels to participate, to feel part of the community, and to have fun!

The program of free workshops includes (but is not limited to):

- web design and web site building
- computer illustration
- programming
- 2-D animation
- robot design and robot programming
- internet safety
- virtual world building
- programming through visual storytelling
- using Photoshop, Illustrator
- social events such as Movie Nights
- Open Houses
- Bring-Your-Mother-To-Work Nights

Not surprisingly, the program has evolved since Tech Nights was first launched. While originally the program was open to both high school and middle school girls, it soon became clear that the age range and maturity levels of the two groups created some friction, and did not meet all needs equally. Many of the older girls, who were interested in CS, became less engaged when attention was focused on younger learners. A new structure was suggested and implemented in the fall of 2005. High school students now participate as Teaching Assistants. By offering leadership roles to older girls they were successfully reengaged within the community, as well as having opportunities to practice teaching, public speaking, and working with others. In addition, high

school students are able to use this experience as part of their college application when they graduate from high school.

The Tech Nights Program Director organizes the entire program, coordinating with volunteers and attendees, producing and distributing flyers, liaising with schools and business owners, and making sure each session runs smoothly. Arguably, this program could not have got off the ground without her amazing commitment, terrific technical skills, hard work and vision. However, her association with Women@SCS, and her training of future leaders to take on her role, will allow the program to be sustained after she graduates.

Feedback and Evaluation

Our efforts to gain funding to support professional evaluations of our outreach programs have not been successful to date. Thus, we are unable to provide the usual measures and data to substantiate what we feel to be successful efforts. Eventually, we hope to have professional evaluations that explore the long term effects and impact of our Roadshows and Tech Nights. However, we have made a concerted effort to gain immediate feedback through questionnaires given to teachers and students who are in our audiences. From our point of view the feedback forms provide a valuable source of suggestions as we work to improve the presentations, along with some welcome kudos for the student presenters! We are particularly encouraged by replications of our programs. The Roadshows have inspired and attracted the attention of CS departments across the nation, and from student groups looking to develop their own outreach programs. Tech Nights has caught local attention and the Tech Nights Director, along with other students, is currently helping to replicate the program at the Braddock Library in Pittsburgh.

Anecdotal feedback from high school and middle school teachers tells us how much they need, and appreciate, the examples and materials we use to demonstrate the breadth of CS. There seems to be a desperate need for teaching resources that situate programming in the wider context of the field. Teachers also seem to share our desire to try to break down the stereotypes that surround the field but they rarely have the resources to do so.

Below are some responses from teachers and students who have seen, and provided feedback on, the Roadshows. *These highlights are noted here for interest value only and are not meant as qualified evaluations.*

Teachers: : *Among our audiences* teachers were overwhelmingly positive about how useful the Roadshow was and thought it was appropriate for students from elementary school on up through college, and for parents and educators as well. Teachers repeatedly affirmed that the personal stories of the student presenters, “their energy and enthusiasm”, and their excitement for their topics, were what made the Roadshow so effective and unique. A number of teachers suggested adding some slides showing younger girls programming/using the computer/being involved with CS. Teachers also suggested we include a slide showing income potential.

Middle/High School Students: *Among our audiences* we found that slightly more boys than girls had taken CS classes. Virtually every respondent had access to a computer at home and many listed themselves as being the primary user. Girls and boys, in fairly equal numbers, claimed to be using the computer primarily for internet and email, but also for applications and

programming, with boys programming more often than girls. Boys appeared to be more interested in studying CS than girls. Among those boys and girls interested in studying CS, they listed “fun/interesting” as the top reason for doing so. Both boys and girls, overwhelmingly, found the Roadshow interesting, informative and helpful. The Robocup/ Robots/AiboDog were found to be their favorite part.

College Students: *Among our audiences* affordability was listed as one of the major obstacles for applying, or not applying, to graduate school. The top listed factors for choosing a graduate school were the reputation of the school, the school’s areas of research, funding opportunities, and location. The vast majority of students found the presentation helpful because of the exposure to new ideas, the information about graduate school, and the personal stories they heard. Robotics, Language Technologies, and Software Engineering were noted as some of the most interesting research topics. Many students requested that more information about the general graduate school experience be included in the Roadshow.

Quotes from some audience members:

“Some day I hope to be a computer scientist just like you” (7th grade girl)

“I think what you do is really awesome” (6th grade girl)

“The show is unique, you should keep it this way.” (high school teacher)

“I liked that you showed a mixture of races” (high school teacher)

At one presentation a CS professor pointed out that the “show” glossed over the grunt work of CS in favor of the exciting parts. We had to admit this was absolutely true and somewhat deliberate since our focus was always on trying to get the students excited about the science. We were rescued by a young African American woman in the audience who argued that while our culture was so intent on getting kids excited about football and sports, we paid so little attention and energy to getting them excited about science!

One of our favorite feedback comments, though frivolous, came from a young child at an on-campus presentation. The children were asked by their summer camp organizer what they had learned about CS. One little boy put his hand up and said very seriously “I’ve learned that computer scientists are very pretty”!

Benefits for our students

We believe that the programs we describe work best when there are mutual benefits. Our undergraduates and graduates are in very intensive academic programs. We are always amazed that they manage to volunteer so much of their time, energy and expertise to outreach work. The Roadshow and Tech Nights are clear examples of the activism of the Women@SCS council members and their strong drive to give back to the community. Our students repeatedly comment on how much they enjoy participating in the programs. They often explain that they wished they had been given similar presentations and opportunities in their own schools.

The Roadshows and Creative Technology Nights provide our students with leadership, teaching and public speaking opportunities. By having graduates and undergraduates team up together to develop and implement the presentations, numerous opportunities for mentoring and learning from each other arise. We believe these outreach programs help our students with confidence building, and provide them with opportunities to practice their skills and illustrate their knowledge in a fun environment.

Conclusion

We live in a culture which specializes in manipulating our thoughts and attitudes through images. Image so easily becomes reality. But culture is constantly changing and we can challenge current images and try to change them as much as be affected by them. Indeed, as we listen to students' perspectives (men and women) as they discuss CS stereotypes we hear them constantly redefining and reshaping the images that surround them.

The Women@SCS students who took on the outreach challenges described above enjoy their fields of study and want to share their enthusiasm and skills, knowing that few girls and women are exposed to the excitement of CS and/or creative technologies. This understanding inspires their efforts. The students who initiated the Roadshow did so with the aim of challenging and diversifying current images of computing-related fields and those who work and study in them. The student who initiated Tech Nights did so because she saw a need to increase the opportunities for giving real hands-on experiences and skills to girls and young women. As women they did not see themselves fitting naturally into the stereotypical images dominated by "geeky guys" but, perhaps more importantly, as students of CS, they did not see images of the field that matched their learning and exposure to an exciting field of study with so many possibilities.

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WEPAN 2006

Paper for "practice-oriented session"

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