

# **The Under-representation of Women in IU Computer Science Undergraduate Degree Program**

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A task force was formed January 2004 at the request of the Director of Undergraduate Studies, Andrew Lumsdaine, with the directive to study the under-representation of women in the undergraduate program in the Department of Computer Science at Indiana University. The task force met numerous times throughout 2004. With these recommendations and extensive study of best practices in the gender and computing literature, the authors Plale and Menzel developed this final report.

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*If we want a different outcome, we're going to have to do things differently.  
We're making too little progress doing more of the same thing.*

-- John White, Dean of Engineering, Georgia Institute of  
Technology[18]

## 1.0 Introduction

Universities across the United States are facing two major challenges to their undergraduate computer science degree: declining enrollments and declining proportion of women relative to the whole (that is, those declaring CS as a major and those graduating with a bachelors degree in CS). The Indiana University Department of Computer Science faces these challenges in addition to a bigger one: the proportion of women in the computer science program at IU is considerably below the national average. This challenge is even more striking because women constitute over 50% of the undergraduate student population at Indiana University. *This report is a call to action.* It is time to take a comprehensive look at our undergraduate curriculum and undergraduate experience in general. The needs of the undergraduate student are changing. If the department is to remain vital, those needs and more importantly, the needs of women and other underrepresented groups, must be understood and met.

This report contains recommendations and strategies for improving the undergraduate computer science experience for the underrepresented student. It reflects recommendations made by the gender task force and best practices identified in the gender and computing literature. The authors Plale and Menzel are solely responsible for the curriculum recommendations in Section 5.0. While the task force examined issues in curriculum, opinions varied as to suggested approaches. So Plale and Menzel developed a model based on best practice identified in literature, drawing heavily from the extensive literature on the Carnegie Mellon study[1,2,10].

The number of students in US universities who declared their major in CS has declined for the past four years and is now 39 percent lower than in the Fall of 2000[7]. The impact of these declines is now being felt among enrollments, which have decreased by 7 percent in each of the past two years. The greatest decline in the past few years has occurred among the top 36 departments, which saw enrollments fall by 19 percent between 1999/2000 and 2003/2004. In comparison, enrollments for those ranked 37 and above dropped 13 percent between their peak in 2001/2002 and last year. It is widely known that the number of women enrolling in CS degree granting undergraduate programs across the United States has been steadily declining since their high in the mid-1980's. In the mid-1980's the proportion of CS BS degrees granted to women 36-38%. For the years 2000 and 2001, the latest year in which data are available, the proportion had dropped to approximately 28%[12]. The proportion of women in the CS department at IU is even lower. Table 1 lists the number of undergraduate women in Computer Science at Indiana University during the 2004-2005 academic year. The table reflects, for each class rank, the number of students who have declared CS as a major, and who have attained a certain standing based on total number of hours taken in the university. Freshmen are omitted because they spend their first year in University Division, so have not declared a major even though they may be taking CS courses.

Table 1 indicates that on our current path the department is able to attract and retain only a handful of the roughly 3,240 women that enter IU each year as freshman. That is a startling 0.12% of the total number of incoming freshman women. This is a deplorably small number. A more diverse student body is good not only for potential students, but crucial to the intellectual health and future of the department and of the discipline. We are failing in our mission to society if we ignore this important problem.

	Women declared majors / Total declared CS majors	Percentage women
Sophomore	4 / 43	9%
Junior	3 / 57	5%
Senior	14 / 96	14.5%

**Table 1: Undergraduate women in IU CS for the 2004-05 academic year. Declared CS majors are students who have declared CS as a major, and who have attained a certain ranking based on hours taken in the university.**

Now is the time for action. Over the last several years the department has developed a base from which it can now step to broader success. Because of the commitment to diversity taken by the administration under Brehm's leadership and by the department under Gannon's leadership, female faculty (including tenured, pre-tenure, and non-tenure) now represents 18% of the total. (This up from 1.0% just 4 years ago.) Additionally, WIC@IU, a grass-roots organization founded in the Computer Science Department by Professors Plale and Connelly is in its third year and is sustaining vibrant involvement. WIC@IU supports women in computing with leadership opportunities, mentoring, and community. The dual factors of critical mass of female faculty and a strong support group for graduate and undergraduate women students form the foundation upon which fundamental change can and should be undertaken to the undergraduate program in Computer Science; change that will make the Computer Science Department a more attractive, welcoming place for women to grow into tomorrow's leaders and scientists.

## 2.0 Overview

The specific strategies developed in this report can be summarized below along the general categories of recruitment, retention, curriculum, and outreach as follows:

### Recruitment --

- Scholarship – work with the Office of Women's Affairs (OWA) and the Office of Admissions to ensure the scholarships being developed for incoming high school students target technology students
- Marketing –
  - commit resources to the development of a department brochure, targeted at undergraduates, that clearly identifies the value of the major to the potential student
  - "tryout" workshop – provide departmental level support for a gender-specific C211 workshop for high-achieving first-year undergraduate women
- Admissions – dedicate resources to the tracking and engaging of identified applicants from application filing through admittance

### Retention --

- Continued monitoring and support for hospitable undergraduate labs
- Chair level commitment to raising awareness amongst faculty and AIs
- Fixed budgetary support for WIC@IU
- Encourage undergraduate research experiences
- Build culture that encourages undergraduate research experiences
- Continued departmental support for the Central Indiana Celebration of Women in Computing (CICWIC) regional conference, held on the odd year of Grace Hopper women's conference.

### Curriculum – (Plale and Menzel)

- The authors support aligning the undergraduate core with the 2001 ACM/IEEE Computing Curriculum. The consequent introduction of topics such as ethics, social context of computing, risks and liabilities, and intellectual property into the core curriculum will broaden the base of potential majors.
- Freshman Integration “funnel” course offered to freshman interested in computing degrees either in CS or Informatics.
- Create specializations within CS degree. Specializations are beyond-core emphases that can either be fully defined within CS or can span CS and other programs for an interdisciplinary experience. Specializations need to be defined with an eye to clear enunciation of its value to students (in terms of jobs or graduate school.)

### Outreach --

- Continued department support for the Java Engagement for Teacher Training (JETT) workshops that have been so successful in building connections between University faculty and high school teachers in Indiana and the surrounding states
- Take steps to help local high schools create AP computer science courses
- Provide funding to expand the “Just Be” outreach activities already underway

There is no single silver bullet solution that will magically increase the number of women in an undergraduate computer science program. An effective solution to the problem requires sustained commitment from the department, college, and university on a broad range of efforts.

## 3.0 Recruitment

The low proportion of women in computer science can be viewed as the result of failures in recruitment and retention[3]. *Recruitment* entails attracting potential students to computer science whereas *retention* is the retaining of an underrepresented student in the program once they have declared computer science as a major.

*"These departments [that do not admit freshmen directly into the major] have to compete with all the other attractive programs on campus, and so they must be particularly appealing. Such departments might examine unnecessary obstacles that may impede entry into their CS program, and also take a broader view of the field.[2]"*

*Recently an IU faculty member's daughter applied to IU with a specified interest in computer science on her application. The young woman had a 1600 SAT score. She was admitted with a single form letter. No follow-up contact, no offer of a scholarship. In sum, there was no effort to recruit her[13].*

## 3.1 Scholarship

The Office of Women’s Affairs recently created the Sarah Parke Morrison Society Scholarship for undergraduate women who are enrolled as full-time students, have financial need, and are first-generation college students. The office is investigating other scholarship opportunities as well. According to Sally Dunn[9], OWA is organizing a scholarship to fund top women from Indiana high schools. The summer before they will be freshman, women students will visit IU and participate in an intensive course designed just for these women. Faculty from all science areas will give mini-sessions to expose the women to what is exciting about their field. Additionally, the Office of Admissions is pushing for scholarships targeted

towards high-end freshman as a recruitment tool. This is an endowment campaign effort, early in its efforts. The CS department needs to work with OWA and OA to ensure that the scholarships sufficiently represent technology. Faculty involvement in the summer workshop will promote computer science as an exciting and rewarding scientific discipline.

### 3.2 Marketing

Departmental resources should be committed towards the development of a **department brochure targeted at undergraduates** that includes an explanation of the value of a computer science degree relative to the other computing options on campus. The value should be expressed in terms a student can relate to, such as future opportunities in the workplace and graduate school. Additionally, the brochure will attempt to break stereotypes by showing our current women students engaged in technical pursuits, and including upbeat stories of recent women graduates, as well as a description of the supportive WIC community.

In concert with the brochure, the department should invite promising first-year women from across the university to a **C211 “tryout” workshop**, held two weeks prior to registration, with the intent being to demystify computer science and level the playing field by acclimating the participants to the C211 expectations and prerequisites.

The idea of this workshop is the brainchild of Gloria Townsend, Professor and Chair of Computer Science at DePauw University, and long-time advocate for gender equity in computing. Professor Townsend has implemented this idea at DePauw and reports that 55% of students enrolled in DePauw’s CS1 for Spring 2005 are women. She credits the workshop as an important contributor to her success (see <http://minerva.csc.depauw.edu/recruiting.htm>.)

Women in the target group are sent the departmental brochure and an invitation to a “tryout workshop” that duplicates the first-week experience in C211 to convince women that some skill with arithmetic and symbolic manipulation are all that is needed for a talented person to embark on a CS major. The “tryout workshop” is developed with the help of TLTL to ensure that materials are appropriately suited for the audience, and evaluation and BEST to ensure tracking is in place.

Specifically, each first-year woman is sent a mailing to her campus address. We suggest that the target pool be screened to include only those women with a certain minimal math SAT or ACT score. Other restrictions could be considered, such as confining the group to women with a prior expressed interest in math or technology. The mailing includes the department brochure and an invitation to a “tryout” workshop that will teach the participants the concepts covered during the first week of C211. This workshop should be about two hours in duration and held in a computer lab so as to familiarize the women with the computing environment. Lindley Hall 115 would be the ideal venue.

Timing of the mailing and the scheduling of the tryout workshop are crucial. The workshop should occur shortly before registration begins for the following semester and the mailing should be sent several weeks earlier. The women will be asked to RSVP if they intend to participate in the workshop. A follow up message could be sent to non-responders by email.

This proposed project will incur certain costs, most obviously are those required to produce and mail the brochure and the clerical work involved in registering women for the workshop as well as following up with the participants to gauge our success. (We envision surveying the women at the end of the workshop and later interviewing those who ultimately enroll in C211.)

The tryout workshop could be designed and run by the C211 staff. We recommend that advanced women undergraduates be recruited to assist during the workshop and that these students be paid a small stipend for

their efforts. We might also enlist these same students to lead study sessions or provide individual tutoring, at departmental expense, for the women who are persuaded to enroll in C211. A promise of support such as this should serve to make the women feel quite welcome. Clearly, this will require support from the university to identify the target group.

We urge the department to embark on this plan immediately. If steps are taken during Spring 2005 to develop the brochure and identify the means of formulating the target group, the first tryout workshop could occur in Fall 2005 with the hope of producing an effect in C211 in Spring 2006.

### 3.3 Admissions

While efforts are underway to address admissions, the task force felt that the computer science department could be more directly involved in the admissions process. Efforts need to be made to reach students during summer orientation. The University Division advisors could be provided more information about our entry courses so that they can better guide students into our major. It was suggested that there is a perception that C211 is too hard or inappropriate for freshmen. Other suggestions include:

- a) Identify applicants who declare computer science as intended area on their application. Department follow up with these people during the time the candidates are considering the multiple offers[9].
- b) University Division advisors advise 85-90% of freshmen. The advisors meet regularly at staff meeting. Arrange with advising staff (Mark Goodner in particular) to get on schedule to present at one of their meetings[9].
- c) Identify women students doing well in beginning courses. Send letter, invite to come in and talk about major. Evaluation criteria are very important[9].

### 4.0 Retention

*“Computer Science Departments across institutions differed in the difference between their male and female attrition rates. This lack of a consistent difference demonstrates that gender characteristics such as early sex role socialization, mathematical achievement or ability, computer interests and attitudes, etc., are not sufficient to explain the disproportionate loss of women from computer science. It appears that environmental characteristics may overcome or exaggerate gender differences[3].”*

*“Retention of certain groups of women is a challenge. First year student retention data by gender indicate that male students were retained at higher rates than females each year between 1988 and 1998. First generation women students were the most likely population to drop out of school. Women also have a higher rate of withdrawal than men in gateway courses in chemistry and math, the two departments sampled in the Bloomington study[14].”*

#### 4.1 Continued Support for Friendly Undergraduate Labs

Good undergraduate lab space should remain a high priority. In February 2004, the Central Indiana Celebration of Women in Computing (CICWIC) drew 85 graduate and undergraduate women from Butler, Rose Hulmann, DePauw, Purdue, and IU to discuss issues facing women in computing. The CS department's undergraduate Burrows lab surfaced again and again during a particular panel discussion as an example of a hostile environment. The department holds the dubious honor of having had the most talked about lab at the conference.

The additional undergraduate lab room in the basement of Lindley created Spring 2004 by the then Department Chair, Dennis Gannon, and encouraged by current Chair, Andy Hanson, is a forward-looking decision that has helped to alleviate the major concerns raised by CICWIC attendees. This issue needs to be continuously revisited. For instance, the laptop room door should remain open, with blinds fixed in an open position. This is now possible now that Lindley Hall is locked in the evenings. Undergraduate space should be a priority in the new building. Undergraduates need generous space allocations. The ideal space is open, airy, and pleasing to the eye (the latter achieved through student works of art, for instance.)

#### 4.2 Awareness Raising Amongst Faculty and AIs

As is supported in the gender literature and highlighted by the following quote below, raising awareness of gender issues is an important aspect of culture change. To be effective, support must come down from the administration, including the department chair, dean.

*"Abigail J. Stewart, a professor of psychology and women's studies at the University of Michigan, credits the administration with taking "a central role in encouraging departments to bring in more women." First, says Ms. Stewart, who is leading Michigan's effort to hire more women, the university distributed sociological studies to faculty members in the sciences and engineering, showing that "bias happens even when people don't intend it." Then the administration enlisted senior professors in those disciplines to run continuing workshops for their colleagues on how to avoid bias. They talk about focusing on job applicants' professional characteristics rather than personal ones. And instead of asking search committees to rate finalists based on a general impression, they suggest that professors rank the candidates according to several specific criteria -- including who would make the best teacher and who would do the most-original research[15]."*

The task force recommends that AIs undergo sensitivity training. Eric Kisling currently does not do sensitivity training but is willing to incorporate it into his AI training class.

#### 4.3 Professional Organization for Leadership, Mentorship, Peers, and Role Models

*The literature of gender issues in computing steadfastly and uniformly has advocated the use of mentors and role models for recruiting and retaining women in computer science[17].*

*Creating a professional organization to provide mentors, leadership opportunities, etc. [...] A top priority is community building[2].*

WIC@IU was organized Fall 2002 to build community among the women students in computing and to provide mentoring and leadership opportunities. [WIC@IU](http://www.cs.indiana.edu/wic/) is currently seeking departmental and college level support in the form of funding for staff. With staff, WIC could take on additional tasks in support of diversity in the department, such as quantifying the dropout rate and categorizing it by multiple criteria (*i.e.*, level, gender, race).

About 45 IU women from CS, SLIS, and Informatics attended the first CICWIC conference at McCormick's Creek in February 2004. (See <http://www.cs.indiana.edu/cicwic/>.) Plans are underway for a second iteration in September 2005. Departmental support on the order of \$75 per CS woman will cover the costs of accommodations, transportation, and refreshments, and will be in line with the commitment from Purdue, DePauw, Butler, and Rose-Hulman.

## 5.0 Curriculum

The Computer Science department must take immediate and pervasive action to stop the leakage in enrollments for both well-represented and underrepresented students in the undergraduate program. In response, the authors Plale and Menzel developed a dual-pronged approach to curriculum improvement aimed at attracting and keeping women. The strategies assume a revisiting of the undergraduate core. The authors Plale and Menzel support bringing the undergraduate core closer in line with the 2001 ACM/IEEE Computing Curriculum.

The first prong of the approach is a freshman level integration (or “immigration”) course taken by freshman students interested in a degree in either Informatics or Computer Science. The course, based on a similar course at CMU, acquaints incoming majors with computing. Students hear from different members of the computing community (i.e., CS and Informatics) who talk about their research, past events, and future trends. The idea is to expand the students' concept of what is available to them as students within the computing “school” (i.e., CS and Informatics). The freshman integration course is shown in Figure 2 as the oval crossing the CS degree on the left of the vertical bar and Informatics on the right of the vertical bar.

The second prong is the creation of “specializations” within the Computer Science undergraduate degree. A specialization is a selected set of courses taken after the CS core curriculum that give exposure to an area outside CS, or allow for a focus within CS. Specializations can be crafted so as to give interdisciplinary exposure in areas in which IU has a strong reputation (i.e., math, science, and Informatics). Through specializations within the CS department, the department can create focuses that strengthen a job seekers resume because they can be listed. Through specializations that cross departments, the department can align itself with IU’s strengths in math, sciences, and Informatics, to create interdisciplinary focuses at the undergraduate level. These interdisciplinary focuses will prepare students for interdisciplinary graduate work and for meaningful jobs today in emerging industries (i.e., bioinformatics, pharmaceutical). Two interdisciplinary specializations are shown as vertical arrows on the CS side of the vertical bar in Figure 2.

The suggested curricular changes, while we believe will benefit women, are targeted primarily at increasing enrollments through making the curriculum more attractive (“specializations”), and giving students a chance to explore the curriculum before choosing (freshmen integration course.) We are intentional in our avoidance of “female friendly” curriculum suggestions (such as more project-oriented courses or pair-wise programming.) The Carnegie Mellon gender initiative undertaken nearly 5 years ago has been extensively studied and documented. Over the past 5 years the school has worked hard to achieve a more balanced environment in the School. By “more balanced”, the authors mean more balanced in terms of gender, more balanced in terms of mix of students and their interests, and more balanced in terms of professional experiences afforded all students[1]. “No prior programming experience required” was the word to the Admissions Office[2]. In recent literature, the primary researchers are reexamining earlier conclusions. In [1] the primary researchers for the ongoing study state that *“even more, we believe that recommendations for curricular changes based on presumed gender differences can be misguided and indeed may help reinforce, even perpetuate, stereotypes.”* This is a significant conclusion. Broaden the base of students and the spectrum of interests and personality types of men and of women becomes more alike than different[1] .

### 5.1 Freshman Integration Course: Giving Female Freshman an Opportunity to Choose

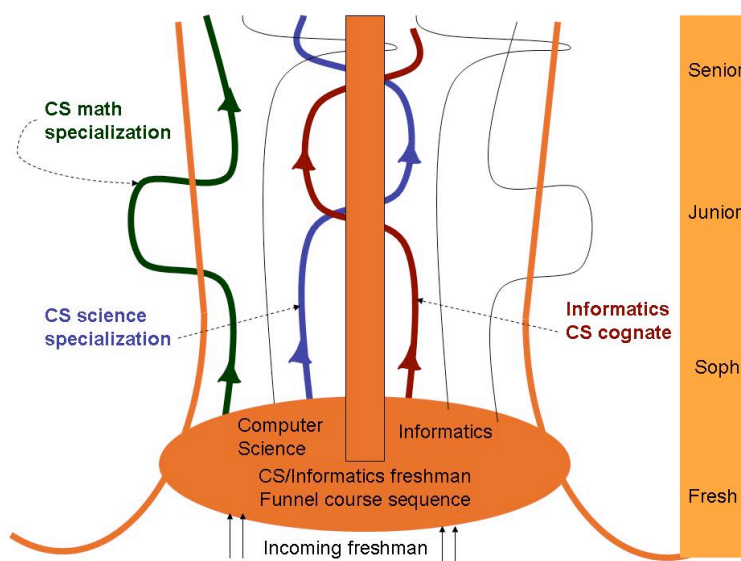
*“Men are more likely than women to become interested in computing at an early age – often describing “epiphany moments” that occurred even before the age of 10 – and they*



are more likely to be interested in computing for its own sake, whereas women tend to become interested in CS as an “acquired taste” that emerges over time[8,10].”

“At the beginning of a college career, women have less well-developed views of what they want out of college than do male freshmen, less clear ideas about what draws them intellectually to a particular major, or what they want from it in career terms[16].”

A common theme emerging in the gender literature is that women more than men may not know that they like CS when they enter a university as freshman. The first course, then, is extremely important in helping undecided students choose. According to the recent Joint Taskforce for Computing Curricula guide[6], there are two basic approaches to an introductory level course sequence - the “filter approach” and “funnel approach”. The *filter* approach calls for curricula that implement an ambitious, tightly focused discipline-specific agenda from the very first course. Filter curricula use introductory courses to lay disciplinary foundations early and/or establish a rigorous performance standard from the beginning and immediately filter out students who do not rise to the standard. In contrast, the *funnel* approach calls for curricula that serve a student audience that is broader than those who will concentrate and succeed in a given discipline. *Funnel curricula* use introductory courses to provide students the learning experience that will help them make a well-informed choice as to whether a given discipline is suitable for them.



**Figure 2 . A freshman integration course would be taken by freshmen students interested in a degree in either CS or Informatics. “Specializations” beyond the undergraduate core provide junior and senior women with opportunities for interdisciplinary study.**

The CS department has historically used the filter approach. But for filter curricula to serve students responsibly, however, a degree program must provide students with some reasonable and substantive support for making an informed choice about the degree program, and this must be done before the student enters the program[6]. While the department undergraduate advisor does an excellent job responding to inquiring students, it is weak in its outreach to the freshman class as a whole. **This dual-edge sword of a filtering approach combined with inadequate support for reaching out to incoming freshman has a far stronger negative impact on female students than on male students because female students tend to come to college with less well developed views of what they want out of college in terms of career than do male students.**

*This problem can be addressed by the addition of an freshman exposure course to the CS curriculum for freshman students who may be interested in a computing major in either CS or Informatics. As the quotes at the beginning of this section demonstrate, many students, a higher proportion of which are women, do not have clarity about their choice of computing major as a freshman. A “funnel” course focusing on the culture, the history, and exciting research in computing, coupled with caring consultation and guidance can give an undecided student tremendous knowledge with which to make an informed choice about computing as a major[5,6]. With the CS department’s current ability to attract 0.12% of incoming freshman women, it is clear that the department is “making too little progress doing the same thing.”*

Professor Springer’s Undergraduate Honors Seminar and I101 are good starting points. In the Honors Seminar, each week a different faculty member from either Informatics or Computer Science presents his or her research at a level appropriate for an undergraduate audience. The presentation is followed by a lively discussion between the students and the researcher. I101 has a project focus and measurable learning objectives. TLTL help can be engaged to ensure the course has measurable learning objectives and metrics used for continuous improvement.

The idea is well founded (see [6]). In the U.K., a first year of introductory computing courses shared across multiple computing disciplines is quite common, and experience there has shown that delaying the decision about choice of major can be beneficial in helping with retention[6]. Carnegie Mellon has such a course (see <http://www.andrew.cmu.edu/course/15-128/>) for first-semester CS majors. The CMU Freshman Immigration course is designed to acquaint incoming majors with computer science. Talks range from historical perspectives in the field to descriptions of the cutting edge research being conducted. It is a one-unit course and is graded pass/fail.

It is recommended that the chair allocate course buyout or partial summer support to ensure excellence in course development and a high level of collaboration with Informatics faculty in its development.

Why a single shared course across CS and Informatics?

- 1.) The University Division advisors are more likely to direct unsure freshmen into a communal funnel course than into a rigorous course like C211.
- 2.) With the impending move of the CS department into the School of Informatics, IU has the opportunity to become a singular informatics and computing powerhouse. This single course serves as the starting point for direct admits to the School of Informatics and for University Division students considering a major in computing. Developed cooperatively by CS and Informatics faculty, the course exposes students to the exciting aspects of both disciplines, and provides a nurturing environment. Advising is built in and provided by Informatics and CS faculty and staff instead of being left to University Division advisors.
- 3.) Funneling across Informatics and CS can help reduce the confusion amongst undergraduate students about the large number of computing degree programs that exist on the Bloomington campus (i.e., Kelly School of Business, Telecommunications, Informatics, and Computer Science.)

5.2 Specializations within CS degree: Attracting Freshman Women

*“Women decide to major in computer science based on a broad set of criteria. The simple enjoyment of computing is a leading factor for women, but other factors also weight heavily in their decisions. They value the versatility of computing, its relation to their interests in math and science, its career path to safe and secure employment,*

*the exciting nature of the field, and the encouragement they received from parents or teachers[10].”*

*The Carnegie Mellon School of Computer Science study, like other research, found that women undergraduate students considered computing expertise a means to an end: 44% of the women surveyed, compared to 9% of the men, “contextualize their interest in computers in other domains such as medicine, space, or the arts.” Among the changes in the undergraduate curriculum were interdisciplinary courses that brought students of different backgrounds together to work on multifaceted problems, an undergraduate concentration in human-computer interaction, a course that lets students use their computer knowledge to work with nonprofit community groups, and the provision of multiple points of entry into computer studies. The reforms resulted in increased levels of satisfaction in students of both sexes, the more experienced computer science students as well as the less experienced [11].*

The emergence of Informatics gives the CS department an unprecedented opportunity to examine its curricula with the objective of offering a portfolio of specializations to meet the needs of a broad mix of students with an interest in computing. As shown in Figure 2, the funnel approach could work together with “specializations” to provide the freshman women with educated choices, and a set of choices that leverage IU’s unique strengths in science, math, and Informatics. Specifically,

-- A **CS math specialization** could serve students who aspire to graduate study, research positions, or who wish to proceed as generalists in computing. Builds strong math skills applied to languages, databases, or systems. Coupled with double major with mathematics, these people will go on to graduate school or be prepared for jobs in statistical analysis, [add more career options]. We could also encourage **double majors**. For instance, the Math department has expressed a desire to work on generating interest in a CS/math double major[9].

-- A **CS science specialization** could serve the CS student who aspires to science cross-disciplinary innovation. A CS science specialization would train a student in CS theory but with sufficient exposure to algorithms, data and knowledge management, and models as applied to a science domain, such as bioinformatics, chemical informatics, or geoinformatics. Students take courses in information management, computational biology, and algorithms. With this background, a graduate is qualified for a highly skilled technical/scientific job in the pharmaceutical, automotive, or energy sectors. Prepares students for jobs in automotive manufacturing: operations automation, automated process integration, tool integration. Medical and pharmaceutical customized data analysis solutions.

We propose constructing 4-5 specializations within the undergraduate degree. A specialization built around IU strengths in math, science, and computing would leverage IU’s strength and uniqueness relative to other state schools. All CS students would take the common core, based on the most recent ACM guidelines for computer science curriculum for instance. Specializations are defined with an eye to clear enunciation of its value to the potential major (in terms of job or graduate school.) Specializations do not sacrifice the department’s mission of conveying core computer science. It requires small changes to the undergraduate curriculum. This kind radical thinking is mandatory if the department is to successfully counter the national fear that a CS degree means a programming job that is being outsourced to other parts of the world. Georgia Tech is in the process of adopting specializations for their undergraduate curriculum and has identified 6-7 specializations.

The CS science specialization complements the Informatics science cognate. Whereas a bioinformatics undergraduate cognate in the School of Informatics will educate biologists in some aspects of computing, the science specialization in CS would educate a CS person in the computing aspects of biology. Both orientations are needed to bridge the gap between today’s complex application domains and technology.

## 6.0 Outreach

*“High school computer science can be critical for introducing girls to computer science. For one-third of the women in their study, a high school programming course became the deciding factor in their decision to major in computer science. This was only true for 9 percent of the males. For males, the “turn on” to computing happens much earlier, usually at home and with friend[10].”*

*Building relationships with local "feeder" high schools.[1]*

### 6.1 Ongoing Support for JETT workshops.

The Computer Science department has hosted a two-day workshop, Java Engagement for Teacher Training (JETT) each of the past two years (see <http://www.cs.indiana.edu/~jett/>) and we urge the department to continue its generous support in 2005. Secondary schools teachers from Indiana and the surrounding states participate in two days of intensive study of Java programming, with an emphasis on teaching strategies and ways to attract individuals from under-represented groups into computing.

An important aim of the JETT workshop is to teach teachers about gender-related differences in learning and how pedagogical approaches and teaching styles, as well as peer culture, contribute to causing or closing the gender gap. High school teachers are ideally positioned to promote realistic notions about computer science and to bolster the confidence of female students who have the aptitude to succeed. Educating educators on this point enables them to become agents of change at their home schools.

Bringing the teachers to our beautiful campus and exposing them to our modern computing facilities as well as our excellent faculty combine to insure that participants will form a high opinion of the department. As a consequence, we hope they will think of Indiana University when advising their brightest students on choosing a college.

### 6.2 Aid Local High Schools in Developing an APCS Curriculum.

The state of computing education at BHSS and BHSN is limited to Windows applications and elementary VB programming. The department should encourage and aid the development of an Advanced Placement Computer Science course at the high school level. Exactly how to go about this is something that needs to be worked out, but it might entail assigning a lecturer to teach such a course and/or providing AI support. Obviously, a dialog between the department and the high school principals needs to be initiated before any action can be taken.

## 7.0 Conclusions

The recommendations made in this report are founded on discussions held during 2004 by the gender in undergraduate education task force, and by extensive reading and identification of best practices from the gender and computing literature. The decreasing interest shown by young women in computer science has developed over the last 10 years. The problem will only be solved by broad and forward-looking thinking about the undergraduate curriculum as it currently stands, and about the culture that the department has acquired. Change will require persistent, funded support from the administration and recognition of the need to address the problem by the faculty.

## Endnotes and References

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