AC 2008-2247: INSPIRE: A LOW-COST PRE-COLLEGE ENGINEERING ENRICHMENT PROGRAM

Brenda Hart, University of Louisville

Director of Student Affairs at the J.B. Speed School of Engineering. Her research areas include recruitment and retention programs for females and under-represented minorities as well as working with first year engineering students.

Veronica Hinton-Hudson, University of Louisville

Currently an Assistant Professor in the Computer Information Systems department within the College of Business. Her research interest includes Quality Engineering and applied statistics, Production Operations, Systems Analysis, Mentoring, and STEM Pre-College Initiative programs.

James Lewis, University of Louisville

Currently an Assistant Professor in the Department of Engineering Fundamentals at the J.B. Speed School. His research interests include parallel and distributed computer systems, cryptography, undergraduate retention and technology used in the classroom.

INSPIRE: A low-cost, urban pre-college engineering program

Abstract

For more than 20 years, the University of Louisville has conducted the INSPIRE pre-college program. The primary purpose of the program is to expose ethnic minority students and females to the various fields of engineering offered at the University. The ultimate goal of the program is to increase the number of students historically under-represented in engineering, particularly at the University. This paper will highlight a low-cost, urban summer pre-college program targeting students under-represented in engineering. With respect to its impact on minority engineering recruitment, the program has been one of the intervention strategies used at the University of Louisville (UofL) to introduce URMs to various fields of engineering. An overview of the INSPIRE program, selected activities, costs and outcomes will be described. Critical success factors, anecdotal observations, and challenges faced by program administrators will also be discussed.

I. Introduction

According to a recent report by the National Center for Education Statistics (NCES), located within the U.S. Department of Education and the Institute of Education Sciences, the U.S. population has become more diverse over the past two decades as the minority population groups (African-Americans, Hispanics, American Indians/Alaskan Natives, and Asians/ Pacific Islanders) have increased more rapidly than the White population. As projected for 2005, minorities made up approximately 33 percent of the U.S. population. These same minority groups are expected to represent nearly 39 percent of the total population by the year 2020. Furthermore, according to the latest population projections revealed by the US Census Bureau and depicted in Figure 1, these minority population groups are expected to be more than half (52 percent) of the resident college-age (18–24 years old) population of the United States by 2050. Additionally, just about a quarter century ago, the National Science Board's Commission on Precollege Education in the Mathematics, Science, and Technology (MST) assessed the state of US precollege education in the subject fields and found it seriously lacking to meet the projected demand.[1]

In the late 1980's the Task Force of Women, Minorities, and Persons with Disabilities in Science and Technology called for cooperation among schools, colleges, industry and federal and state governments to increase the pool of science and engineering talent, particularly for underrepresented minority groups, through programs similar to those instituted following the Soviet launch of Sputnik in 1957—which ushered in new political, military, technological, and scientific developments.[2] Two decades later, the pipeline statistics are not as promising given the seriousness of the need for such technical skills.

According to the 2002 data provided by the Engineering Workforce Commission, Whites earned 68.68% of the bachelors degrees awarded in the various engineering disciplines while African-American only earned 5.09%. Hispanic recipients were slightly higher than that of African-Americans at 6.52% and American Indians were less than one-half of a percent.[3] The *Science*

and Engineering Indicators of 2006 reports that, with the exception of Asians/Pacific Islanders, URMs represent only a small proportion of those persons employed in science and engineering (S & E) occupations in the United States. Collectively, URMs constitute 24% of the total U.S. population, 13% of college graduates, and a mere 10% of the college educated in S&E occupations. Although Asians/Pacific Islanders constitute only 5% of the U.S. population, they accounted for 7% of the college graduates and 14% of those employed in S&E occupations in 2003.[4] Women on the other hand, constituted slightly more than a quarter (26%) of the college-educated workforce in S&E occupations (and nearly 40% of those with S&E degrees) but close to half (46%) of the total U.S. workforce during that same time.

Representation of racial and ethnic minority engineering students across the U.S. has not increased significantly between 1990 and 2002. Figure 2 shows that despite the progress in undergraduate engineering degrees granted to minority groups, the proportion of minorities URMs and women entering engineering has been on a decline since 1995, with exception to the Asian population.[5, 6] Attracting and retaining under-represented minority (URMs) and female students continues to be a major concern for most engineering schools in this country. With the "critical shortage" of technically skilled workers, such as engineers, many scholars in academe believe continuous targeted strategies, such as pre-college programs focused on science, technology, engineering and/or mathematics (STEM), provide a viable pipeline for many universities, particularly at the undergraduate level.

Pre-college engineering programs targeting URMs and females have been in existence at various colleges and universities in the United States for over 30 years. However, many have yielded varying degrees of success relative to meeting the goal of attracting, enrolling and retaining these URMs and female students to their respective colleges and universities. Until recently, few program directors focused on the need for validated assessment methodologies and participant tracking methods that could be used to further corroborate the value of such pre-college initiative and programs.[7] The remainder of this paper details a pre-college engineering program as a low cost model for other engineering schools, particularly in urban communities, as they struggle to address their contributions to meeting the critical needs of our country's STEM pipeline.

II. Program Background

In early 1980, personnel from the University of Louisville Speed School of Engineering and the Jefferson County (Kentucky) Public Schools met to discuss the need to heighten the awareness of the opportunities within engineering in the Louisville area. One outcome of these discussions was to design and implement a summer enrichment program on the University of Louisville main campus to address this need. Since the summer of 1981, the University of Louisville has provided an avenue for a group of female and under-represented minority students to be introduced to engineering by participation in the INSPIRE program.

A. The INSPIRE program model

INSPIRE is an acronym for Increasing Student Preparedness and Interest in the Requisites for Engineering. It is a four-week, five days a week, non-residential summer enrichment program designed to provide an introduction to engineering to students who have been historically under-

represented in the engineering field. Those targeted for the program include African American, Hispanic/Latino, Native American and female students who are in Louisville-area public and/or private high schools.

B. Program Planning and Participants

Within eight weeks of the start of INSPIRE, brochures and applications are sent to the area high school counselors and math/science department chairs, local youth groups, and churches with large African American congregations. The program director puts additional efforts towards targeting African American youth who may currently participate in other local academic enrichment programs such as the YMCA Black Achievers Program and the Lincoln Foundation. Special efforts are made to target minority students who may have the aptitude for advanced study in the STEM fields but who may not have performed up to their abilities in the early years of high school. Guidance counselors are asked to identify the "show promise" students. Students in the program must be female and/or an under-represented minority who has completed the 9^{th}, 10^{th}, or 11^{th} grades by the start of INSPIRE. While most students are attending public schools, the program does accept students from private or parochial schools as well.

Program participants are selected by the director of the INSPIRE Program from a pool of applicants. The student's high school counselor must submit a recommendation supporting the student's participation. In addition, applicants must provide a written and signed evaluation from their current math or science teacher. Current transcripts are submitted as part of the application process. The student applicants also have to submit an essay indicating why they would like to participate in the program. Lastly, the applicant must commit to participating in the program for the entire four weeks. Exceptions are rare but are accepted on a case-by-case basis. The student must have written proof of the incident causing the lack of participation for the entire four weeks.

Each summer the program director accepts between 20 and 25 students. The enrollment is kept at this small number so there can be close interaction between the students and also between faculty and program participants. Another reason enrollment is capped at 25 is because field trips are an important part of the program and large numbers would make such off-campus activities less manageable.

Financial support from corporate sponsors and the University of Louisville allows for program participants to attend the program without any out-of-pocket costs. However, arrangements to get to and from the campus each day are the responsibility of each program participant.

C. The curriculum of INSPIRE program

The INSPIRE program is conducted Mondays through Fridays from 9:30AM to 12:30PM during the month of June. The 2006 INSPIRE schedule is shown in Figure 3. This particular proposed schedule exposes each program participant to 19 sessions (57 total hours) consisting of 4 (~21% of program time) plant trips, 11 (~58% of program time) engineering discipline sessions, and 4 (~21% of program time) non-engineering related sessions. A field trip to a selected local area industry is scheduled for each week. The selection of the industry primarily depends upon a few

critical factors such as schedule availability, INSPIRE access to practicing engineers at work, availability of transportation, interdependencies of other sessions, etc.

The program participants utilize the classroom and laboratory facilities at University of Louisville Speed School of Engineering for both engineering as well as non-engineering sessions. Figure 4 provides a succinct synopsis of seven of the engineering, discipline related, sessions. Over the last decade, several engineering modules have been developed across the engineering discipline that can be used for pre-college students in 9^{th} through 12^{th} grades. Each disciplinary faculty chooses the session to be used and notifies the INSPIRE director accordingly.

Non-engineering related sessions are conducted by a combination of the program director, graduate students, and alumni of the engineering school or consultants depending on the session objectives, resource availability and expertise, and effectiveness. These sessions provide the participants with information on what it really takes to be prepared to major in engineering, exposure to various work environments of practicing engineers as well as an assessment of their learning styles.

Minimum course taking guidelines for graduation requirements have been enacted by many states in the U.S. since the early 1980s. These minimum course taking standards are usually consistent with the *New Basics* standards recommended by the National Commission on Excellence in Education (NCEC) for high school graduation. Kentucky New Basics requirements (in Carnegie units) include: 4 units of English/language arts, 3 units Social Studies, 3 units Mathematics, 3 units Science, 1 unit Health/Physical Education, and 1 unit Arts/vocation.[8] The pre-college curriculum (PCC) required for admission into the University of Louisville is in alignment with the NCEC requirements, including an additional 2 units in foreign language for incoming freshmen. Table 2 shows the PCC required for incoming freshman at the University of Louisville. Although most high school students are told by their high school counselor the coursework requirements for graduation, this information is revisited during one of the INSPIRE non-engineering related sessions. Emphasis is placed on taking calculus (if offered), given the math basis of engineering. Physics and chemistry are the recommended science courses as well as electives that include typing and micro-computer applications.

Each engineering session consists of a combination of brief introductory lecture/discussion, followed by a hands-on activity, often in teams. The session ends with a brief discussion and reflection on the experience relative to its respective engineering discipline and concepts taught at the beginning of the period. This suggested teaching strategy uses a *quasi* problem-based learning (PBL) approach that engages the students with active learning as opposed to the traditional passive didactic lecture format for the session time. Problem-based learning, in its most general form, was developed in medical education in the early 1970's. It is an educational approach that is "student-centered" and age appropriate for high school students. According to Barrows and Tamblyn [9], PBL can be described as *"the learning that results from the process of working toward the understanding or resolution of a problem."* The goals of PBL are to provide the student with an active role in learning and to allow the student to take responsibility for learning. In addition, this *quasi* PBL teaching strategy promotes (1) the use of problems as the main tool in the learning process; (2) learning by doing—helping the student to acquire and

apply knowledge and/or skills outside of the lecture and books; and (3) cooperative learning (especially when working in teams)—working together actively on a structured activity, such as in the Industrial Engineering—Production Planning session.[9-12]

Since one of the programmatic goals of the INSPIRE program is to introduce the students to various aspects of engineering, faculty members and graduate students from their respective department conduct the engineering related sessions. Although some topics may vary slightly from year to year, recent sessions provide the students with information on the following engineering disciplines: electrical, chemical, industrial, mechanical, computer, civil and bio-engineering. Furthermore, undergraduate African American and female engineering students who are members of the National Society of Black Engineers (NSBE) and/or the Society of Women Engineers (SWE) also interact with the high school students and serve as role models during the month long program.

D. The True Colors® Exercise

Along with introducing the high school students to various aspects of fields of engineering and technology, the INSPIRE program's non-engineering related sessions assist the students in identifying vocational interests and personality profiles. These outcomes may impact their learning style as well as the effectiveness of any interpersonal relationships, particularly for under-represented minorities. Latham[13] noted that as the face of America's classrooms changes, teachers and administrators are being called on not only to respect their students' diversity but also to capitalize on the possibilities that diversity presents for teaching and learning.

In the late 1990's, the INSPIRE program director began the 4-week program with an activity entitled True Colors. The True Colors® was founded in 1978 by Don Lowry. Based on the work of clinical psychologist David Keirsey, who studied the work of psychologists Carl Jung, Katherine Briggs and Isabel Myers, Lowry theorized that all people fit into one of four broad categories of personality.[14] Lowry's True Colors® program asks participants to identify their "color spectrum" using four cards that represent key personality types: Blue, Gold, Green or Orange. Each color has particular strengths and each analyzes, conceptualizes, understands, interacts and learns differently. But these differences, if not acknowledged and understood, can become barriers to interpersonal communication, making understanding between people of different types difficult.

True Colors®, which expands upon Keirsey's four temperament types, translates complicated personality and learning theory into *"one of the easiest, most convenient ways of understanding and appreciating human behavior."* However, True Colors® can only be administered by a True Colors® certified trainer. The director of INSPIRE has such certification, thus she conducts this particular session with the assistances of a few current engineering students. The program participants receive instruction and background information on True Colors® and are given the True Colors® printed materials. The content expands upon Keirsey's four temperament types while it translates complicated personality and learning theory into an easy and convenient way of understanding and appreciating human behavior. Students respond very favorably to the True Colors® session.

E. Other Program Features

The students also participate in an educational workshop in which they are provided with information on the college application process as well as the financial aid process. The students are instructed on the critical requirements of completing the FAFSA (free application for federal student aid) form. They are also instructed on the importance of high school course curricula, high school grades, and impact of their performance on the ACT/SAT. In addition, the program participants receive guidance on building a personal portfolio, including such components as community service, extracurricular activities, arts and writing portfolios, transcripts and letters of recommendation.

Over the years, the program has included field trips to selected area industries such as General Electric Appliance Park, the Louisville Water Company, North American Stainless, Toyota Manufacturing and the Metropolitan Sewer District's Floyds Fork Wastewater Treatment Plant. Oftentimes the leaders of these industrial sessions are alumni of the University of Louisville and Speed School of Engineering. During these sessions INSPIRE students get to learn about the host company and how/where they use engineers. This component of the program provides students an opportunity to expand their understanding of what engineers do.

In discussions with the students after these field trips it has been revealed that, in many cases, these students had never before visited an engineering site and thus had never seen the types of projects that engineers are engaged in. By incorporating these off-campus field trips in the program we are able to let these high school students actually see engineers at work. It is especially important for them to see females and minorities engaged in such important technical occupations.

III. INSPIRE Program Costs

Unlike programs with similar mission and goals, INSPIRE is a low-cost, non-residential model. It is offered daily for one-half day and goes for four weeks in the summer. Significant costs are spared as a direct result of not having to feed and house the program participants. In addition, the targeted cohort during each year is capped at not more than 28 participants.
A sample budget is outlined and shown in Table 1.

The most expensive items are the refreshments and field trips. On the days where a field trip is scheduled, the transportation and refreshments are provided by the INSPIRE program. The next most expensive items are the prizes, tee shirts and program materials, with an average cost of $400. Each program participant is provided a notebook of various materials needed throughout the program (i.e. schedule, copies of session instructional materials, program surveys, etc.). Also, program brochures and applications are budgeted items. In addition, this sample budget does not account for any compensation to the program instructional faculty. In years past when additional funds were allocated to the program, each participating faculty received a stipend of $400. These funds were often used for conference registration or professional travel. However, because of decreased availability of funds and school administration preferring faculty to volunteer their time as a service component for performance evaluation, instructional personnel have not received compensation for their responsibilities to the program for the past four years.

The faculty develops all instructional materials for their session as well as provides any needed lab items. Although some faculty choose to assign their respective graduate students as helpers in the laboratory portion of the session, these sessions could also be conducted entirely by graduate students or senior-year undergraduates.

This program model could be easily expanded to full day sessions with or without it being a residential program. However, those decisions would have an immediate direct cost impact as well as increase the potential liability to the hosting university or college. Since a large proportion of the students who apply and choose the University of Louisville are from the metropolitan Louisville area, there has not been a desire for such program expansions.

IV. Impact of INSPIRE and Future Opportunities

An ultimate goal of the program is to increase the number of underrepresented minorities who enroll at the University of Louisville, particularly in engineering. Personnel in the Office of Institutional Research and Planning have assisted us in "tracking" the students who subsequently enrolled at the University of Louisville. Based on our most current records, which include fall 2007 enrollments, 692 students participated in the INSPIRE program between the years of 1981 and 2007. Table 3 summarizes the outcome and matriculation of the INSPIRE students from 1981 thru 2007. There were 462 students identified who actually enrolled in the university at some point. This includes program participants who may have attended the university's High School Visitor program. This represents 66.76% of our cohort. Of those 462 INSPIRE participants who enrolled into the University of Louisville, 195 (42.21%) persisted and were awarded a degree from U of L. Ascertaining tracking information after high school graduation has been a challenge. However, efforts are underway to "track" former INSPIRE participants who enrolled at other institutions, within and outside the state of Kentucky.

There were 80 (out of the 195) students awarded the bachelors or masters degrees in engineering (41.03%). In the early years of the INSPIRE program, students who enrolled at the University of Louisville also had the option of pursuing associate degrees in engineering. There were 4 INSPIRE participants who acquired an associate degree. Including these students, the percentage would increase to 43.08%. There were also other math/science based degrees granted among INSPIRE participants; namely, 9 medical degrees, 11 degrees awarded in biology, 6 in math and 1 in Computer Information Systems.

As of spring 2007, there were 41 former INSPIRE participants currently enrolled at the University of Louisville as noted in part 3e of Table 3. Twelve of these 41 students have already earned one degree and are taking additional classes. Twenty-nine of these 41 students are working on their first degree.

By conducting the INSPIRE program for so many years, the University of Louisville has clearly increased the number of underrepresented minorities with baccalaureate degrees in engineering. What is less certain is whether or not the students who participated in INSPIRE would have either chosen engineering or the University of Louisville. Further research and analysis needs to be completed to ascertain a more definitive response from prior program participants. However,

with respect to the goals of the program, it is successful at what it does—*enabling participants to acquire a degree of interest, proficiency, and understanding of the requisites for engineering*. Therefore, the student returns to high school with a much better understanding of what is offered at the University of Louisville with respect to engineering and what they need to do to be ready to pursue such a career field.

Other opportunities for further research include the outcomes data analysis of the program pre- and post- survey information. Although post program surveys were always an integral part of INSPIRE, it was not until recently that a validated assessment tool for pre-engineering program in the form of a pre- and post-survey instrument was used.[7]

Lastly, the records of program participants need to be stored in electronic form (e.g. database file) as opposed to paper forms in binders. This would facilitate further analysis of program data. The authors are in the process of developing a user-friendly database for the INSPIRE program office use.

V. A Successful Program

Program evaluations, given on the last day of the program to each participant, indicated the INSPIRE program was a success, particularly in increasing the knowledge about engineers, engineering as a career choice, and what programs are offered at UofL. The majority of the students rated the program as 'very successful' in the post-program survey. Here is a sampling of participants' remarks when asked for other comments at the end of the questionnaire:

> *"It was a new experience and I was allowed to meet new people and also see what engineers do. It gave me a motivating force to pursue engineering."*
>
> *"I really enjoyed this program. [I'm] still not sure if I want to be an engineer, but it [INSPIRE program] opened my eyes to new options."*
>
> *"This was a great program and I really enjoyed taking this class. I got to see the U of L campus so I'm going to apply to the Speed School in the fall."*

When asked *"Would you recommend that your friends participate in this program?"* on the post-survey instrument, nearly 100% of the participants responded with *Yes.* When asked to explain why (or why not), the *yes* responses included comments such as:

> *"… because it helps further peoples knowledge about engineering, and it also helps us find [out about] colleges or universities to go to."*
>
> *"… if you are interested in a field of engineering, this program allows you to choose the career of study you would like to participate in."*
>
> *"… It's a good experience."*
> *"… because it is interesting and a fun way to spend your summer."*
>
> *"… because it is helpful."*
>
> *"… because it can broaden their horizon to other aspects of engineering."*

"… it's fun and teaches a lot."

"... it is a good program if you are interested or thinking about going into engineering."

"… because it is a great program."

"… because it is helpful for any student planning on going to college."

"… it is a fun program."

"… I think it is a great learning experience & it will help if you want to go into engineering."

"… if the person likes engineering, then they should take this [program]."

The few participants, who responded *No* to the same question, indicated that their friends would not be interested in participating in such a program.

Based on the overall success and the long- and short-term impact of the program—exposing URMs and females to engineering, the INSPIRE program shall continue in the future. Enhancement to the program shall be consistent with feedback for not only the program participants, but the math and science high school faculties and the university faculty and graduate students.

VI. Conclusions

Based on a request from the U.S. Congress in 2005, the National Science Foundation has recently published a national action plan to address the critically pressing issue faced by the U.S. relative to STEM education.[15] This plan discusses the need to increase the number of students in STEM related career fields by ensuring success and interest throughout the K-12 pipeline and beyond. Along with targeted strategies, an effective pre-college program must "…(1) promote awareness of the engineering profession, (2) provide academic enrichment, (3) have trained and competent instructors, and (4) be supported by the educational system of the student participants." [6]

A low cost, summer enrichment program for under-represented minority students interested in the engineering profession has been discussed in this paper. With respect to its impact on minority engineering recruitment, the program has been one of the intervention strategies used at the University of Louisville (UofL) to introduce URMs to various fields of engineering. An overview of the INSPIRE program, selected activities, costs and outcomes were presented. Critical success factors, anecdotal observations, and challenges faced by program administrators were also noted. This model can be easily adapted to any university and used by other engineering schools to address the need to bring more under-represented minorities into the pipeline for STEM-based career fields. The INSPIRE program appears to have short and long-term outcomes relative to its participants of *piquing interest* in the field of engineering and a heightened appreciation for who they are individually. We will continue to follow the participants to ascertain further outcome patterns related to program participants who did not attend the University of Louisville but elected to pursue degrees in higher education at other

institutions. One question deserving of future research is validation of the influence participation in these type 'pipe-line' programs really has on students' degree and/or college choice.

Figure 1. U.S. population 18–24 years old, by race/ethnicity: July 1990–99 and projections to 2050

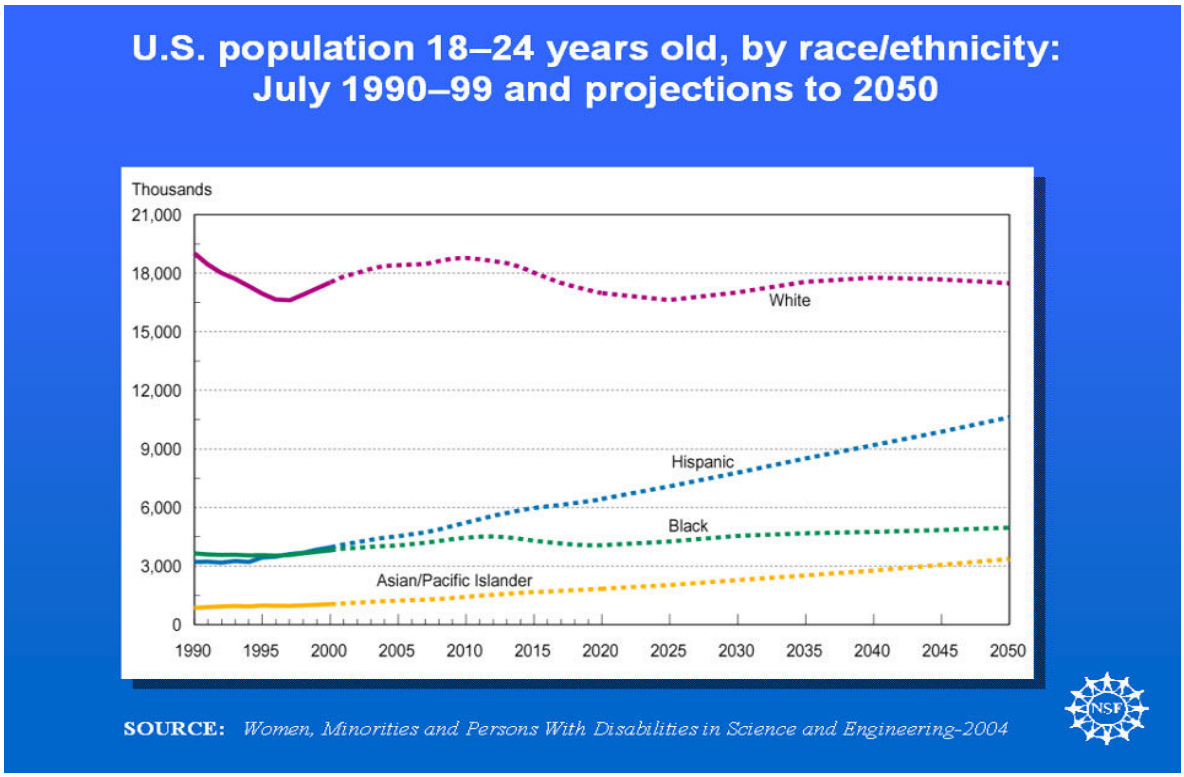

Figure 2. Minority proportion of undergraduate engineering enrollment

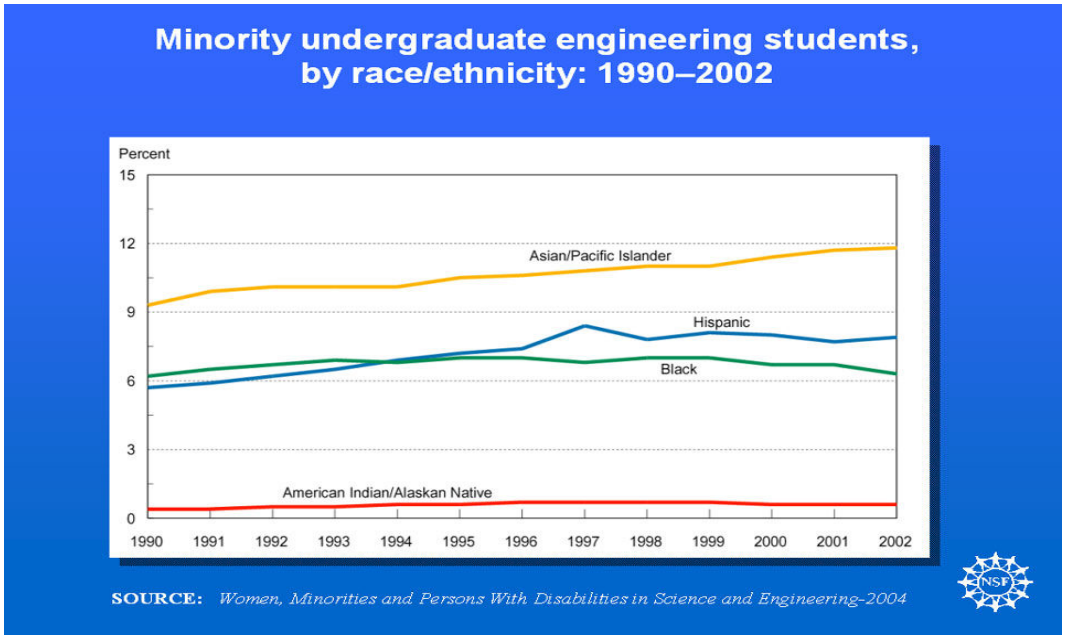

Figure 3. Sample INSPIRE Schedule

Speed School of Engineering
University of Louisville
INSPIRE 2006 Proposed Schedule
June 6-30, 2006

	Monday	Tuesday	Wednesday	Thursday	Friday
June 6 - 9		**Orientation** Prof. Brenda Hart **True Colors Workshop**	**CAD** Prof. Robert Matthews 9:00-10:00 AM Graphics Building **Roadway and Bridge Construction** KY Department of Transportation	**Educational Workshop**	**Plant Trip** Cummins Columbus, IN
June 12 - 16	**Intro to Rapid Prototyping**	**Intro to Chemical Engineering**	**Production Planning**	**Plant Trip** GE Appliance Park	**ASCE Session** "Westpoint Bridge Designer"
June 19-23	**Plant Trip** Toyota Motor Manufacturing GeorgeTown, KY	**Intro to Computer Engineering & Computer Science** Dr. Ramanchan Ragade	**Intro to Mechanical Engineering** Dr. Ellen Bechtold Dr. Mike Day	**Operations Research** Dr. Gerald Evans	**Introduction to University Life**
June 26-30	**Intro to Bioengineering**	**Intro to Electrical Engineering**	**Concrete Mixing Experience**	**Plant Trip** Waste Water Treatment Facility	**Program Wrap-Up Assessment** Prizes Engineers

Figure 4. Selected engineering related session descriptions

Introduction to CAD - During this session, the professor presents Engineering Graphics through the use of industrial standard CAD software (AutoCAD 2002). The development of both 2D drawings and 3D models are demonstrated. Students are given an opportunity to have hands-on use of the workstations.

Chemical Engineers as "Universal" Engineers - During this session, the students are introduced to the field of chemical engineering – where ChE's work, what ChE's do, how they do it, etc. Students are divided into small groups to see various demonstrations of traditional chemical engineering operations. They then learn a bit about what the future holds for chemical engineers and what exciting, new areas are emerging in which chemical engineers can participate.

Introduction to Civil Engineering - Following a general introduction to mixture design and field control of Portland cement concrete, a hands-on concrete mixing session is held in the construction materials lab. A second Civil Engineering session is on "roadway and bridge construction" and the students build bridges and test them for strength and endurance.

Introduction to Electrical Engineering - In this session, the professor and his team of graduate students provide the students with an introduction to EE. The students then learn a bit about "autonomous robotics" and watch robots playing robotic ping-pong.

Introduction to Mechanical Engineering - The professor leading the session on mechanical engineering initially describe some of the typical activities carried out by mechanical engineers. The students then work with a computer program that shows various mechanisms and energy transfers. Later a second ME professor provide the students with instructions for a design exercise and the students develop their machines. At the end of the session the students tour several of the ME labs as well as the Baja buggies being assembled by members of the student chapter of the Society of Automotive Engineers (SAE).

Operations Research – An IE professor provides a general introduction to operations research (OR) and describe, in detail, how to formulate a few standard OR problems. The discussion continues with emphasis on engaging the students. The students are then taken to the IE computer lab and allowed to use the optimization software for a problem solving exercise.

Production and Manufacturing "Just in Time" – This module introduces the students to two principal methods of controlling production systems: (1) a "push" system and (2) a "pull" or "just in time" system. Through hands-on simulations, students experience the advantages and disadvantages of both control schemes for assembly line production. Students are divided into teams of three which physically simulate the production of the product (a book). Using different production control methodologies, the teams compete against one another to see which team can meet the customer requirements of (1) orders on time, (2) maximize quality, and (3) reduce (or minimize) scrap.

Table 1 Sample program budget*

Item Description/Category	Cost ($)
Transportation (field trips)	650
Refreshments	720
Parking permits	40
Student assistant (wages)	200
True Colors® workshop (honorarium)	300
Educational workshop (honorarium)	300
Tee shirts	350
Prizes	420
Printing (applications, brochures, posters)	425
Miscellaneous (postage, Xeroxing, etc.)	220
TOTAL	3,625

* Program faculty stipends are not included

Table 2. University of Louisville Pre-College Curriculum (PCC)*

All freshmen must have their pre-college curriculum (PCC) met. Pre-College Curriculum involves the successful completion of:

- Four credits of English/Language Arts
  English I, English II, English III, English IV (or AP English)
- Three credits of Mathematics
  Algebra I, Algebra II, Geometry
- Three credits of Science
  Credits to include life science, physical science, and earth/space science (at least one lab)
- Three credits of Social Studies
  From U.S. History, Economics, Government, World Geography and World Civilization
- 1/2 credit of Health
- 1/2 credit of Physical Education
- One credit of History and Appreciation of Visual, Performing Arts
  History and appreciation of visual and performing arts or another arts course that incorporates such content.
- Two credits of Foreign Language
  Required or demonstrated competency in a foreign language.
- Seven credits of Electives (five rigorous credits)
  Recommended strongly: one or more courses that develop computer literacy

* Effective for Fall 2006

Table 3: Distribution of Program participants

Table 3a. Distribution of program participants

# of Participants 1981 - 2007	# of Participants enrolled at university	# of Participants status Unknown
692	462	230
	66.76%	33.24%

Table 3b. Program participants by Race/ethnicity

	African American	Asian	Hispanic	White	Other	Total
Male	104	27	3	54	0	188
Female	119	21	5	128	1	274
Total	223	48	8	182	1	462
Percentage	48.27%	10.39%	1.73%	39.39%	0.22%	

Table 3c. Participants who Finished a Degree by race/ethnicity

	African American	Asian	Hispanic	White	Other	Total
Male	36	13	3	35	0	87
Female	32	10	3	62	1	108
Total	68	23	6	97	1	195
Percentage	14.72%	4.98%	1.30%	21.00%	0.22%	42.21%

Table 3d. Program Partipants by Degree rac/ethnicity and gender

Degree	African American Male	African American Female	Asian Male	Asian Female	Hispanic Male	Hispanic Female	White Female	White Male	Other Female	Total	Percentage
Engineering	16	7	10	1	1		21	24		80	41.03%
Arts and Sciences	9	13	3	7	2	1	17	4	1	57	29.23%
Business	3	6				1	12	3		25	12.82%
Engineering Technology	4						1	1		6	3.08%
Police Administration	1									1	0.51%
Nursing		1					4			5	2.56%
Medicine			1				3	1		5	2.56%
Law				1			1	1		3	1.54%
Dental		1								1	0.51%
Education		1								1	0.51%
Graduate--Business	1							1		2	1.03%
Graduate--Education	1	1				1				3	1.54%
Graduate--Social Work		1								1	0.51%
Graduate --Public Affairs							1			1	0.51%
Allied Health	1	1					2			4	2.05%
Total	36	32	14	9	3	3	62	35	1	195	100.00%
Percentage	18.46%	16.41%	7.18%	4.62%	1.54%	1.54%	31.79%	17.95%	0.51%	100.00%	

Table 3e. Program Participants still enrolled

	African American	Asian	Hispanic	White	Other	Total
Male	13	4	0	3	0	20
Female	7	3	2	8	1	21
Total	20	7	2	11	1	41

References

[1] "The National Science Board Commission on Precollege Education in Mathematics, Science and Technology, Educating Americans for the 21st Century: A Plan of Action for Improving Mathematics, Science and Technology Education for All American Elementary and Secondary Students So That Their Achievement is the Best in the World by 1995." National Science Board, Arlington:National Science Foundation, 1983.

[2] DeLoughry, T. J., "Panel Urges Colleges to Boost Production of Minority Scientists." *Chronicle of Higher Education*, 34(40), 1988.

[3] American Association of Engineering Societies, "Engineering and Technology Degrees , *Special Tabulations,* 1990-2002." Engineering Workforce Commission, Washington, DC. 2004.
Women, Minorities, and Persons with Disabilities in Science and Engineering: 2002, National Science Foundation, Division of Science Resources Statistics, NSF 03-312. Arlington, VA 2003.

[4] National Science Board, *A Companion to Science and Engineering Indicators 2006*. Arlington, VA: National Science Foundation, NSB 06-02, February 2006.

[5] National Science Foundation, *"U.S. Population 18-24 years old, by race/ethnicity: July 1990-99 and projections to 2050."* Women, Minorities, and Persons with Disabilities in Science and Engineering: Division of Science Resources Statistics, 2002.

[6] Chubin, D. E., May, G. S., & Babco, E. L. (2005). Diversifying the Engineering Workforce. *Journal of Engineering Education*, 94(1), 73-8.

[7] Marra, Rose M.; Bogue, Barbara (2004). "The Assessing Women in Engineering Project: a Model for Sustainable and Profitable Collaboration," *Journal of Women and Minorities in Science and Engineering*, Vol. 10, Issue 3, p.60.

[8] Planty, M., Provasnik, S., and Daniel, B., "High School Coursetaking: Findings from the Condition of Education 2007." U. S. Department of Education, National Center for Education Statistics. (2007).

[9] Barrows, H.S., A Taxonomy of Problem-based Learning Methods. *Medical Teacher*, 20, 481-6, 1986.

[10] Milter, R. G., and Stinson, J. E., "Problem-Based Learning in Business Education: Curriculum Design and Implementation Issues." *Educational innovation in economics and business administration: The case of problem-based learning*, G. Gijselaers, Tempelaar, S., Keizer S., ed., Kluwer Academic Publishers, London. 1993.

[11] Duffy, T.M. (1994). Corporate and Community Education: Achieving success in the information society. Unpublished paper, Bloomington IN: Indiana University.

[12] Savery, J. R. and Duffy, T.M. Problem Based Learning: An Instructional Model and its Constructivist Framework. *Educational Technology*, 35 (5):31-38, 1995.

[13] Latham, A. S., "Responding to cultural learning styles." *Educational Leadership*, 54(7), 88-89, 1997.

[14] Keirsey, D., and Bates, M., *Please Understand Me: Character and Temperament Types*, Prometheus Nemesis Book Company,1984.

[15] National Science Board, "A National Action Plan for Addressing the Critical Needs of the U.S. Science, Technology, Engineering, and Mathematics Education System." National Science Foundation, NSB-07-114, 2007.

Bibliographic Information

BRENDA G. HART is Director of Student Affairs at the J.B. Speed School of Engineering. Her research areas include recruitment and retention programs for females and under-represented minorities as well as working with first year engineering students.

VERONICA HINTON-HUDSON is currently an Assistant Professor in the Computer Information Systems department within the College of Business. Her research interest includes Quality Engineering and applied statistics, Production Operations, Systems Analysis, Mentoring, and STEM Pre-College Initiative programs.

JAMES E. LEWIS is currently an Assistant Professor in the Department of Engineering Fundamentals at the J.B. Speed School. His research interests include parallel and distributed computer systems, cryptography, undergraduate retention and technology used in the classroom.