

CAMP IE—A Discipline-Specific Model for the Recruitment of Minorities into Engineering

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Abstract

In spite of progress made over the last 20 years, recruitment and retention of African American students remain a problem at most engineering schools. Many universities have developed programs that seek to introduce pre-college students to the engineering profession early in their high school careers. The University of Louisville is no exception. In collaboration with the local public high school system, the University of Louisville's Department of Industrial Engineering developed "*CAMP IE*". This unique program is a discipline-specific, five week, Saturday morning "camp" for 9th and 10th grade students who have been historically under-represented in engineering. Given the demographics of Louisville, this program chose to target African American youth. This paper describes how "*CAMP IE*" was developed, its goals and key elements, and how its principles can be modified to meet the recruitment needs of other engineering colleges.

I. Introduction

Over the years, minority youth have been sorely underrepresented in institutions of higher education in general and in industrial engineering programs in particular. Although some minority high school students have vague ideas of what engineers do, few of them have had the opportunity to interact with engineers and better understand the work they perform.

Within the Jefferson County Public School system, there are many underrepresented minority students who have the aptitude to be successful in engineering. However, these young people often lose interest and motivation due to other compelling vices, negative peer pressure or a lack of influential positive role models nurturing and encouraging them. To counteract the foregoing problem and further provide encouragement to those who are capable and interested in engineering, the Department of Industrial Engineering at the University of Louisville (UofL) in collaboration with the Jefferson County Public Schools (JCPS) Comprehensive Partnership for Minority Student Achievement (CPMSA) Program Office developed and piloted a model camp—the "*CAMP IE*" Program.

This paper will describe the elements and goals of the program and present some of the initial outcomes from the pilot group of 46 students. In addition, the authors present some resulting general principles that make the camp effective, particularly in an urban environment. Finally, the authors suggest some recommendations for further research with respect to the longitudinal effects of these students.

II. Program Background

In 1996, funding was granted by the JCPS/UofL Coordinating Committee for the development and piloting of “*CAMP IE*”, a collaborative education project. The funding agent’s primary interest was to encourage educational collaboration between the local public schools and the University of Louisville that involve both the JCPS teachers or administrators and the UofL faculty or administrators. In addition, as the project evolved, enhanced funding was received from the CPMSA Program Office via a National Science Foundation Comprehensive Partnership for Minority Student Achievement (NSF/CPMSA) grant, which is a 5-year partnership with JCPS and NSF to address the critical problem of preparing more underrepresented minority students to enter college and pursue math/science/technology -related careers.

The “*CAMP IE*” model is a 5-week, held consecutively, Saturday morning program, designed by the Industrial Engineering and Engineering Management faculty and some key JCPS high school teachers for prospective Industrial Engineering students, with an emphasis on underrepresented minority students. The program was designed to promote engineering and science interests in African American students very early in their high school study of math and science. In addition, the program, consisting of a combination of short course instructional segments, hands-on laboratory experiences and motivational and self-assessments, provides the students with a “taste” of the industrial engineering discipline.

The Department of Industrial of Engineering at the University of Louisville offers a unique accredited five-year Master’s degree in Industrial Engineering. In addition to developing a solid foundation in engineering principles, the degree program also provides the undergraduate student with a background in the arts, humanities, and social sciences. The program offers a “hands-on” curriculum that is consistent with the department’s philosophy that “the student must learn by doing it, not just reading about it.”

Although the pursuit of an Industrial Engineering degree at the University of Louisville is a challenging task, recruitment of African American students to the discipline of industrial engineering is also a challenge for the department as well as the university at large. The University is a state supported, urban institution located in Louisville, Kentucky. Currently 91% of the student body comes from the Commonwealth of Kentucky. The average age of the undergraduate student at the university is 25 years old. A review of the matriculation data at the university over a six-year period, from 1993 to 1998, reinforced the need for a program such as “*CAMP IE*”. As shown in Figure 1, relative to the admission of all first-time freshmen over the past five years, African American students have consistently averaged below 20% with a decreasing trend since the Fall 1996. The undergraduate enrollment for the fall of 1998 was 14,647 with 53.5% female students and 12.6% African American students.

III. Model Justification

The City of Louisville (in which Jefferson County Public School system resides) covers over 375,000 square miles of metropolitan land, has a population of over 365,000 people with 32% underrepresented minorities. In 1992, the Jefferson County Public School district had over

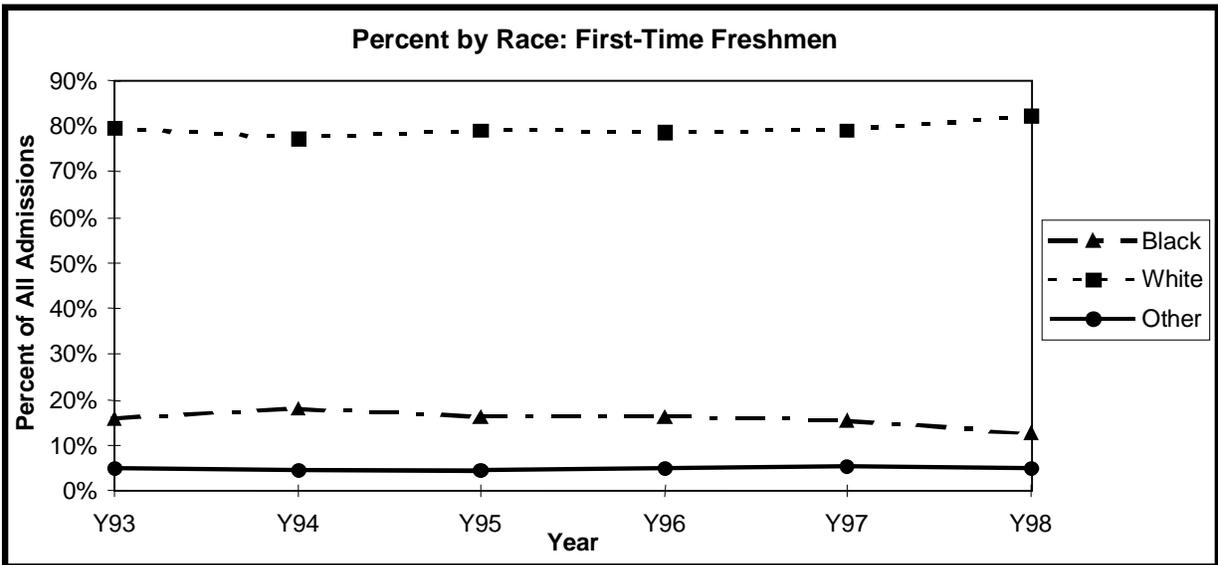


Figure 1. Percent by Race the First-Time Freshman Entering University of Louisville

96,000 students. Over the five years of the CPMSA National Science Foundation grant period, the demographic representation within the thirty-four CPMSA schools had an average 41% African American students. It is hypothesized that efforts to focus on the schools with the highest populations of underrepresented minority students would mean having the greatest systematic impact of getting more of these students into the “pipeline” of readiness for math/science/technology technology -related careers. There is no published research regarding the longitudinal assessment of this hypothesis, which is beyond the scope of this paper.

Nonetheless, as seen in Figure 1, the percentage of black students has remained disproportionately relative to that sector of the population of the Jefferson County Public School district, while the percentage of first time white students is consistent relative to their presence within the school district.

Figure 2 shows the percentages of first time freshmen students from Jefferson County from the period of 1993 to 1998. African-Americans are, by far, the largest group of underrepresented students at the University of Louisville. The percentage of African American students from Jefferson County started out at just over 52% in 1993, gradually rising and peaking in 1996 at just over 60%, then declining and stabilizing at the current level of approximately 56%. Although the percentages of “other” students followed a highly erratic pattern, the actual numbers of these students from Jefferson County who matriculate into the University of Louisville annually is still quite small. These demographics reinforce the justification of the targeted group of schools and students for the “*CAMP IE*” model.

The Speed Scientific School is the University's College of Engineering. Degrees are awarded in six areas of engineering—civil and environmental, chemical, electrical and computer engineering, computer engineering and computer science, mechanical, and industrial engineering. There is also an evening program that enables students to earn a master's degree in engineering management through the Department of Industrial Engineering.

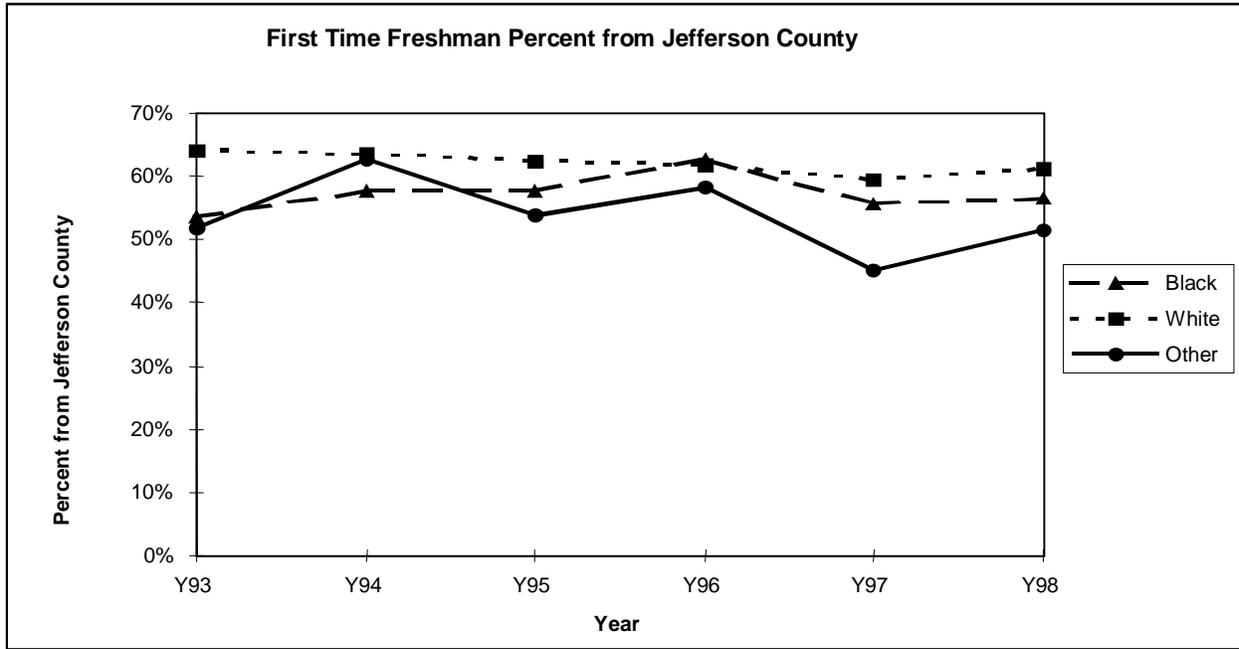


Figure 2. Percent of First-Time Freshmen from Jefferson County

Figure 3 details the percentage of first time freshmen entering the engineering school by ethnicity. This figure shows that, in 1993, the percentage of white students was approximately 82%. While the percentages of white students entering engineering are consistent relative to the university at large, the numbers for the black students are disproportionately lower. That is, the number of underrepresented minority students entering engineering at the University of Louisville is even lower as a whole relative to those entering the university at large. Thus, the percentages for the Black students entering engineering school have not been as steady, but rather erratic. In 1993 it was 10% while dropping sharply to 4% in 1994, rising again in 1995 to a high of 10%, declining steadily afterwards with a slight rise again in 1998 to 8%.

This could give rise to the evidence of the consistent pattern of poor counseling for children of color while in high school according to B. Denise Hawkins in her research on pre-college counselors⁴. For educator Adelaide Luvenia Hines Sanford, the correlation between counseling and college choice is clear--a greater number of minority students enroll in community colleges, in part because they lack information about four-year institutions and the requisites academic requirements and possibly because of the schools' open admissions policies. According to Sanford, counselors tend to focus on children who fit their preconceived notions of success and those who will conform, rather than those who can improve with the proper motivation⁴. Keeping inner-city minority high school motivated, while encouraging them to prepare to pursue academically rigorous and rewarding professions, such as engineering is a continuous challenge.

The projected shortage of scientists and engineers, particularly among the African American population, has caused many organizations to initiate programs that attempt to introduce pre-college students to the technical professions early in the high school years. It is hoped that these young people would have a “peaked interest” in these professions and, at the very least, that they pursue such professions. Many college freshman do not pursue technical majors simply because they lack the math and/or science background⁵. This presents an opportunity for the university community to reach out to the public high schools to ensure readiness and strengthen this portion of the pipeline to the pursuit of a technical career.

IV. Structure of the Program

The primary purpose of the “*CAMP IE*” pilot project was to proactively address the need to increase enrollment in the engineering discipline. In addition, the project provided a positive avenue to better market the field of Industrial Engineering to high school students while at the same time allowing those in the discipline to serve as role models to these prospective students.

In developing the program, we realized that some key factors were to our advantage. First of all, IE was the discipline within engineering that had historically experienced low enrollment relative to the other disciplines. Figure 4 shows the distribution of engineering students entering each of the academic disciplines as incoming freshmen. The figure shows that from 1993 to 1998 the industrial engineering department, relative to the other disciplines, remained the smallest in enrollment by far.

Over that 5 year period, the number of students directly entering industrial engineering ranged from a low of 1 student entering in 1994 to a high of 6 students entering in both 1997 and 1998. Secondly, the discipline of industrial engineering had been historically “ill-marketed” to students, when compared to the others. Furthermore, the program needed to provide high school students with an early exposure to college, while complementing existing pre-college initiatives. Another critical advantage is that the program directors had collaboration and support from JCPS and UofL personnel in developing and implementing the concept. Lastly, another critical factor is that there was a commitment from the Industrial Engineering faculty members to enhance recruitment efforts and align with key feeder schools within the JCPS system, particularly for underrepresented minority students.

The percentages by race of those freshmen students who declare industrial engineering as their choice are shown in Figure 5. For example, during FY95 and FY97, of all freshmen students entering the University of Louisville who declared industrial engineering as their engineering discipline of choice were White. Only three black students over the five year period declared industrial engineering as they entered the University of Louisville. Although it may appear rather sporadic, it shows the impact of the lack of focused effort on discipline specific recruitment.

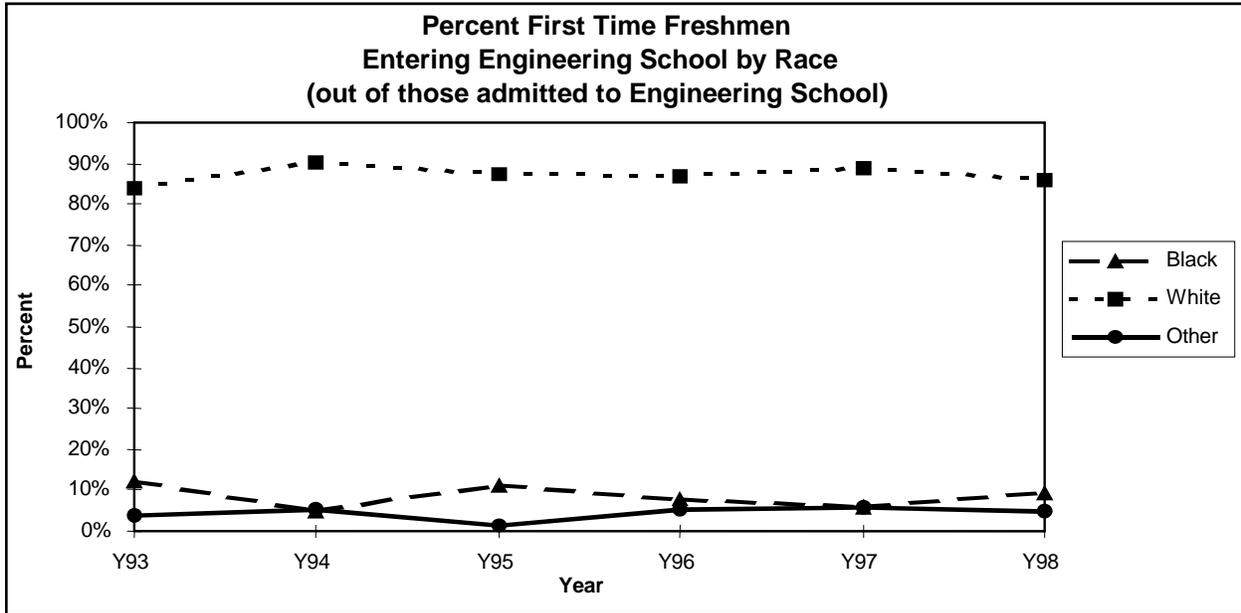


Figure 3. Percent First Time Freshmen Entering Engineering School by Ethnicity

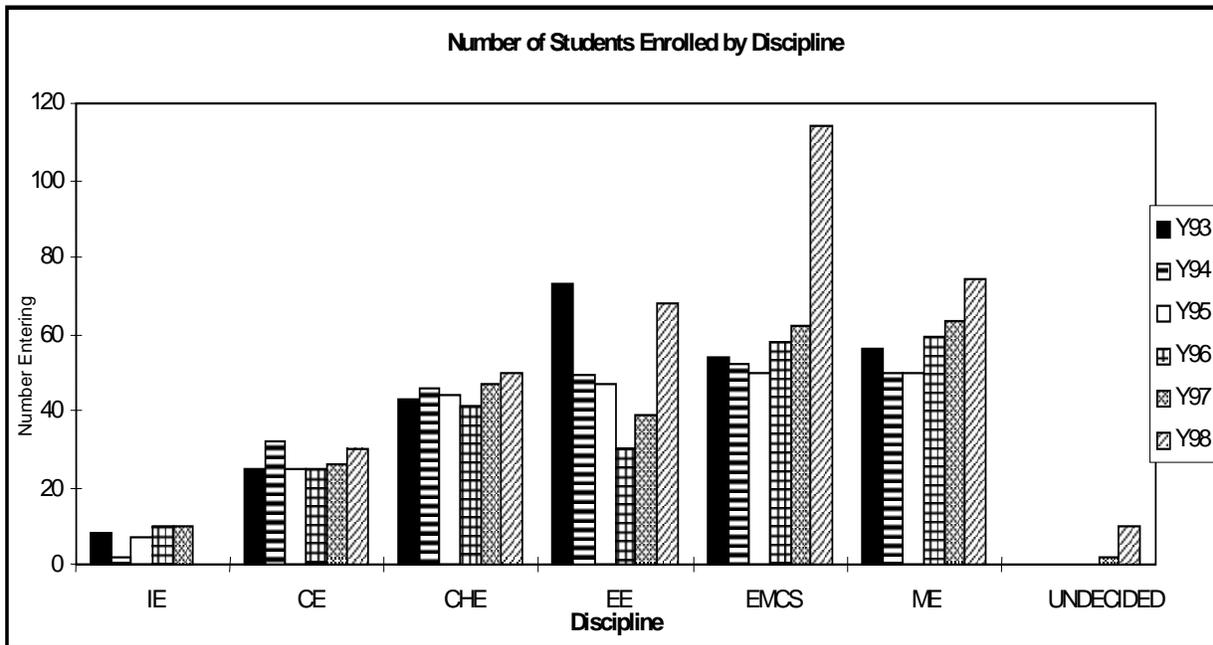


Figure 4. Number of Students Enrolled by Engineering Discipline

V. Content

The schedule for the program is shown in Figure 6. A critical component of the first meeting was the module entitled, “True Colors.” A human relations model and tool, “True Colors” was used in an effort to introduce the “*CAMP IE*” students to the value of diversity as well as to enhance and increase awareness of interpersonal skills, communications, and motivational characteristics.

Based on the work of psychologists Dr. Carl Jung, David Kersey, Isabel-Briggs (of the Myers-Briggs instrument) and Don Lowery, “True Colors” is a user-friendly model for improving relationships and celebrating the uniqueness of each of us. As part of CAMP “IE”, it is an easy, entertaining way to help the students start to better understand themselves and more effectively interact with other people. It also helps students embrace their differences and understand how these differences may have an impact on self-esteem and may affect their choices of classes in high school. And, of course, the choice of high school classes in turn impacts the student’s chances to pursue a technical degree in college. In addition, the first session introduced the students to the Internet. Although successive sessions did not need this mini-module, the research component of the session was retained. The students were asked to group themselves in teams of not more than four students (preferably not from the same high school). Then over the next three weeks of the camp, each group was to submit their “surfing the net” scavenger hunt findings. The scavenger hunt consisted of 20 trivial questions about engineering and engineering management.

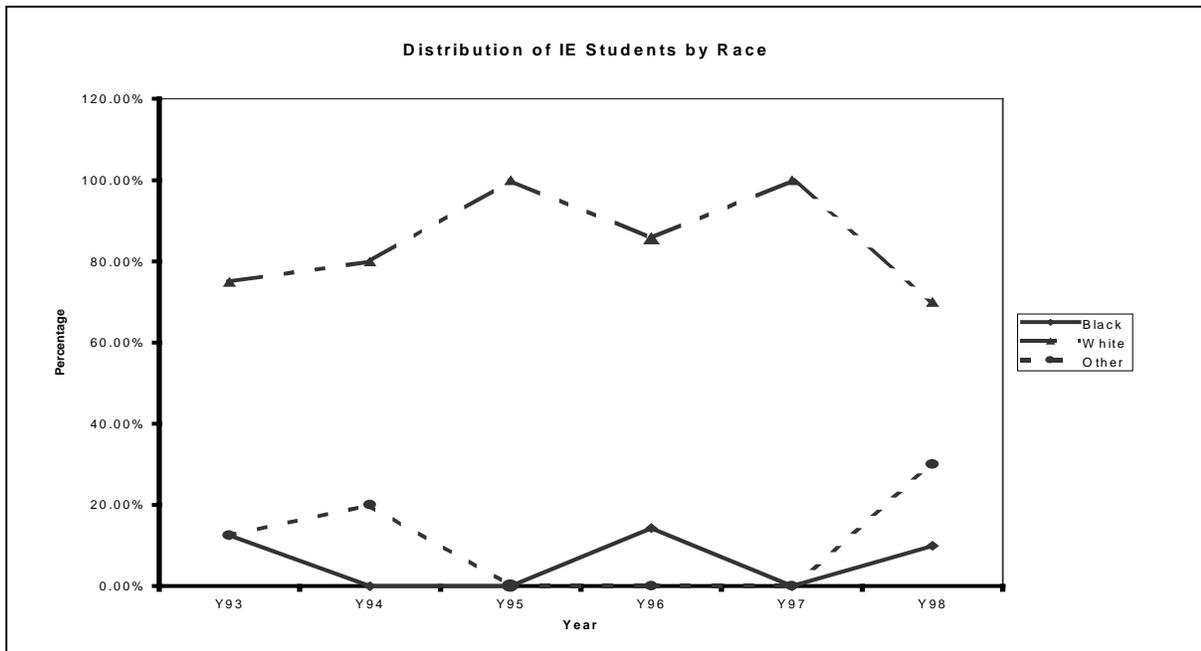


Figure 5. Distribution of Industrial Engineering by race.

Following the first week, the students were randomly divided into two groups (e.g. Group A and Group B) to facilitate smaller class sizes over the following three sessions. The core industrial engineering modules—Design of Experiments; Production and Manufacturing “Just in Time”; and Operations Research and Mathematical Modeling—were all of the same format. There was a 50-minute instructional component that introduced the concepts and applications to the students, then following a 10-minute break, the students engaged in a hands-on laboratory assignment where they were expected to implement some of the concepts they had been taught. The laboratory portion also allowed the students to compete in teams on the assignments with acknowledgments and prizes awarded at the closing session brunch.

| Saturdays | 10/19/96 | 10/26/96 | 11/2/96 | 11/9/96 | 11/16/96 |
|------------|---|--|---|---|--|
| 9:00 A.M. | VOGT 311 Opening Session Welcome and Program Introduction <i>"True Colors"</i> Ms. Deborah Carlton <i>Internet 101</i> Prof. V.H. Smith MITC Room 003 | SACKETT HALL ROOM 100 MODULE 2 <i>Production and Manufacturing "Just-in-Time"</i> Dr. G.W. DePuy Lab - Ernst 212 | VOGT 311 MODULE 1 <i>Design of Experiments</i> Dr. J.S. Usher Lab - VOGT 314 FAL | JB Speed 107 MODULE 3 <i>Operations Research and Mathematical Modeling</i> Dr. G.W. Evans Lab - IE Lab | SubShop - MITC (Brunch @ 11 a.m.) Closing Session <i>"U of L Support"</i> <i>"What's Next : Get Ready for Engineering"</i> <i>"Supporting the Goal"</i> |
| 12:15 P.M. | Lunch SubShop - MITC | Lunch VOGT 311 | Lunch VOGT 311 | Lunch VOGT 311 | Awards/Recognition |
| 9:00 A.M. | VOGT 311 Opening Session Welcome and Program Introduction <i>"True Colors"</i> Ms. Deborah Carlton <i>Internet 101</i> Prof. V.H. Smith MITC Room 003 | VOGT 311 MODULE 1 <i>Design of Experiments</i> Dr. J.S. Usher Lab - VOGT 314 FAL | JB Speed 107 MODULE 3 <i>Operations Research and Mathematical Modeling</i> Dr. G.W. Evans Lab - IE Lab | VOGT 311 MODULE 2 <i>Production and Manufacturing "Just-in-Time"</i> Dr. G.W. DePuy Lab - VOGT 314 | SubShop - MITC (Brunch @ 11 a.m.) Closing Session <i>"U of L Support"</i> <i>"What's Next: Get Ready for Engineering"</i> <i>"Supporting the Goal"</i> |
| 12:15 P.M. | Lunch SubShop - MITC | Lunch VOGT 311 | Lunch VOGT 311 | Lunch VOGT 311 | Awards/Recognition |

Figure 6. "CAMP IE" Program Schedule

VI. Participants

There were 45 students participating in the pilot project of which 36 students successfully completed the 5-week program. These students represented 4 of the 5 CPMSA designated high schools and three non-CPMSA designated high schools. Although the pilot program was designed to accommodate only 40 students (20 students per grouping), the demand for the program was nearly 50% more than expected. Allowances were made for students with commitments to other equally educational enriching programs or activities. Table 1 presents a summary of some of the demographics of the participants.

| Summary of High School Students (registrants/participants) | | | | | | | |
|---|----------------------|--------------|---------------------|--------------|--------------|---------------|--------------|
| SCHOOL | 9th Graders | | 10th Graders | | TOTAL | | |
| | M | F | M | F | Male | Female | TOTAL |
| | duPont Manual | 3/3 | 3/3 | 5/5 | 3/3 | 8/8 | 6/6 |
| Central | 2/1 | 2/2 | 5/3 | 1/1 | 7/4 | 3/2 | 10/6 |
| Iroquois | 4/2 | 7/3 | 1/0 | 0/0 | 5/2 | 7/3 | 12/5 |
| Western | 2/2 | 5/5 | 4/4 | 4/4 | 6/6 | 9/9 | 15/15 |
| Eastern* | 0/0 | 1/1 | 0/0 | 1/1 | 0/0 | 2/2 | 2/2 |
| Waggener* | 0/0 | 1/1 | 0/0 | 1/1 | 0/0 | 2/2 | 2/2 |
| Southern* | 0/0 | 0/0 | 1/1 | 0/0 | 1/1 | 0/0 | 1/1 |
| TOTAL | 11/8 | 19/15 | 16/13 | 10/10 | 27/21 | 29/24 | 56/45 |

NOTES: 1) Registrants/Participants
2) * non-CPMSA Schools

Table 1. Summary of Participants

All students in the program were identified by their respective JCPS/CPMSA site coordinator(s). The students were currently enrolled in a JCPS high school and categorically noted as “shows promise” for excelling in a math or science based career field.

VII. Results and Assessments

The participating students, parents, teachers, as well as the faculty of the Department of Industrial Engineering were overwhelmingly pleased with the outcome of the pilot program. This model has been mentioned as an “ideal” model for pre-college engineering efforts for minority students. Unlike other pre-college programs, “*CAMP IE*” has a discipline specific focus within engineering, although during some of the motivational sessions other engineering disciplines are discussed.

A pre- and post-camp survey instrument was developed and administered prior to the start of the first session and just prior to the awards brunch of the closing session, respectively. On a Likert-type scale ranging from 1(low) to 5(high), the participants’ mean rating for their enthusiasm about participating in “*CAMP IE*” was 4.28, suggesting high enthusiasm about the experience. Each component of the program received greater than a 3.3 overall rating. All forty of the respondents on the post-camp survey indicated that they would recommend this program to a friend or peer. When asked whether they thought they would like to become an engineer, 72.5% indicated positively. When asked if they would like to become an Industrial Engineer, 57.5% indicated they would, while 37.5% indicated they would not, and 5% said maybe. Overall, the program met the expectations of at least 97.5% of the student participants as indicated from the

post-camp surveys. The program received an overall rating of 4.525 on the Likert-type scale ranging from 1(low) to 5(high), suggesting great satisfaction with the entire experience.

In addition, on a weekly basis during the administering of the program, the participants (including the participating faculty from the high schools) were asked to complete two open response questions prior to departure. The following comments were taken from these open response sheets.

Prompt 1: “What I liked *most* about today...”

“meeting new people (from different schools) and working on the internet.”

“We did ‘hands-on’ things.”

“The personality test (True Colors), it helped me understand why I think and act a certain way. It was a fun experience and the commercial was very creative.”

“Learning about production lines. Working on the book making assignment (working competitively).”

“Doing interesting activities and working well with others.”

“I learned what not to do when conducting an experiment. It was a good hands-on experiment. Using tools and computers made it really fun.”

“The competition of the mathematical engineer and how we tried to get it. The professionals who talked with us and used everyday situations such as restaurants and hospitals who use operations research and mathematical modeling. The animation on the computer was neat. At first, trying to comprehend everything was slightly difficult but everyone soon got the hang of things. I hope my group did well.”

Prompt 2: “What I liked the *least* about today...”

“Listening to the lecture.”

“When other students were talking it made me get off track.”

“Losing the competition (game).”

“No snacks between the breaks.”

“No breakfast in the morning at the 9:00am session.”

These comments indicate that the students clearly reflected on their most and least liked elements of each Saturday’s session. This feedback was used to further improve and enhance future camp programs.

VIII. Preliminary Post Secondary Results

A survey was sent to the 23 students who were graduated in the class of 1999. These students had been 10th graders when they participated in this pilot study. There was a 65.2% return rate (n=15). When asked about their career choice as they prepare to enter college during fall 1999, 4.6% indicated a science-related career choice, 53.3% chose engineering, 26.7% expressed business or computer science as a choice. Over 85% of the respondents indicated that they had actively participated in pre-college support programs such SECME, Black Achievers' Program (an African American youth program offered through the YMCA for grades 8-12), and CPMSA Club.

The survey instrument also asked these participants to indicate whether they knew about the Speed Scientific School PRIOR to their "*CAMP IE*" experience. Eleven of the students (73%) indicated that they did. Although 87% of these students indicated that they had thought about engineering as a career choice prior to their "*CAMP IE*" experience, over 78% of them did not know much about Industrial Engineering. It was also noted that the persons who these students indicated as motivating them the most were either their teachers, parents or friends.

Now that these 23 students have completed their first term in college, the authors will conduct another survey to assess how many of these students actually enrolled in college and how many actually followed through with their initial choices of college major as noted at the time they participated in the program. The authors also plan to survey the members of the pilot group who are in the class of 2000 in high school to see if their interest in engineering, science, or a math related career field continues.

IX. General Guiding Principles

Although teaching specific concepts of industrial engineering was an element of the program, it was not the primary goal. The emphasis of this program was two-fold: 1) to encourage collaborative educational research project between JCPS and UofL faculties and administrators; and 2) to create a "pipeline" of prospective underrepresented minority students, who "show promise" of matriculating into a math/science/technology -based degree program upon graduation from high school, through a discipline-specific "camp" model.

Through this unique learning experience, we offer some general guiding principles to those persons interested in implementing a similar program using "*CAMP IE*" as a model. The program developers felt these to be key to an effective camp, particularly in an urban setting:

- (1) Have hands-on activities well integrated into each session.
- (2) Limit the lecture time to no more than 45minutes. This is consistent with what the students most likely experience during the regular school day.
- (3) Keep the students involved at all times.
- (4) Employ undergraduate and graduate students as helpers or lab assistants.
- (5) Make the activities, in both the lecture and lab, fun.
- (6) Ensure that there are instructors involved in the program who can act as positive role models.

- (7) Integrate the use of computers and applications programs as much as possible.
- (8) Give the high school teachers an active role each week (e.g. attendance, observational feedback, helper, etc.)
- (9) Include awards and recognition for the participants during as well as at the closing of the program.
- (10) Program offering during the school year versus the summer adds uniqueness and some continuity for an appreciation of math and science.

X. Model Adaptability

Although this pilot program focused primarily on introducing more minority students to the field of industrial engineering, the model could easily be modified to introduce students to other engineering disciplines. The University of Louisville offers degrees in five other engineering disciplines, including electrical and computer engineering. To actively pursue more students of color into engineering programs, each department could modify this "CAMP IE" model and conduct discipline-specific Saturday morning sessions. Each department would thus be actively engaged in the recruitment of a diverse student population, instead of delegating such responsibilities to a general student services office.

The "CAMP IE" model will be used to develop a similar program for introducing African American students to careers in Computer Information Systems at the University of Louisville, thus creating a pipeline of students that will have a greater chance of success in this major. Collaborative efforts are being initiated with local industry, JCPS, and local service agencies that are committed to the education and economic empowerment of the youth in Louisville, particularly African American youth.

XI. Conclusions

We have presented the development of a unique discipline-specific camp model that can address the need to prepare more underrepresented minorities to enter the "pipeline" for math/science/technology -based career fields. The projected shortages of scientists and engineers, as well as information technology, have caused many organizations to initiate programs that attempt to introduce pre-college students to the technical professions as early as possible. As we progress in the twenty-first century, we will still need our best and brightest minds to contend with the challenges that lie ahead. Underrepresented minorities, particularly African Americans, must be prepared to be included in the "pipeline" to fill these challenges.

Colleges and universities must be proactive in ensuring that there are underrepresented minority students that have been made aware, in an active sense, of the career possibilities open to them. Although parents, teachers and friends have proven to be very influential in the career choice made by high school students today, colleges and universities can be on the winning end of this baton as they continue to engage in collaborative partnerships with local school districts and industry.

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