Piltdown Man or Inconvenient Truth? A Two-year Study of Student Perceptions about Computing

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Abstract

Survey results from a two year project are presented. The survey instruments were developed through review of the literature involving similar studies of student perceptions and with the assistance of social scientists. The study includes both high school and college student perceptions of computing. The survey also contrasts student perceptions of "Computer Science" versus "Information Technology." The results show that little difference exists between college and high school students' perceptions. We suggest appropriate action items based on this and similar research coupled with a warning to avoid jumping to hasty conclusions based on empirical research where the numbers may not tell the whole story, i.e., avoid the embarrassment of the Piltdown Man[1] fiasco from an earlier century.

Keywords: enrollment trends, student perceptions, information systems education, NSF scholarships, STEM, ITEST

1. BACKGROUND AND MOTIVATION FOR THE STUDY

After 20 years of offering only a traditional Computer Science degree, our College began offering an Information Systems degree program in 2002. At that same time, we began offering NSF S-STEM scholarships (formerly CSEMS). The impact that these two initiatives have made on our computing enrollments has been reported previously (Battig 2007). Since then, we have received another NSF S-STEM grant for student scholarships. The upshot of these initiatives is that our computing enrollments have been holding steady at a little over 2% of our total undergraduate enrollment. We have found that this figure is consistent with the experiences of other institutions in our comparative and aspirant pool (see Figure 1 in Appendix A).

In 2006 we began collecting data regarding student perceptions of computing in our immediate geographical area. Our study includes both high school and college students. Our purpose in conducting this research is to identify trends, compare those trends with other relevant research, and then to formulate appropriate action based on the results. Our initial ideas about what that "appropriate action" would look like included amending our curriculum and modifying our recruitment strategies for undergraduate students. We were fairly certain that media portrayals of offshoring, outsourcing, layoffs, and other negative imagery would turn out to be the Piltdown Man of IT in this decade. What we're discovering, however, is that whether the media has it right or not is largely out of our control. The temptation we must avoid is to absolve ourselves from blame and miss the opportunity to influence the perceptions of our current high school and college students.

There's been quite a bit of "hand wringing" over the past few years in the Computing disciplines (we refer here to Information Systems, Computer Science and related fields). Most of it is attributable to the enrollment declines that have been observed.

Some would argue that "finger pointing" is a more accurate metaphor as the trend is undeniable and the real sport is found in determining the cause(s). A short list of commonly cited culprits might include: Y2K's inflation of the IT workforce, the Internet, dot com bust, the proliferation of computers and the attendant familiarity, offshoring, globalization & economic factors, media portrayals & inaccuracies, and outdated pedagogy (both K-12 and higher education). What is striking about this list is that the average pedagogue or practitioner is helpless to change the impact of these with the possible exception of "outdated pedagogy." Y2K is over – we can't change history. Ditto for dot bomb and the proliferation of ubiquitous computing. The economic factors of offshoring and globalization are difficult to predict, let alone control. Media portrayals are subject to the idiosyncrasies and biases of the individuals involved and experience has taught us that it is a double-edged sword to engage in trying to influence media power-brokers. Even pedagogy is difficult to affect due to the enormous scope of institutional systems that need to be involved (and experience tells us that it is difficult to get a group of professors to agree on something). Then of course there's the difficult to articulate possibility that a cyclical enrollment force is at work that we simply can't explain. After all, we're dealing with trying to explain the decisions of human beings, what we've come to call "social science."

A lengthy prelude as given above is a helpful reminder to us that we're dealing with a subject matter that often defies quantification, classification, or prediction. Therefore, we must take great care in drawing conclusions based on limited data or in scenarios where too many variables are beyond our control, which is often the case where human subjects are concerned. Given the perplexing decline of enrollments in our undergraduate computing programs, we have endeavored to study what others have done and engage in some experimentation in our own environment as well. In the remainder of this section, we will discuss some of the literature addressing this issue that is non-experimental in nature. In subsequent sections we will look at other experimental studies, our own study, and make concluding remarks.

The ACM Job Migration Task Force engaged in a serious effort to address the impact of globalization on our disciplines (Aspray 2006). The Task Force gave special attention to pedagogy in the section entitled "Education in Light of Offshoring." One could draw a multitude of conclusions based on this work. However, one constant theme woven throughout this section is the importance of a liberal education in the context of a changing world. The following is a laundry list of ideas from this work that support this assertion: giving students a liberal education, teaching them to think critically, importance that the education emphasizes teamwork and communication skills, acquaint students with different languages and cultures, prepare students to be creative and innovative, engage in life-long learning. The upshot of this list is that although we may need to address pedagogical issues through making our curricula more relevant and attractive, we must not lose sight of the fact that a liberal arts core is what gives our students the ability to think critically and begin a pilgrimage of lifelong learning.

Convincing exposition maintains that most of the factors that are blamed for declining numbers of students also existed during the boom years (Denning 2005). Therefore, our goal should be to embed the practice of innovation into our curricula. The benefit of such an approach is that the narrow view of computing as a field of programmers can be changed to that of innovators armed with computing technology. Some are convinced that the problem is rooted in a negative and inaccurate impression of the computing professions among pre-college students (Patterson 2005). The solution that has been proposed is to encourage participation in the CSTA (Computer Science Teacher's Association) among pre-college teachers. The image problem has even led some to conclude that we need to change the names of degree programs and avoid using outdated terms such as "Computer Science" (Immohr 2007). In addition to working to educate the public about the inaccurate representations of computing, the creation of inter-disciplinary computing programs should be considered (Mahmoud 2005). Examples include bioinformatics and environmental modeling. Coupled with degree options such as a Bachelor of Arts degree, these strategies may also increase the enrollment of women in computing. In summary, we should strive to not only teach innovation in our curricula, but we should practice innovation through our own creative changes in our educational approach.

At this point we should mention that there are some who hold that the notion of an IT worker shortage is mythical. Duke University Engineering professor Vivek Wadhwa says, "This whole concept of shortages is bogus, it shows a lack of understanding of the labor pool in the USA." (Chickowski 2008) The logic contends that wages are essentially flat in the IT labor market in the US and therefore no evidence of a labor shortage can be inferred in a free market economy. Furthermore, the enrollment rates for computing disciplines at America's colleges and universities mirror the rational student's perceptions about wages. Therefore, once wages begin to climb, enrollments will grow. Thus, we might say that the lack of increasing wages in the economy is an "inconvenient truth" for those of us who are experiencing sharp declines in our undergraduate computing programs.

A debate rages in the STEM fields about the impact of globalization on enrollments in those disciplines. No doubt the two 800 pound gorillas in this debate are China and India. Those in the US are concerned about the widening gap of production since both China and India have been graduating engineers at an accelerated pace. However, "many aspects of the debate are murky, starting with the numbers themselves (Gereffi 2008)." This research shows that the gap is smaller than many think since China and India count many inferior program graduates in the statistics. As a result, many graduates in these countries experience substantial unemployment. Therefore, "the key issue in engineering education should be the quality of the graduates, not just the quantity, since quality factors have the biggest impact on innovation and entrepreneurship." Thus if we don't get our facts straight, history may show us as a group that promoted the hype of a Piltdown Man.

2. RELATED RESEARCH

In preparing our study, we primarily reviewed sources that contained studies investigating perceptions from college or high school students about computing as an academic field of study. However, a few pertain to the IT job market and its impact on enrollments. Here we will summarize the findings as they pertain to the work that we are engaged.

A novel approach to studying the IT job market is to "systematically sample job advertisements" in major metro areas over the past two decades (Litecky 2008). The study compares advertising rates from the 1990s with the current decade in 35 geographic areas. Furthermore, the study concludes that the IT job market has recovered and that "recent declines and low enrollments in CS and MIS programs means the number of graduates will be low enough so that, as the market improves, job demand might be even greater than in the boom times of the 1990s." Certainly there's nothing inconvenient about this research for current students in undergraduate computing programs.

We found two studies that were closely related to our work. The first involved a survey of over 800 Calculus and Pre-Calculus students in California and Arizona high schools (Carter 2006). The author's hypothesis was that enrollment declines are attributable to either a lack of information or incorrect notions about what the study of computing involves. The most striking outcome of this study was that the overwhelming majority of students surveyed (80%) indicated that they had "no idea" what Computer Science majors learn. Furthermore, the study concluded that only 2% of respondents had a "good grasp" of what Computer Science majors learn. The survey instrument provided investigation into the negative influences on the selection of Computer Science as a major. The top three negatives were: not wanting to sit in front of a computer for long periods of time, respondent has already decided on another major, and the respondent prefers a more "people-oriented" major. The failure of students outside of CS to grasp the essence of the field is repeatedly demonstrated in the literature. However, we suspect that one would find similar results in many science-oriented fields (e.g., chemistry and chemical engineering).

A recent study of over 400 college underclass students (mostly freshmen) sought to measure their attitudes and perceptions about computer-related undergraduate programs (Woratschek 2007). Although this study contained a great deal of information, one important outcome was that most did not choose a computer related major because "they were not interested in a technical career." A significant percentage also felt that "I didn't think I would like the work" and that "I didn't think the employment prospects were good." Of greatest interest to us in this study is the emphasis on high school influences. The authors point out that high school computer science education is inadequate because the majority of students take courses involving word processing, typing, and keyboarding. We feel this is analogous to teaching mechanical engineering by securing student internships at Jiffy Lube. Yet another case for Piltdown Man!

Another study with a *student misinformation about computing* hypothesis was conducted by surveying college freshman regarding the factors influencing their choice of major at a state university in Louisiana (Lomerson 2006). The authors initially believed that high school guidance counselors were a significant influence on a student's choice of major. However, the study concluded that "self collected inputs" and the student's "family" are far more influential. Significant negative influences for not choosing a computer-related major in this study include a lack of interest in "technical careers" and respondents believing that they would "not like the work" involved in this profession.

Nebraska high school students have been surveyed about their perceptions of information technology careers and skills needed for success (Gupta 2000). The students in this study reported that they acquired computing skills by being "self-taught" more than from teachers, classmates, or relatives. The respondents' top uses of computers were for word processing, the Internet and games. Not surprisingly, the students' perceptions of skills necessary for success in IT careers placed "keyboarding" and "computer skills/knowledge" well above "programming" and "math" in this study. What is surprising about this study is that the students overwhelmingly chose "good money/benefits" as the most positive motivator to pursue an IT career.

Our investigation considered two studies done in conjunction with non-majors (CS0) courses for undergraduate students. In the first study (Kurkovsky 2007), most of the students were Business or liberal arts majors taking a first course in computing. The vast majority of students expressed that they had no clear idea of what Computer Science is or what to expect to learn in a first course. Most respondents were required to take the class for their major. The most popular answers to "what is CS to you?" were "how computers work" and "using computers for a purpose." The second study was conducted in the context of creating a CS0 course for both CS majors and non-majors (Brady 2004). The authors point to some positive realignments of student perceptions of CS on their small college campus as a result of students taking their CS0 course. The observations about student perceptions are based on pre and post surveys. Initially, students tend to view Computer Science as programming. Afterward, students have a much broader and accurate definition of Computer Science. Once again, however, these authors have concluded that students really don't have much of an idea of what CS embodies. All of this continues to remind us of what Dijkstra said: "Computer Science is no more about computers than astronomy is about telescopes."

One of the most comprehensive surveys about student perceptions of Computer Science was conducted with over 4,000 high school students in New York State (O'Lander 1996). Although there are many facets of this study, we will focus on a couple. First, the study determined that the most common factors leading to student apprehension for Computer Science as a major were perception of their computing ability and their enthusiasm toward computing. The reader will note that this study was conducted during the last valley of the cyclical CS enrollment graph, a little more than a decade ago. With that in mind, consider the author's remark concerning career and employment opportunities in computing: "It is undoubtedly the weak positive perception of careers and opportunities that mainly accounts for the declining enrollment in Computer Science as a major over the past decade." In the historical context of this remark, there was no offshoring movement or "dot bomb" to blame.

Rather, the author points to the perception of a weak IT sector in the economy.

One international stop on the literature review train is a study done among high school students in their final year of study in South Africa (Seymour 2004). Once again, these authors have offered a vast number of measures of student perceptions yet we will only consider a subset. Their results show that computer access has a negative influence on the choice of IS or CS as a major. Furthermore, they show that a lack of Internet access at school and home coincides with an increased interest in studying IT related material. Thus, they rightly conclude that "familiarity breeds contempt." Also of interest, this study concludes that perceptions regarding starting salaries are not significant motivators. However, negative and positive perceptions about future job prospects do influence a student's inclination to study CS or IS. Lastly, these researchers showed that there is anecdotal evidence (via student comments) that suggests students don't understand the difference between IS and CS.

Our final stop based on the "Social Cognitive Career Theory" that seeks "to examine the particular set of factors that sway students to choose a computing major" (Akbulut 2007). A major tenant of this study is that self-efficacy, a student's judgment of being effective or capable in the major, will largely determine their aspiration to study computing. The study concludes by offering some recommendations, which we will do as well. The following four recommendations are offered in the area of self-efficacy:

- Demonstrate tasks before asking students to complete them
- Recruit peer groups to deliver persuasive messages to students
- Ensure students experience immediate and frequent successes
- Create classroom environments that are fun and entertaining.

While we find the first two recommendations to be prudent and helpful, the second two on this list will often be contrary to the very nature of computing pedagogy. We're certainly not saying that our teaching should be harsh and dull! However, there are many lab experiences in computing pedagogy that will not provide students with immediate and entertaining experiences, e.g., the first exposure to type II nested queries in SQL, or from an earlier era, the master-file update algorithm!

3. PARTICULARS OF OUR STUDY

During the fall 2006 term, we began to develop a survey instrument for use among high school students and in our introductory Business class (taken by over 200 students each year, mostly freshmen). The survey design was created in concert with an economics professor experienced in surveying human subjects. We were also influenced by surveys used in the research described in the previous section. We field-tested the survey with a small group of students and made minor adjustments afterward. The original college survey is shown in Appendix B. The high school version contained minor changes from the collegiate version (for example, we did not ask high school students if they've taken a computer science course).

The results of our high school survey are based on a survey conducted at a local high school computer applications course in April of 2007. The survey produced 199 usable results (55%/45% male/female and 67% freshman). The top answers to select questions are shown in Table 1. The reader will note that the three strongest perceptions held by this group in response to these statements are that CS: is respectable (52.76%), involves difficult problems (48.74%), and has post graduation opportunity (48.74%). Also of interest is that these high school students generally either don't know or have no opinion regarding offshoring and salary prospects. Our second section of statements allows students to choose their top two potential motivators for studying Computer Science from a list of six (Table 2). Our hypothesis was that the second statement involving "computer games" would be the top choice. We were surprised to see "high pay" far out pace this response. We also found it interesting that working "in a field that involves both technology and people" finished second overall, which may provide some insight into attracting and recruiting potential students.

After the survey was administered in the local high school courses (in sections of about 30 students), a professor and student from our department visited the classroom and provided a dynamic presentation about the ubiquitous nature of computing in our society and the career opportunities available related to computing. The sessions were designed to be highly interactive and dialogical. 45 days after the classroom visits, the high school students were given the same survey again to see if their perceptions would change as a result of the presentation. There were no substantial changes in student perceptions (Tables 3 & 4) other than the fact that "make a lot of money" transitioned from "no opinion" to "agree." The lesson that we took from this exercise is that one day at a high school produces a minimal impact on student understanding of our discipline. Clearly we need a more sustained and methodical presence in the high school curriculum!

Our next move was to try our survey on college students to determine if they are better informed about computing than high school students. To accomplish this we were given access to the freshman level "Foundations of Business Administration" course at our institution. We received 106 valid surveys from the four sections that participated. Our demographics show an audience that is primarily male (55% vs. 45%) and freshman (61%). We also computed the percentage of Business majors (75%), whether they had taken a computer science course (a surprising 36% - we suspect they're counting an MIS course that is Excel intensive), and their self-reported GPA (we asked the high school audience this as well, but have no means to verify the data). We computed the average GPA for our survey students as 3.09. This computation gave us a bit of confidence regarding the truthfulness of our students in that our Registrar informed us that in the previous semester the average institutional GPA was 3.10 and that the average GPA in all Business courses was 3.05. Tables 5 and 6 display the most prevalent responses.

The most striking issue one notices when comparing Tables 5 & 6 with Tables 1 & 2 is their uncanny similarity. The same responses are the top responses in both survey groups. Both high school and college students are apparently in the dark about offshoring and the amount of money computer scientists make given that "no opinion/don't know" is the top answer for both groups. However, money seems to be a motivator since it is the top reason given for studying computer science. A quarter of the college students are motivated by "a field that involves both technology and people," and 18% are motivated by "a field that is constantly changing." These are clearly two angles that could be leveraged in the promotion of computing as an undergraduate field of study.

After we finished the tabulation of the college results during the summer of 2007, we began to wonder if the 36% who had taken a computer science course would differ substantially from the overall group. We hypothesized that they would be more knowledgeable about the field as a result of taking a course (we assume they've taken our Introduction to Computing course that Business majors can take in place of the MIS course alluded to above, but we can't be sure). Therefore, we tabulated those surveys as a separate group to see if there we any noticeable differences. The answer in general is that there were no obvious differences within this subgroup who had taken a CS course. For example, those completing a CS course also listed "no opinion/don't know" as the top answer (31.58%) for the offshoring question ("work will eventually be done overseas…"). However, one interesting difference is that this subgroup ranked working in "a field that involves both technology and people" as the number one motivator at 30.99%, outdistancing "high pay" at 26.76%. Again, we continue to see evidence that our non-major CS course does not inform students about the issue of offshoring (which we believe is overstated in the general media) and that students may be substantially motivated to study computer science when it is perceived as an interesting confluence of working with technology and people.

During the summer of 2007 we began to wonder about the fact that our survey instruments measure perceptions of "Computer Science." Specifically, we began to think that perhaps the term is too academic, pedantic or vague in the mind of students. After all, many undergraduate courses of study exist that involve computing that make no use of the root word, compute (e.g., Management Information Systems, Information Technology). Armed with renewed curiosity, we revised our survey instrument by replacing the phrase "Computer Science" with "Information Technology." As a result, we surveyed the "Foundations of Business Administration" course in December of 2007 and April of 2008 using the new phrase. We were motivated to determine how student perceptions would differ with the use of a more practical and less theoretical term for the computing disciplines.

Our new survey demographics were similar to those before. Of the 129 surveyed, 59% were male, 44% were freshman, and 62% were Business majors. Again, we considered the validity of the survey by checking self-reported GPA against college averages. The self-reported GPA of this group was 3.22, whereas the College and Business averages were both 3.13. Thus we either have some brighter students in our sampling, or perhaps slightly more arrogant ones. But in either case, a .09 difference seems within reason. Finally, 33% of this group reported that they had taken a Computer Science course previously (we did not change the wording of this question to "Information Technology" since we offer no such courses). Tables 7 & 8 display the top responses.

We will now contrast Tables 7 & 8 with Tables 5 & 6 to determine the impact on student perception the term "Information Technology" has compared to "Computer Science." In general, we can say that some responses indicate a slightly more positive perception of "Information Technology," but overall there appears to be no appreciable difference from "Computer Science." For instance the top two motivators continue in both groups: money and working with "both technology and people." In fact the two groups are within two percentage points of each other. Thus, we would have to conclude from this data that a change in name of an academic program from "Computer Science" to "Information Technology" does not foster a significant change in perception among this sampling audience.

4. DISCUSSION AND FUTURE WORK

As we stated earlier, our purpose in this work is to take our findings, in concert with the relevant research of others, and formulate appropriate action. For starters, we know that our field's short history has been one of instability in terms of enrollments as show in Figure 2 below (Vegso 2007). We also know there are many factors that influence these enrollments, including perceptions and economic conditions. The economic outlook for IT workforce growth appears to be positive. Thus we believe that appropriate action is to influence perceptions in appropriate ways as educators. We will now look at our strategies for doing so at both the high school and college level.

As we contemplate our experience of working with high school students, we have noticed that they gain one of two primary perceptions of computing based on their high school coursework. The vast majority in our state are required to take a "computer apps" course that is primarily keyboarding and Microsoft Office tools. The experience, coupled with ubiquitous use of Facebook and iPods, leaves students with a stunted view of computing as merely *tool using*. The anecdotal evidence from our surveys suggests that students feel they have mastery of the computer in a tool-using capacity and therefore would certainly not find the field rich enough to merit study at the undergraduate level. On the other hand, a few students will embark on the Computer Science AP path. Unfortunately, this path leaves students with a stunted view of computing as well. The problem with AP courses is that they reach so few students and more specifically, those students are left with the view that computer science is programming. Therefore, many of them may not pursue studies at the undergraduate level because they do not appreciate the richness and the breadth of our problem solving field. For example, they have come to understand how to sort a simple list in Java, but have no idea about how to use a Genetic Algorithm to solve a difficult business problem because they are not even remotely aware of the many novel approaches revealed in the Artificial Intelligence sub-specialization (I could of course choose examples from Networking, Database, Operating Systems, Ergonomics, Knowledge Management, or a dozen other sub-specializations that we are familiar with). This dichotomy of misunderstanding the computing field is also prevalent in the study of over 800 high school students (Carter 2006).

Given that our college sampling audience is primarily freshman Business majors, we should not be so surprised that the results are so similar to the high school group.

They've been exposed to the same limited information about computing in their educational experience. Thus, we've concluded that our impact on student perceptions and understanding of our disciplines in computing will be very limited if we restrict ourselves to rectifying this situation at the college level. Clearly we need to move further back in the pipeline. However, we can do something about clarifying the breadth and richness of computing among our undergraduates. Specifically, we've begun to emphasize lab exercises that reveal the breadth of computing to our freshman CS and IS majors in our introductory Java programming courses. Furthermore, we've inserted three distinct lecture points during the semester in which we discuss the fact that programming is only a tool to the engineer or information technology worker. During the first and last lectures of the semester we inserted specific material to articulate to students that the mastery of the programming language should not be confused with the essence of what the discipline is about (the famous Dijkstra quote is even invoked). The students are reminded again when the GUI material is presented as they are given a sampling of the concepts involved in HCI/Human Factors/Ergonomics and how programmers must step out of their own experience in order to design interfaces that are truly helpful to the customer. The goal of this process in our introductory programming courses is to make sure that we don't lose students from our major due to misconception.

The real issue though is not losing our existing students (as important as that is). The important issue is attracting more students into our disciplines for the right reasons (i.e., not money). Here we are particularly interested in looking at the trends in our research as they pertain to motivators. We notice a steadily climbing rate of interest in "a field that involves both technology and people." Similarly, we see increasing interest in "a field that is constantly changing." Thus, we believe that we need to promote these ideas through enhancing the K-12 curriculum in our state in throughout the country. Specifically, we need to promote the notion of a "breadth of computing" instead of merely "tool using" or "programming." The need for this kind of curricular innovation is not something that we alone have stumbled upon. The NSF has specifically targeted funds toward this notion in the ITEST program (Innovative Technology Experiences for Students and Teachers). Our faculty has initiated a working group of industrial and academic partners along with government and the department of education in our state to begin the enhancement at the K-12 level. In addition to writing a grant proposal to the NSF this year, we are beginning a pilot project in concert with a local high school. Our pilot project will work with one high school technology teacher to create a "breadth of computing course" as an alternative to the traditional "computer apps" course. After the pilot, we plan to revise the curriculum and then seek to promote the concept around the state as a model for adoption by our state department of education. We are embarking on this "grassroots" approach because our past experience has shown us how difficult both logistically and politically it can be to influence the department of education in a "top down" manner. Thus, we are seeking to get the K-12 teachers and administrators excited about this idea first.

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6. REFERENCES

Akbulut, Asli Y. and Clayton A. Looney (2007) "Inspiring Students to Pursue Computing Degrees." Communications of the ACM, vol. 50, no. 10, pg. 67-71.

Aspray, William, Frank Mayadas, and Moshe Vardi, Editors (2006) "Globalization and Offshoring of Software: A Report of the ACM Job Migration Task Force." http://www.acm.org/membership/learn more/pdf/shortv.pdf.

Battig, Michael (2007) "Examining the impact of a new Information Systems Program and NSF STEM funding on computing enrollments." Proceedings of the

24th Annual Information Systems Education Conference, Pittsburgh, Pennsylvania.

Brady, Alyce, Pamela Cutter, and Kelly Schultz (2004) "Benefits of a CS0 Course in Liberal Arts Colleges." Journal of Computing Sciences in Colleges, vol. 20, no. 1.

Carter, Lori (2006) "Why Students with an Apparent Aptitude for Computer Science Don't Choose to Major in Computer Science." SIGCSE Bulletin, vol. 38, no. 1, pg. 27-31.

Chickowski, Ericka (2008) "Is There Really an IT Labor Shortage?" Baseline Magazine. http://www.baselinemag.com /c/a/IT-Management/Is-There-Really-an-IT-Labor-Shortage/4/

Denning, Peter J. and Andrew McGettrick (2005) "Recentering Computer Science." Communications of the ACM, vol. 48, no. 11.

Gereffi, Gary, Vivek Wadhwa, Ben Rissing, and Ryan Ong, "Getting the Numbers Right: International Engineering Education in the United States, China, and India," 2008, Journal of Engineering Education, vol. 97, no. 1, pg. 13-25.

Gupta, Uma G. and Lynne E. Houtz (2000) "High School Students' Perceptions of Information Technology Skills and Careers." Journal of Industrial Technology, vol. 16, no. 4.

Immohr, Larry (2007) "Is 'Computer Science' an Outdated Term?" Wired Campus Blog. The Chronicle of Higher Education.http://chronicle.com/wiredcampus/article/2101/is-computer-science-an-outdated-term.

Kurkovsky, Stan (2007) "Making Computing Attractive for Non-Majors: A Course Design." Journal of Computing Sciences in Colleges, vol. 22, no. 3.

Litecky, Chuck, Biben Prabhakar and Kirk Arnett (2008) "The Size of the IT Job Market." Communications of the ACM, vol. 51, no. 4.

Lomerson, William L., and Lissa Pollacia (2006) "CIS Enrollment Decline: Examining Pre-College Factors." Information Systems Education Journal, vol. 4, no. 35.

Mahmoud, Qusay H. (2005) "Revitalizing Computing Science Education." IEEE Computer, vol. 38, no. 5, pg. 98-100.

O'Lander, Richard (1996) "Factors Effecting High School Student's Choice of Computer Science as a Major." Proceedings of the symposium on Computers and the quality of life.

Patterson, David A. (2005) "Restoring the Popularity of Computer Science." Communications of the ACM, vol. 48, no. 9.

Seymour, Lisa, Mike Hart, Peter Haralamous, Tasneem Natha and Chai-wen Wend (2004) "Inclination of Scholars to Major in Information Systems or Computer Science." Proceedings of SAICSIT, pgs 97-106.

Vegso, Jay (2007) "Continued Drop in CS Bachelor's Degree Production and Enrollments as the Number of New Majors Stabilizes." Computing Research News, Vol 19/No. 2.

Woratschek, Charles R., and Terri L. Lenox (2007) "Student Attitudes and Perceptions Regarding Computing and Its Related Disciplines." Proceedings of the 24th Annual Information Systems Education Conference, Pittsburgh, Pennsylvania.

7. ENDNOTE

[1]Piltdown Man is a famous archeological hoax consisting of fragments of a skull and jawbone collected in 1912 from a gravel pit at Piltdown, England. The fragments were thought by many experts of the day to be the fossilized remains of a previously unknown early human (the "missing link"). The "find" remained the subject of controversy until it was exposed in 1953 as

a forgery, consisting of the lower jawbone of an orangutan with the skull of a relatively modern man.

APPENDIX A – Tables & Figures

Institution	CS/IS/IT	Total	%
Fairfield University	30	4008	0.75%
St Lawrence University	18	2182	0.82%
Wheaton College	19	1561	1.22%
Skidmore College	35	2759	1.27%
Assumption College	30	2129	1.41%
Wesleyan University	41	2813	1.46%
Connecticut College	28	1872	1.50%
Middlebury College	36	2406	1.50%
Stonehill College	38	2371	1.60%
Bowdoin College	28	1734	1.61%
Providence College	66	3998	1.65%
Saint Michael's College	41	1992	2.06%
Colgate University	59	2782	2.12%
Smith College	58	2634	2.20%
Colby College	42	1865	2.25%
Hamilton College	43	1821	2.36%
Wellesley College	55	2318	2.37%
Williams College	56	2003	2.80%
Trinity College	79	2353	3.36%
Siena College	121	3220	3.76%
Amherst College	62	1648	3.76%
Bryant University	302	3268	9.24%
AVERAGE:	49.5	2179.2	2.29%

Figure 1 – Computing Enrollments as a percent of Total (includes all computing-related majors, e.g., CS, IS, MIS, IT, etc.). Source: Saint Michael's College Institutional Research.

QUESTION	Top Ans.	Percent
Computer Scientists are "geeks"	Disagree	39.20%
Computer Scientists solve difficult problems	Agree	48.74%
Computer Science work will eventually be done overseas and future job prospects are bleak	N/O	37.69%
Computer Science is a respectable occupation	Agree	52.76%
Computer Scientists make a lot of money	N/O	40.20%
Computer Scientists have many career opportunities after graduation	Agree	48.74%
Computer Scientists do important work that is critical to society	Agree	44.72%
Computer Science is a very difficult subject to study and succeed	Agree	33.67%
Computer Science is boring compared to other subjects/majors	Disagree	35.18%
Computer Science is a subject that requires too much math	Disagree	32.66%

Table 1 – Most common responses to ten statements about CS

Opportunity to get a high paying job after graduation	31.75%
Prospect of developing interesting applications such as computer games	15.32%
Opportunity to study a field that involves problem-solving	11.70%
Opportunity to study in subject that is both practical and makes use of mathematics	10.31%
Opportunity to work in a field that involves both technology and people	15.88%
Opportunity to work in a field that is constantly changing	15.04%

Table 2 – Percent of students selecting a statement as 1st or 2nd motivator

QUESTION	Top Ans.	Percent
Computer Scientists are "geeks"	Disagree	43.79%
Computer Scientists solve difficult problems	Agree	51.63%
Computer Science work will eventually be done overseas and future job prospects are bleak	N/O	32.68%
Computer Science is a respectable occupation	Agree	60.13%
Computer Scientists make a lot of money	Agree	45.10%
Computer Scientists have many career opportunities after graduation	Agree	48.37%
Computer Scientists do important work that is critical to society	Agree	50.98%
Computer Science is a very difficult subject to study and succeed	Agree	40.52%
Computer Science is boring compared to other subjects/majors	Disagree	39.22%
Computer Science is a subject that requires too much math	Disagree	37.25%

Table 3 – High School survey 45 days later

Opportunity to get a high paying job after graduation	35.89%
Prospect of developing interesting applications such as computer games	14.98%
Opportunity to study a field that involves problem-solving	10.80%
Opportunity to study in subject that is both practical and makes use of mathematics	6.62%
Opportunity to work in a field that involves both technology and people	17.77%
Opportunity to work in a field that is constantly changing	13.94%

Table 4 – High School "motivators" 45 days later

QUESTION	Top Ans.	Percent
Computer Scientists are "geeks"	Disagree	32.68%
Computer Scientists solve difficult problems	Agree	49.06%
Computer Science work will eventually be done overseas and future job prospects are bleak	N/O	39.62%
Computer Science is a respectable occupation	Agree	57.55%
Computer Scientists make a lot of money	N/O	35.85%
Computer Scientists have many career opportunities after graduation	Agree	40.57%
Computer Scientists do important work that is critical to society	Agree	57.55%
Computer Science is a very difficult subject to study and succeed	Agree	31.13%
Computer Science is boring compared to other subjects/majors	Agree/Dis*	28.30%
Computer Science is a subject that requires too much math	Disagree	34.91%

Table 5 – Original College survey from Spring 2007 semester
* Tie between "Agree" and "Disagree" on the "boring" issue

Opportunity to get a high paying job after graduation	29.79%
Prospect of developing interesting applications such as computer games	14.36%
Opportunity to study a field that involves problem-solving	6.91%
Opportunity to study in subject that is both practical and makes use of mathematics	6.38%
Opportunity to work in a field that involves both technology and people	24.47%
Opportunity to work in a field that is constantly changing	18.09%

Table 6 – College "motivators" Spring 2007

QUESTION	Top Ans.	Percent
Information Technology majors are "geeks"	Disagree	41.86%
Information Technology majors solve difficult problems	Agree	50.39%
Information Technology work will eventually be done overseas and future job prospects are bleak	Disagree	33.33%
Information Technology is a respectable occupation	Agree	45.74%
Information Technology workers make a lot of money	Agree/NO*	34.88%
Information Technology majors have many career opportunities after graduation	Agree	43.41%
Information Technology workers do important work that is critical to society	Agree	48.84%
Information Technology is a very difficult subject to study and succeed	Agree	37.98%
Information Technology is boring compared to other subjects/majors	Agree	34.88%
Information Technology is a subject that requires too much math	Agree/Dis**	27.91%

Table 7 – Survey from the "Information Technology" group
* Tie between "Agree" and "No Opinion" on the "money" issue
** Tie between "Agree" and "Disagree" on the "too much math" issue

Opportunity to get a high paying job after graduation	31.17%
Prospect of developing interesting applications such as computer games	10.39%
Opportunity to study a field that involves problem-solving	6.93%
Opportunity to study in subject that is both practical and makes use of mathematics	4.33%
Opportunity to work in a field that involves both technology and people	25.97%
Opportunity to work in a field that is constantly changing	21.21%

Table 8 – Motivators for the "Information Technology" group

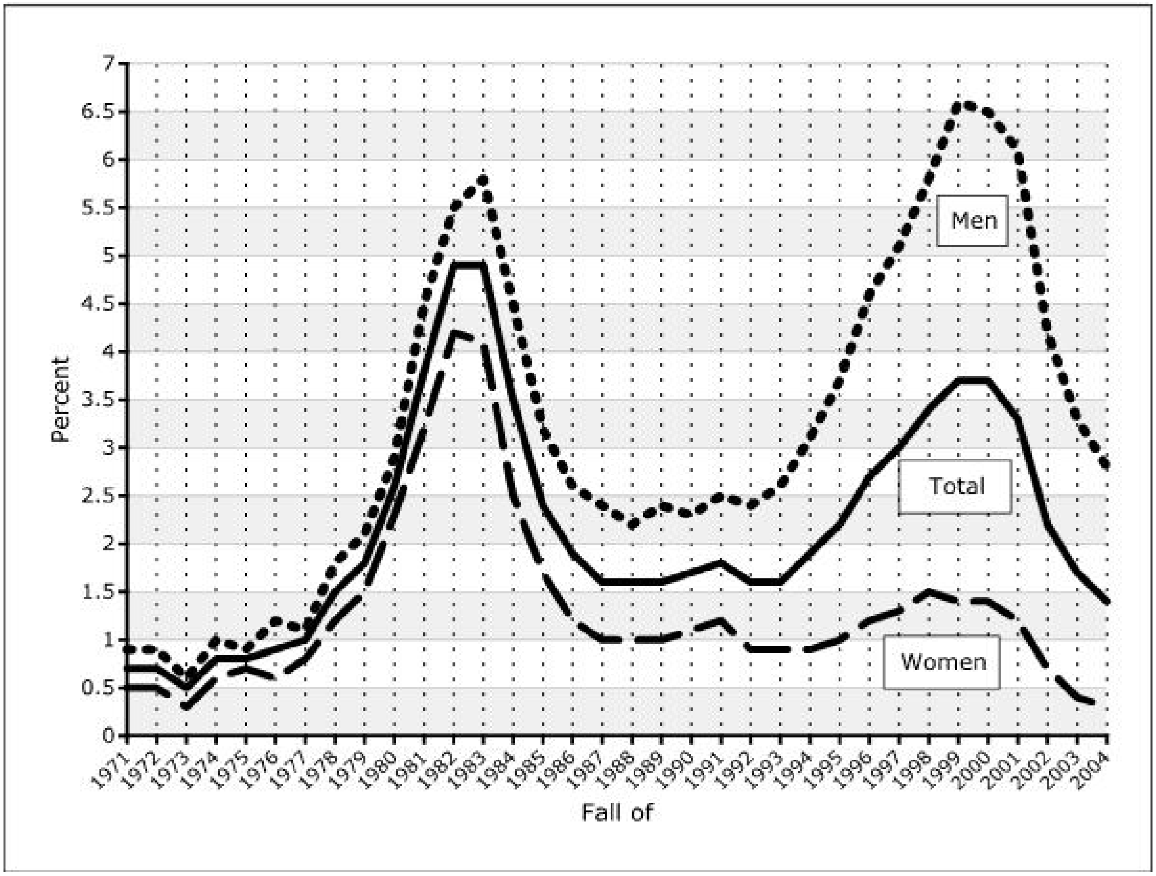

Figure 2 – Computing enrollment trends over the past 30+ years (CRA)

APPENDIX B - Perceptions of Computer Science Survey

A. The following is a list of statements that have been made about Computer Science majors, please circle the number indicating the extent to which you agree or disagree with each statement.

1 = Strongly Agree, **2** = Agree, **3** = Disagree, **4** = Strongly Disagree, **N/O** = No Opinion/Don't Know

Computer Scientists are "geeks"	**1 2 3 4 N/O**
Computer Scientists solve difficult problems	**1 2 3 4 N/O**
Computer Science work will eventually be done overseas and future job prospects are bleak	**1 2 3 4 N/O**
Computer Science is a respectable occupation	**1 2 3 4 N/O**
Computer Scientists make a lot of money	**1 2 3 4 N/O**
Computer Scientists have many career opportunities after graduation	**1 2 3 4 N/O**
Computer Scientists do important work that is critical to society	**1 2 3 4 N/O**
Computer Science is a very difficult subject to study and succeed	**1 2 3 4 N/O**
Computer Science is boring compared to other subjects/majors	**1 2 3 4 N/O**
Computer Science is a subject that requires too much math	**1 2 3 4 N/O**

B. Which of the following statements describe how you feel about choosing Computer Science as a major? Place a "**1**" by your top answer, and a "**2**" by your second choice, if you have one.

_____Opportunity to get a high paying job after graduation
_____Prospect of developing interesting applications such as computer games
_____Opportunity to study a field that involves problem-solving
_____Opportunity to study in subject that is both practical and makes use of mathematics
_____Opportunity to work in a field that involves both technology and people
_____Opportunity to work in a field that is constantly changing

C. In your opinion, what are the major advantages of a Computer Science major (degree in Computer Science)?

1.____
2.____
3.____

D. In your opinion, what are the major disadvantages of a Computer Science major (degree in Computer Science)?

1.____
2.____
3.____

E. How would you recommend that the Computer Science Department improve or change their image or reputation? What would you recommend that they do differently?

F. Background information (Circle correct response where applicable):

1. **Male** / **Female**
2. What is your current major?____________________
3. Year in school: **Freshman** **Sophomore** **Junior** **Senior**
4. Have you ever taken a CS (Computer Science) course at XXXXXXX? **Yes** / **No**
5. Which of the following best describes your academic performance in school (Circle One):

A A/B B B/C C C/D D D/F F