

**Final Report
of the
Workshop on Increasing Participation
of Minorities in the Computing Disciplines
(CDA-9401736)**

**Airlie Center
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Executive Summary

The primary motivation for this workshop was the 1991-92 Taulbee survey published in the March 1993 issue of the Computing Research News. It indicated that less than 1% of the PhDs in computer science that year were earned by African Americans and less than 2% were earned by Hispanics while African Americans and Hispanics comprise about 21% of the U.S. population according to the 1990 Census data. No CS PhDs were reported as earned by Native Americans. The low production of minority CS PhDs is just one indication of lack of participation of minorities within the computing and information science disciplines. Other data indicate similarly low participation throughout all levels. As a result we decided to design a workshop which would examine the root causes and make some recommendations that might improve the situation. The workshop was planned in October 1994 and held in May 1995. Our original goal was to consider issues relating to the participation of African Americans, Hispanics, and Native Americans; however, because the number of Native Americans enrolled in CS programs is so small, their academic experience is significantly different from that of other minorities. We acceded to the suggestion that we focus the workshop on issues relating only to African Americans and Hispanics. Although the initial goal of the workshop was to identify those issues which are specific to minority students and institutions and to propose remedies, the real strength of the workshop is that we were able to formulate our conclusions and recommendations in generic terms. Minority students and institutions comprise a part of the fabric of diversity in U. S. society.

The most significant conclusions to come out of the workshop are the following:

- A variety of types of mentoring is essential to the success of students at all levels. The base of mentors must be expanded. Same gender and same ethnicity are not required. Scalability of mentoring is a problem.
- The reward structure of academic institutions **must** be revised to reflect the importance of teaching and mentoring.
- The nation needs explicit metrics for evaluating teaching and mentoring.
- Despite the current glut of PhDs in computer science, some minority institutions should develop PhD programs in computer science.
- The computer science community needs to acknowledge the continuum of need from basic computer/information literacy to PhD-level research.
- All academic institutions (minority and majority) need to clearly articulate their missions. Different missions have different infrastructure requirements.
- The notion of *replication* of successful federal programs needs to be more carefully analyzed.
- Better coordination between professional organizations, community organizations, industrial organizations and educational institutions with respect to the overall development of children is possible through effective use of the Internet.

- New K-12 curriculum in information management which is integrated with traditional mathematics and science is required.

Our conclusions (for the most part) apply to all students and all institutions. If acted upon through specific projects, we feel that all students would benefit and that minority participation would gradually rise to proportionate levels. To expect a precipitous rise in minority participation resulting from an impulse intervention is folly. The bottom line is that mentoring is the key basic activity; it is a *human intensive* activity; and unfortunately, at this point, we do not know how to scale it well.

Based on these conclusions a number of recommendations surfaced during the workshop. Some recommendations were very specific and others were fairly general. Only a few recommendations were directed specifically at NSF. We attempted to phrase the general recommendations so as to allow flexibility in their implementations by agencies and organizations with specific missions.

- Redistribute research/education dollars to encourage academic institutions to evolve their reward structures to reflect an emphasis on quality teaching and mentoring.
- Publish (hardcopy and electronically) explicit assessment criteria and the evaluation process for all federally-funded projects.
- Foster mentoring programs in majority institutions at both the graduate and undergraduate level.
- Develop partnerships between minority and majority institutions with strong CS programs.
- Encourage industrial partnerships with minority institutions.
- Provide Internet access to minority institutions - both high schools and colleges. Currently the CISE NCRI Connections program and NASA MUSPIN are doing a good job at the college level. These efforts need to be expanded.
- Provide funding for equipping minority institutions with computing facilities which will support a strong CS curriculum.
- Develop new more human-oriented and intellectually exciting high school computing curricula.
- Continue and expand if possible the Young Scholars, Research Assistantships for Minority High School Students (RAMHSS), and the Research Experiences for Undergraduates (REU) programs.
- Develop community-based networks and train parents as mentors.
- Study a variety of institutions which have already begun to re-emphasize teaching and mentoring (such as Wisconsin, CUNY, etc.) with respect to the issue of replicability.
- Study the issue of scalability of different forms of mentoring.
- Provide \$20 million per year in matching funds for institutions which attract corporate sponsorship for minority students.

The body of the report contains a complete description of the process of participant selection, the panel topics, summaries of the panel discussions, a list of specific project ideas, and important but unaddressed questions. Appendix A of this report contains a list of often used acronyms. For full and complete detailed recommendations, the reader is referred to the Working Papers. The Working Papers are available as Northeastern University College of Computer Science Technical Reports, TR NU-CCS-95-08.

Acknowledgements

First, I would like to thank all of the participants for taking time out of their busy schedules to participate in the workshop. It was their energy, insights, thoughtfulness and dedication which made the workshop such a successful and rewarding experience. Secondly, I would like to thank the organizing committee for their hard work in planning and executing the event, with special thanks to those who helped shuttle participants to and from airports. The amount of preparation required for such a workshop is often underestimated and I want to give special thanks to Diane Burke for making everything go so smoothly. Finally, I thank the CISE Office of Cross-Disciplinary Activities for funding this very worthwhile project.

Principal Investigator's Comments:

As mentioned above, I was initially motivated to organize this workshop by the depressing participation data for minorities in computing published in the annual Taulbee survey. I had modest goals of running a workshop in which a small number of educators considered the limited issue of increasing enrollments of minorities in graduate CS programs. Once the organizing committee met and I got a sense of the breadth of the problem, I became convinced that a workshop which encompassed five interrelated but broad topics could be successful. The major deciding factor was the enthusiasm of the organizing committee. My goals for the workshop were simply to raise a number of questions which had not been addressed by this community, hopefully refine some of those questions, and possibly recommend solutions for a few. For the most part, I consider the workshop a success! Many good ideas surfaced.

If one quote could capture the sense of what was needed prior to the workshop, it is one that appeared in a position paper submitted by Charles Isbell:

“On my planet, we only have one word: *money*.
All other words are helper words.”
Mister Boffo

If I had to rework that quote as a result of the workshop, it would read as follows:

“In our universe, we only have one word: *mentoring*.
All other words are helper words.”
Ms. Diversity

Despite the accomplishments of the workshop, some aspects could have been improved. If I were to do a critical personal assessment, I would point to the following failings:

- I was unable to attain balanced participation between African Americans and Hispanics as well as males and females. As a result, I felt that the some of the discussions lacked certain perspectives.
- I was unable to get sufficient participation by industrial and professional organizations.
- I was able to coax only 14 of the 34 participants into submitting position papers.
- The organizing committee put a great deal of effort into preparing stimulating questions for the participants. Only about 53% (28/52) of these questions were addressed at the workshop (see table below).
- I was unable to stimulate serious discussion of effective use of new technologies such as digital libraries, WWW and virtual reality.
- There was insufficient time for “birds of a feather” sessions.
- Participants backed off when we faced some of the more sensitive issues, such as the quality of academic preparation of undergraduates from some HBCUs.
- I was unsuccessful in convincing the participants to organize themselves into some body (e.g. a committee) for the purpose of solving these problems.

As a quantitative measure of the effectiveness of the workshop, the following table was developed. It presents a summary of the number of questions posed in the letter of invitation to participants, the questions discussed at the workshop, and whether at least one solution was proposed. It also lists the number of new questions generated at the workshop. Fully 90% of the questions and issues raised at the workshop were not specific to minorities.

Questions

Panel	Posed in Letter	Discussed at Workshop	Solution Proposed	New at Workshop
1	16	7	1	0
2	8	6	1	0
3	13	6	0	2
4	5	5	3	2
5	10	4	0	1
Total	52	28	11	5

1 Introduction

In September 1994 The CISE Office of Cross-Disciplinary Activities of the National Science Foundation funded a workshop to study the problem of increasing the participation of minorities (specifically African Americans and Hispanics) in the computing disciplines. This project was prompted partly by the disturbing statistics on minority participation in computer science published in the annual Taulbee Survey of the Computing Research Association (CRA). The grant was made to Northeastern University with Bryant York as principal investigator. A planning meeting was held on October 12, 1994 to design the workshop. Bryant York served as chair of the organizing committee and selected the other members of the committee on the basis of active service to minorities in computing and diversity considerations. The committee consisted of:

Dr. Andrew Bernat, University of Texas - El Paso

Dr. Bernat serves as chair of the Department of Computer Science of the University of Texas at El Paso (UTEP). He is the principal investigator of one of the most successful projects in the NSF Institutional Infrastructure for Minority Institutions (IIMI) program. UTEP is a minority institution with a large Hispanic population and a significant African American population. Dr. Bernat is active in the IEEE-CS, a member of the IEEE-CS Educational Activities Board (EAB), and a former board member of the Association of Department Heads of Computer Science and Engineering Departments at Minority Institutions (ADMI).

Dr. Robert Cartwright, Rice University

Dr. Cartwright is the former chair of the Dept of Computer Science at Rice University. He is a member of the Board of the Computing Research Association (CRA) and chair of its Committee on Minorities (CRAM). Dr. Cartwright runs a mentoring program in a local, predominantly Hispanic, Houston high school.

Dr. Don M. Coleman, Howard University

Dr. Coleman is the chair of the Department of Systems and Computer Science in the School of Engineering at Howard University. He has been active in computer science and minority participation issues for almost 30 years. Dr. Coleman is also a board member and former secretary of ADMI.

Dr. Roscoe C. Giles, Boston University

Dr. Roscoe C. Giles is Associate Chair for Graduate Studies at the Department of Electrical, Computer, and Systems Engineering at Boston University and Assistant Director of the Center for Computational Science. He is advisor to the local chapter of the National Society of Black Engineers (NSBE), a member of the Society of Black Physicists, and works

with the New England Board of Higher Education (NEBHE) minority mentoring program. He was awarded the Scholar/Teacher of the Year award at Boston University in 1994 and has been active in outreach of computational science in education to local primary and secondary schools. Professor Giles is on the Board of Directors of Fayerweather Street School in Cambridge, MA.

Dr. Valerie Taylor, Northwestern University

Dr. Taylor is an Assistant Professor of Electrical Engineering and Computer Science at Northwestern University. She is a 1991 PhD from University of California - Berkeley, an NSF Presidential Young Investigator, and a member of the CRA Committee on the Status of Women in Computing.

Dr. Ramon Vasquez-Espinosa, University of Puerto Rico – Mayaguez

Dr. Vasquez-Espinosa is the associate chair of the Department of Electrical and Computer Engineering at the University of Puerto Rico - Mayaguez. He is the principal investigator of one of the very successful IIMI projects and he is a member of the Board of ADMI. He has succeeded in obtaining NSF funding to help establish PhD programs in computer science and computer engineering at both the Mayaguez and Rio Piedras campuses of the University of Puerto Rico.

Dr. Bryant W. York, Northeastern University

Dr. York is Associate Professor and Research Director for the College of Computer Science at Northeastern University. He is a former NSF program officer for the IIMI program, a member of the CISE Advisory Committee, a member of the ACM Education Board, chair of the ACM Committee on Minorities, and a mentor for minority students in the NEBHE mentoring program.

1.1 Participant Selection

During the planning meeting, a list of topics and a format were decided upon. It was also decided that we would not videotape or audiotape the sessions in order to increase the level of openness of the participants. The committee was further charged with the task of developing a list of potential workshop participants. The prime criterion for inclusion on the list was dedication to the development of African American or Hispanic students while maintaining broad participation. The list was subjected to an additional set of diversity criteria along a number of dimensions: (1) sector: academic/industrial/non-profit, (2) ethnic, (3) professional level, (4) institution type (majority or minority), and (5) academic discipline. The committee produced a list of 70 names which was shortened to about 45 by eliminating

overlap in the diversity criteria. A number of potential invitees were unable to attend for a variety of reasons and a partial list of those people is included below. Since most of these people serve in several capacities, we have only included the role in which they would have been involved in the workshop.

- Howard Adams, Notre Dame, Executive Director, National Consortium for Graduate Degrees in Engineering for Minorities (GEM)
- Marian Blalock, Purdue, Co-founder, National Society of Black Engineers (NSBE) and National Association of Minority Engineering Program Administrators (NAMEPA)
- Louis Cain, BellCore, industrial support of graduate students
- Yvonne Freeman, Head of NASA Office of Equal Opportunity
- Mary Ellis, Chair of CS, Hampton University
- Gerald Engel, NSF, IEEE-CS, former NSF program manager for IIMI
- Jose Fortes, Professor, Purdue University
- Johnny Houston, Chair of CS, Elizabeth City University
- Herman Hughes, Professor, Michigan State University
- Edward Lazowska, University of Washington, Member, CRA Board of Directors
- Ben Martin, Professor, Morehouse College
- Shirley McBay, Founder, Quality Education for Minorities (QEM)
- Robert Moses, Founder, The Algebra Project
- Joseph O'Rourke, Smith College, Director, CRA Mentoring Project
- Major R. Owens, Representative, U. S. Congress
- David Patterson, UC-Berkeley, Chair, CRA Board of Directors
- George Peterson, Executive Secretary, ABET
- Mabel Phifer, Black College Satellite Network (BCSN)
- Alan Shaw, MIT Media Lab, community networks developer
- Valerie Thomas, former NASA MUSPIN Program Director
- Uri Treisman, UT-Austin, Founder, Math EXCEL program
- Carla Trujillo, UC-Berkeley, Minority Programs Administrator
- Ivan Van Sertima, Founder and Editor of *Blacks in Science*
- Rick Weingarten, Executive Director, CRA
- John Werth, UT-Austin, Chair, ACM Education Board, CRA Board Member
- Bettie L. White, NASA, Dir. Minority University Res. and Educ. Div.
- Reginald Wilson, American Council on Education (ACE)
- Bill Wulf, University of Virginia, former Assistant Director, NSF CISE
- Paul Young, Assistant Director, NSF CISE

The workshop was held May 4-7, 1995 at the Airlie Center in Airlie, Virginia. Participants were asked to submit position papers in advance of the workshop and to present their papers at the workshop. The workshop was organized around five panel topics: (1) Leveling the Playing Field, (2) Pipeline Issues, (3) Institutional Environments, (4) Quality, Evaluation

and Measurement of Graduate Programs in CS, and (5) Mentoring and Breaking-in.

The final list of participants is enclosed below. We were able to achieve the following kinds of diversity:

- Sector: Academic - 26, Industrial - 2, NSF - 3, NASA - 1, Other - 3
- Ethnic: African American - 20, Hispanic - 7, White - 7, Middle Eastern - 1
- Gender: Female - 5, Male - 30
- Academic Levels: Deans - 3, Dept. Chairs and former chairs - 10, Professors or former professors. - 26, Graduate Students - 1, Undergraduates - 0, Center Directors - 2
- Recent PhDs (since 1988) - 6
- Academic Institution Type: Minority Institutions - 9, Majority Institutions - 8
- Minorities from Majority Institutions - 8, Minorities from Minority Institutions - 11, Majorities from Minority Institutions - 1, Majorities from Majority Institutions - 3

Several of the participants are members of ACM, CRA, IEEE-CS, and BDPA; however, we did not obtain a tally.

List of Participants

- Robert Aiken, Temple University
- John Alexander, U. District of Columbia, National Association of Mathematicians
- Joseph Barba, City College of New York
- Sandra Johnson Baylor, IBM TJ Watson Research Center
- Jesse Bemley, Joint Educational Facilities, Inc.
- Jerome Bennett, NASA MUSPIN
- Andrew Bernat, University of Texas - El Paso
- Diane Burke, Northeastern University
- Robert Cartwright, Rice University
- John Cherniavsky, NSF CISE/CDA
- Don Coleman, Howard University
- Eugene DeLoatch, Morgan State University
- Clarence Ellis, University of Colorado
- John Foster, Prairie View A&M University
- Roscoe Giles, Boston University
- Louis Gomez, Northwestern University
- Manuel Gomez, University of Puerto Rico - Rio Piedras
- Harry Hedges, NSF CISE/CDA
- Charles Isbell, MIT
- J.R. Jones, Quality Education for Minorities (QEM)
- Andrea Lawrence, Spelman College
- Anthony Maddox, Northeastern University/UCLA

- Larry Oliver, ADMI
- Manny Pacillas, University of Texas - El Paso
- Neville Parker, City College of CUNY
- Domingo Rodriguez, University of Puerto Rico - Mayaguez
- Richard Tapia, Rice University
- Sandra Ramos Thuel, AT&T
- Valerie Taylor, Northwestern University
- Doug Troeger, City College of New York
- Ramon Vasquez-Espinosa, University of Puerto Rico - Mayaguez
- Mary Vernon, University of Wisconsin
- Lucius Walker, Howard University
- Nagi Wakim, Bowie State University
- Luther Williams, NSF EHR
- Bryant W. York, Northeastern University

2 The Workshop

The workshop began with an opening address by Dr. Luther Williams, Assistant Director, Directorate for Education and Human Resources, National Science Foundation. His talk was entitled, *Effective Deficit Reduction: Investments in the Education and Training of a Diverse Scientific and Technological Workforce*. Dr. Williams made several significant points which set the tone for the rest of the workshop. The major points are summarized below:

Effective Deficit Reduction: Investments in the Education and Training of a Diverse Scientific and Technological Workforce

Luther Williams

- There is concern about neglect of human resource development in the current frenzy of federal budget slashing. He quoted Jack Gibbons (Assistant to the President for Science and Technology) as saying “it makes no sense to balance the federal budget at the expense of a viable human workforce.”
- Differentials in participation have existed for years and continue to exist. They led to affirmative action in the 1960s instead of true investment in human infrastructure. Affirmative Action was a misguided attempt to address inequities in the workforce. It facilitated small changes and missed the broader issue of human resource development.
- The workshop must consider its issues in the current context of declining federal budgets, the reinvention of federal agencies, and the political, economic and social realities of U. S. society.

- The document, *Science in the National Interest* is a good starting point in that it lays out five basic objectives:
 - Basic research
 - Technology transfer
 - Partnerships
 - Criticality of producing scientists and engineers
 - Need for broad literacy in science and information technology
- The workshop needs to acknowledge the continuum of need from basic computer/information literacy to PhD-level research.
- Students should *not* be required to be the *agents of change*. They need to be deposited in supportive educational environments.
- Successful university programs of the 1960s - 1990s have been devoted to increasing the “presence” of minorities. They were successful in recruiting, but then presented these students to faculty who had not bought into the overall program of human development. We got the predictable, bad outcome - low retention. Schools that eliminated 90% of these students were rated of “high quality” (a self-fulfilling prophecy).
- The approximately \$95 billion spent on Title I programs since 1965 embodied a form of “compensatory deference” and forced a cycle of remediation. They were effectively transportation programs (busing); no educational outcomes were specified.
- What is needed is a national enterprise to develop a “Human Resource Mantra” acknowledging the role of human capital.
- Reject the traditional lament and push forward on problem solving as we would in our individual research endeavors.

Dr. Williams also presented some data on the success of the Alliances for Minority Participation (AMP) program which he expects to increase the number of science, engineering and mathematics B.S. degrees awarded per year to minorities to 50,000 by the year 2001. In the three years since the inception of this program, the number has increased from about 4,000 per year to about 18,000 per year. The hallmark of this program is *assessment*. Awardees must generate explicit goals and their progress with respect to those goals is closely monitored.

Finally Dr. Williams discussed the expected budget reductions for NSF over the next five years. He strongly advised the participants to consider all of their recommendations in the economic context of declining budgets and the social context of equity and accountability.

Underrepresentation: Anatomy of Failure and Steps Toward Success

Richard Tapia

The invited after dinner talk entitled, *Underrepresentation: Anatomy of Failure and Steps Toward Success*, was given by Dr. Richard Tapia. In this presentation Dr. Tapia outlined

the history of development of his minority programs at Rice University, described and characterized certain failures and successes. Some of the important issues addressed:

- At Rice students entering with a combined SAT score of 900 or below have a 100% correlation with failure. Quite a bit can be done with students between 900 and 1200. Rice experiences a 90% retention rate among all students including minorities. This retention rate for minorities is very high and directly attributable to the nurturing atmosphere. Dr. Tapia gets a good portion of his African American students from HBCUs.
- The city of Houston is a “diversity laboratory” consisting of approximately one-third Black, one-third Brown and one-third White population. Dr. Tapia has attempted to maintain these proportions among his student groups and insists upon multi-ethnic affinity groups.
- A good part of the success of his program is due to the effective implementation of the extended family concept. Dr. Tapia spends a great deal of time with his students in a variety of settings. This raised the issue of how to scale the *human intensive* activity of individual mentoring.
- The delicate issue of academic preparedness of African American students coming from undergraduate math and CS programs at HBCUs to graduate careers at Rice was raised. Although the transition to graduate school may require an increased effort on the part of most students, Dr. Tapia reported cases of African American students (from HBCUs) who claimed they had to significantly increase their effort in order to survive in graduate school. How much of this anecdotal data represents a quality issue and how we can disentangle the quality issue from the ancillary issues are two of the challenges posed by Dr. Tapia.
- Dr. Tapia cautioned against lumping all Hispanics or all African Americans into a single category; class may play a bigger role than ethnicity. He explained how distinctions between New York Puerto Ricans, Island Puerto Ricans, Cubans, Texas Mexicans, and California Mexicans manifested themselves in terms of self-image, academic attitudes and other important factors.

Some of Dr. Tapia’s important recommendations are:

- In order to be really effective in developing and sustaining minority programs, one must first acquire some amount of power within the institution.
- When visiting an institution to talk on minority issues, insist upon giving your technical presentation in your discipline on the previous day. This guarantees academic credibility which enhances your talk on minority programs. Dr. Tapia counsels all of his students to implement this policy as well.
- Use peer mentoring to expand the base of mentors.

- Work to change the reward structure of academic institutions to reflect better teaching and mentoring.

2.1 Leveling the Playing Field

Participants in this panel were given the following charge:

In the quest to make minority institutions (MI's) more “competitive” research and educational entities, we often cite the historical impediments under which such institutions have evolved. Papers for this panel will explore methods for compensating for these historical barriers. The papers developed here can/could/should discuss the rationale for making such institutions viable, i.e., is it cost effective to invest resources in such institutions for development of separate independent CS graduate programs? Should minority institutions focus on undergraduate education and develop articulation agreements with large institutions for the graduate training of their students? What are the trade-offs?

Given that it makes sense to do so, what are the best strategies for developing competitive research and graduate programs at minority institutions? Cooperative programs with traditional (Forsythe List) universities? Industry-based consulting of the faculty? etc.

What are the most effective strategies for bringing minority institutions on the Internet/NII/GII? How will the advent of digital libraries affect education at MIs? Should NSF provide support for local MI campus networking? Can the model developed for increasing participation of Blacks, Hispanics, and Women in graduate programs be applied to the growing situations in which white males are minorities in U. S. graduate programs? Other aspects of the “Leveling the Playing Field” problem up for discussion:

- When resources are invested in “leveling” does the overall national quality suffer?
- Models for bringing MI's up to speed (success stories)
- What are the impacts of set-aside programs on the respect of work done in MI's? Are set-asides a good leveling mechanism?
- Are there necessary and/or sufficient conditions for identification of MI's for investment(research infrastructure) or does (political) equity dictate an across the board strategy?
- What are the relationships to existing NSF and other federal agency programs such as MIE, RIMI, RCMS, II-MI, MURED, MBRS, MARC, etc.

Three papers were submitted and two presentations were added to this section at the beginning of the workshop. Domingo Rodriguez decided to speak on fostering critical thinking and Jerome Bennett of NASA spoke on networking programs with minority universities.

Presentations:

- Leveling the Playing Field – Fact vs. Fiction, Bob Aiken
- MYCAP: Minority Youth Computing Awareness Program, Larry Oliver
- Leveling the Playing Field, Sandra Ramos Thuel
- Fostering Critical Thinking in the Information Age: A Key in Leveling the Playing Field, Domingo Rodriguez
- NASA MUSPIN: Infrastructure for Minority Universities, Jerome Bennett

Session Summary

In Bob Aiken's talk he proposed the CCC model (Cash, Connections, Confidence). He sees getting enough money to pay for an education as the biggest problem faced by minority students at Temple. Temple has 17% minority students. Other related problems are *isolation* – many minority students continue to feel isolated at majority institutions and lack of academic confidence which may derive from inadequate mentoring and/or academic preparation. He proposed a three-pronged solution: (1) The federal government could provide \$20 million per year in matching funds for institutions which attract corporate sponsorship for minority students. If we assume \$5,000 per year per student, we could help 8,000 students. At a 90% retention rate that would mean 7,200 students or a four-year pipeline with 1800 students graduating per year. Bob stressed the need for more university/government/industry cooperation; argued that student retention can be improved through more and better mentoring; enhancement of faculty at MIs through grants for joint research (e.g. Undergraduate Faculty Enhancement (UFE), AMP, Research Opportunities Awards (ROA)) is needed; and MI CS departments can be developed through “twinning” (partnering with a majority institution), block grants for infrastructure, and the establishment of endowed chairs. The question of how we can accomplish this in the context of declining federal budgets was raised. Increased industrial participation was basically the answer.

Larry Oliver talked about his Minority Youth Computing Awareness Program (MYCAP). He gave a very long list of serious societal problems we are facing and tied them to the breakdown of the family, sense of community, and influence of church. He then suggested we focus on: (1) capturing the interest of the youth and (2) considering the whole person and the current environment in crafting solutions. His proposal is to develop family, community, and religious affiliations through TV broadcast of computing awareness lectures to local churches. The idea is to capture the student by age 7.

Sandra Ramos Thuel dealt with three main issues: (1) Should we really be developing MI graduate programs? (2) Is graduate minority education a development or a partnership? (3) How can institutions and the federal government effectively invest their money. Her conclusions were that we should be encouraging partnerships between MIs and MAs for the development of MI graduate programs in CS. Dr. Thuel listed five criteria for effec-

tively investing in graduate programs at MIs which follow the acronym FACTS – **F**oresight, **A**ccountability, **C**ommitment, **T**enacity, and **S**elf-awareness. She outlined her two-pronged approach to developing MI graduate programs, dual emphasis on (1) building a competitive campus research infrastructure and (2) establishing strong partnerships. In addition, she presented a few of the 16 specific suggestions (which are fully described in her paper) for implementing this approach.

Domingo Rodriguez addressed the issue of fostering critical thinking. His basic thrust was that we should get students started on research early; it is a mistake to wait until graduate school. He acknowledged the usefulness of the NSF Research Experiences for Undergraduates (REU) program and recommended expansion of it.

Jerome Bennett discussed NASA’s programs to build infrastructure at minority universities. Whereas the NSF CISE/NCRI Connections program was designed to bring the Internet to the campus; the NASA program has been designed to develop campus networks. Many MIs were able to get the network to campus, but unable to get enough on-campus faculty access. Mr. Bennett discussed NASA’s new program in high performance computing (\$500K grants) and its donations of HPC equipment to MIs (especially the donation of an ETA-10 to Morgan State University in 1991 and the recent upgrade of that equipment). His key point was that extensive networking infrastructure is needed NOW, given the pace of growth of the Internet and WWW. MIs cannot be left behind.

Ideas, Issues and Questions raised during discussion:

- Universal agreement on the central importance of good **MENTORING**.
- Expand the base of mentors – peer mentors, parents, the notion of “adjacent level mentoring”. We need to learn to exploit the *reciprocal* nature of these types of mentoring. Mentor and mentee both gain from the experience.
- Mentoring is a *human-intensive*, not easily scalable activity. How can we scale it?
- How can we train more mentors? One idea is to train parents via community-based computer networks like the one developed by Alan Shaw of the MIT Media Lab in Dorchester, Massachusetts (a minority community of Boston).
- How do we increase industrial support of university students in partnership with federal programs?
- Institutions need to change the reward structure to acknowledge the importance of teaching and mentoring. Mary Vernon pointed out that the University of Wisconsin has already started this process. Doug Troeger mentioned that CUNY began its process about two years ago by installing a new University administration. These two institutions could provide models.
- Dedication to professionalism on the part of faculty needs to be re-emphasized. Much can be done with few dollars by some community based organizations, such as Joint

Educational Facilities (JEF) in Washington, DC and Playing to Win in New York to name just a few. Why can't larger institutions be as efficient and effective?

- There is a fine line between *cultural invasion* and *cultural synthesis*. We must be sensitive to this in a diverse culture. How can minorities maintain cultural identity while integrating into the larger U. S. culture and the cultures of math, science, and engineering?
- The NII is rapidly expanding and there is need to invest resources in MIs NOW! Otherwise the imbalance of resources will lead to a greater disenfranchisement than slavery.
- MIs usually have "cultural presence" in the communities from which minority students come. MAs should *also* try to establish cultural presence in these communities so that awareness of these institutions comes early in the life of the student.
- Ownership of knowledge is one of the keys to maintaining the interest of inner city minority youth in math, science, and engineering. We must find ways to give them ownership and empower them.
- The nation needs explicit metrics for evaluating teaching and mentoring. Assessment is KEY!
- What can be learned from the successes in math, science, and engineering of Asian immigrants? Can it be packaged and delivered to African Americans and Hispanics?
- We must be responsible to the student throughout the K - PhD or K - Life spectrum. Current economic trends demand lifelong learning.

2.2 Pipelining

Participants in this panel were given the following charge:

Despite the pivotal role that computer science is playing in the emerging information-based economy, computer science is an unpopular career choice among African Americans and Hispanics. In this panel we wish to explore the root causes and to propose innovative solutions. This requires an understanding of the entire educational pipeline from K - PhD. Each stage of the pipeline has its own distinctive character in terms of human development and educational solutions are further complicated by a number of social variables. Papers for this panel might consider some of the following questions:

- What are the main leakage points in the pipeline and how can a more wholistic understanding of social, cultural, and educational factors help to stop the leakage?
- What is the role of mathematics training vis-a-vis informatics training at the K-12 level? Can knowledge of information processing empower students at an early age and stimulate scientific interest?
- How can we evolve the computer culture fostered by current K-12 computing curricula

including the College Board AP Computer Science syllabus to one which is more flexible and diverse?

- How can adequate infrastructure be provided to predominantly minority institutions including both K-12 schools and institutions of higher learning?
- How do we address the scarcity of role models for minority students?
- How effective are NSF programs such as AMP and CRCM?

Presentations:

- Incorporating Computer Activities in the Fabric of Science and Mathematics Courses, John W. Alexander
- Expanding the Pipeline: Changing the Culture of Computer Science Education, Robert Cartwright
- Some Prescriptions for a Systemic Computer Science/Computer Engineering Pipeline Initiative Program with Emphasis on the K-12 Link, Neville Parker

Session Summary

John Alexander spoke on the importance of experiential learning and the need to focus on the community college level as an important point in the pipeline. Clear articulation agreements should be established. National quality standards would allow institutions to set appropriate goals. He also discussed the importance of incorporating computing activities into science and mathematics courses at the K-12 level.

Robert Cartwright spoke on changes needed in the secondary school computer science curriculum. Based on his experience teaching introductory computing courses at Rice, he conjectured that a large number of minority and women students are “turned off” by CS because introductory courses focus on teaching a low-level “machine-oriented” model of computing that appears detached from human concerns. This approach to teaching CS has been institutionalized in the College Board CS AP Examination. At Rice University, Prof. Cartwright and his colleague Matthias Felleisen have developed a new introductory computing curriculum that emphasizes a high-level “algebraic” model of computing. The model explains general computation as an extension of grammar school arithmetic. After students have mastered the algebraic model of computing, the curriculum introduces a complementary machine-oriented model of computing. With the new curriculum, Profs. Cartwright and Felleisen have experienced much higher rates of retention among women and minorities. They are now working on adapting this curriculum for use in high schools.

Neville Parker argued for mandatory math, science and computer science/information science throughout the K - Life curriculum. Too many choices lead to too many leakage points in the pipeline. Dr. Parker insisted that we do not have to impose curricula on the schools, but provide them tools and ask how they want to use them. The emphasis should be on

systemic change.

Charles Isbell spoke briefly on the stratification of the pipeline and the need to target solutions to each level. He outlined a model for taking advantage of the cascading effect of solutions.

Ideas, Issues and Questions raised during discussion:

- To access more minority students, focus on the community college area of the pipeline.
- Maybe national articulation agreements could be developed along the lines of the Florida model. Florida has state-wide articulation for its engineering programs.
- Revise the high school computing curriculum, adopting the algebraic model of computing.
- Abandon the College Board AP Exam in computer science or significantly revise it.

2.3 Institutional Environments

Participants in this panel were given the following charge:

The purpose of this panel is to try to understand what types of institutional environments are most conducive to the production of high quality African American and Hispanic students. Here we are concerned with three areas: (1) physical/electronic infrastructure, (2) human infrastructure, and (3) social context. For example, what is the minimal amount of electronic infrastructure required at a minority institution to provide its students with a high quality education? Is dial-up access to a remote workstation at a majority institution sufficient or is fiber to a high performance local desktop workstation necessary? What computing and communications infrastructure is minimally necessary to take advantage of remote educational and research opportunities (courses offered across the Internet, etc.)? Is it necessary that all institutions invest in the same level of electronic infrastructure or are there models for sharing of expensive computing resources (e.g. the NSF Supercomputer Centers). Do partnerships between minority and majority institutions and national labs make sense? In what contexts?

On the human infrastructure front we are interested in several issues including: (1) the sufficiency of faculty at many small institutions (including some minority institutions) to provide a high quality CS/CE educational and research experience, (2) the effectiveness of “collaboratories” and “research experiences for undergraduates” in keeping minority students interested in CS, (3) the production of minority BSs, MSs, and PhDs in CS/CE, and (4) the market for minority PhDs in CS/CE.

On the social front we are concerned with the “sometimes heard” view that minority insti-

tutions are viewed as “nurturing” and majority institutions as “hostile” by many minority graduate students. Is this view widely held? If so, why? Should students be educated in distinguishing between “highly competitive” and “hostile” environments? What insights do minority entrepreneurs have to offer on this topic? What characteristics are majority corporations looking for in minority CS graduates?

The organizing committee was quite surprised that no papers were submitted to this session, although issues related to this panel surfaced in several other areas.

Presentations:

- An Overview of the NSF/CISE/CDA IIMI program, John Cherniavsky

Session Summary

John Cherniavsky described the NSF CISE/CDA IIMI program. The program began in 1989. Two major awards were made each year through 1993. Each award was for approximately \$2 million over 5 years. The purpose was to develop the research and educational infrastructure of minority institutions. The program was changed in 1994 to the MII program; it was opened up to 2-year institutions and consortia. Dr. Cherniavsky’s assessment of the IIMI program was: (1) the goals were not well thought out initially, (2) mechanisms for assessment were not built into the awards, (3) systemic change was not accomplished, and (4) many MIs lacked minority faculty role models and this reduced the effectiveness of the awards. Bryant York (as a former IIMI program officer) registered some disagreement with John’s assessment. He pointed out that although explicit assessment mechanisms had not been built into the program announcement for the IIMI program, all the winning proposals had described explicit evaluation criteria and procedures and they all implemented them. Andrew Bernat mentioned that the IIMI program developed UTEP’s CS Department into a research class program. Ramon Vasquez-Espinosa pointed out that the University of Puerto Rico is now poised to start PhD programs in CS and CE as a result of IIMI awards to UPR-Mayaguez and UPR-Rio Piedras. Sandra Ramos Thuel is just one example of a graduate of UPR-Mayaguez who went on to get her PhD at CMU. This year UPR-Mayaguez sent 9 students to majority graduate schools in CS or CE.

Ideas, Issues and Questions raised during discussion:

- Not all MIs have the same goals; each needs to clearly explicate its mission. Becoming a research institution may not be part of every MI’s mission.
- Some MIs are ready to develop PhD programs in CS/CE and can make effective use of federal infrastructure support - e.g. Howard Univ, UTEP, and University of Puerto Rico.
- Given the premise that PhD programs do not pay for themselves, how do you convince the administration of an MI that it needs a new PhD program in CS?

- Masters degree programs which are designed to put graduates into industry do pay for themselves. These programs have different characteristics from masters programs which feed PhD programs. Some MIs might wish to focus on the industrial-type MS programs as a niche. Industry is looking for talent and is unconcerned where it comes from.
- Maybe CS and Engineering should look at common objectives.
- How did Morgan State support the cost of the ETA-10 that was donated by NASA in 1991? Sold computer time to small/medium-sized businesses. Is this a viable approach for other institutions?
- The cost of networking/computerization is very high. Equipment becomes obsolete faster now. How will MI deans and administrators pay the recurring costs of maintaining such environments? University of Wisconsin had a practice of selling its computing equipment just before it became obsolete and using the revenue to fund the next generation of equipment. This has become increasingly more difficult as vendor discounts are no longer as deep as they once were and obsolescence occurs faster.
- Are user fees charged to students a viable mechanism for paying for computer/networking infrastructure? Northeastern University's students will vote on such a fee this year.
- We need to distinguish the nature of different institutions in terms of the kind of support they receive. Institutions are private, public, combined private-public. There are different types of private-public institutions - e.g. Howard University and Gallaudet receive special federal support (a line item in the federal budget); Cornell has a private component and a state-funded component.
- Computer scientists need to do a better job of selling their discipline to the U. S. public. We need to do research in the national interest. If *Computing the Future: A Broader Agenda for Computer Science* did not successfully define CS and get the word out, how can this group expect to do so?
- Research and the National Needs (RANN) was tried in the 1970s under President Carter and was considered a failure. How do we avoid the mistakes of RANN? We can demonstrate the importance of CS by research results and technology transfer into technologies that everyone can appreciate.
- Universities are different from companies and they should not be expected to perform on the same basis.
- Why is diversity important? The workforce is becoming diverse; it's a matter of economic survivability. The marketplace is validating the need for a diverse workforce.
- Diversity is **NOT** the ability to simulate the behavior of White males as a demonstration of assimilation into the culture. Diversity is the ability to take advantage of our differences for the betterment of the society. The U. S. population at large accepts assimilation, but does not yet accept diversity.
- We need to think about what *replication* means for successful federal programs. We need a mechanism for separating replicable parts from idiosyncratic parts. We need to

identify what is generic and what is needed to adapt the program to local conditions.

- What portion of a university's traditional library budget should begin to be spent on digital libraries? This is an important infrastructure question. The quality of an institution's libraries correlates highly with its ranking. Is this one way for MIs to begin to level the playing field quickly?
- The acceleration of change is clear in the information age. The changes in the last three years are comparable to the changes of the last twenty years in terms of networking - ARPANET → CSNET → Internet → WWW. Change will be abrupt; shouldn't MIs prepare now in terms of the WWW and digital libraries, as well as other technologies. Value-added derives from being an "information provider" not just a consumer.

2.4 Quality, Evaluation and Measurement

Participants in this panel were given the following charge:

Graduate CS/CE programs have been/are being established at a number of minority institutions. It is important that these programs both be and be perceived to be of high quality. Quality is a loaded term—we all believe that we know it when we see it. Our perception of quality drives our acceptance of the faculty participating in and students matriculating from these programs, yet perception frequently lags or doesn't match reality. Papers for this panel should address at least one of the following questions:

- Is it possible to determine the true quality of a graduate program via measurement/evaluation and, if so, how?
- How do we align general perception and this measured reality?
- What steps must minority institutions take to raise the quality of their graduate programs to meet these evaluation criteria?
- Is there a role for non-minority institutions in these efforts?
- Are any of these steps suitable for projects which would demonstrate the value and/or difficulty in enhancing the quality of these graduate programs?

Presentations:

- Maintaining the Mission: Developing Good Graduate Programs for Minority Institutions, Charles Isbell
- Affinity Groups for Student Success, Andrew Bernat
- Evaluating the Quality of Graduate Programs at Historically Majority and Minority Institutions, Sandra Johnson Baylor

Session Summary

Charles Isbell questioned whether it is a good idea to turn MIs into Research I (Carnegie Classification) institutions. The traditional mission of most MIs has been to provide a supportive environment for good undergraduate education. This is not true for all MIs. Some “recently minoritized” institutions such as CUNY were comprehensive universities with a strong tradition of research and teaching long before becoming an MI. For example, CCNY lists the most Nobel Laureates among its graduates of any U. S. institution. All of them graduated when there was a significant emphasis on teaching. A good graduate program has three main requirements: (1) resources/infrastructure (2) a supportive environment and (3) a research tradition. How do we impart a research tradition to an MI with no history of research? Charles would prefer not to see graduate programs developed at MIs if they undermine the original educational mission of the MI.

Andrew Bernat spoke on affinity groups as models for student success. Affinity groups are not traditional research groups. They have a mix of graduate and undergraduate students working with faculty. There is a broad base of activity, including research, proposal writing and curriculum development. A lot of peer mentoring takes place. The secret is to get students involved.

Sandra Johnson Baylor spoke on evaluating the quality of graduate programs at majority and minority institutions. Dr. Baylor laid out a number of criteria which included: (1) sufficient computing and networking infrastructure, (2) amount of external funding, (3) peer recognition of the faculty, (4) research results, publications and citations of the faculty, and (5) the research and technical abilities of the graduate students. She stressed the importance of both human and physical infrastructure in developing and maintaining a high quality graduate program in CS.

Ideas, Issues and Questions raised during discussion:

- How do we define quality? What measures should be used? Should we use the traditional measures used by MAs for MIs? How do you get faculty to embrace this mission?
- Being awarded a PYI, NYI, or PFF changes the perception of quality for an individual; the award of several PYIs changed the perception of the quality of the Computer Science Department at Wisconsin, for example.
- Each institution’s individual culture is a contribution to U. S. and world culture. It needs to be recognized as a resource.
- More programs requiring university/industry partnerships are needed.
- Each institution (majority/minority) must be clear about its mission in the broader context.

2.5 Mentoring and Breaking-in

Participants in this panel were given the following charge:

It has become clear in the last five years that mentoring plays an important role in an individual's success. We are concerned here with issues surrounding the mentoring of African American and Hispanic undergraduates, graduate students, and junior faculty in CS/CE disciplines. Some important questions are: What are the necessary qualities of an effective mentor for undergrads? for grads? for junior faculty? Must the mentor also be minority? Is peer mentoring effective? Must the mentor and mentee be co-located or can effective mentoring be accomplished via telephone, Internet, video teleconferencing, etc? What responsibilities does a PhD advisor have for the post-PhD development of his/her students? How much should an advisor explain to a new PhD about the federal funding process? the tenure process?

The topic of mentoring leads to the following related issue on representation of minorities on the influential bodies of the field – i.e. breaking into the circles of power. Some questions are: What professional organizations, advisory boards, editorial boards, program committees, etc. have significant influence on the CS/CE community? Once these have been identified, how can minorities gain positions on these powerful bodies, given that there is a political component to the non-elective processes? Is it the responsibility of the mentor to assist with this task?

Papers for this panel may address one or both of these issues.

Presentations:

- Two Examples of Lost Opportunities, Jesse Bemley
- Structural Requisites for Undergraduate Mentoring in the Computing Disciplines: Working Paper, Doug Troeger and Joe Barba
- Perspective on Mentoring for Increasing the Participation of Minorities in the Computer Science/Computer Engineering Professions, John Foster
- Mentoring and Breaking-in, Mary Vernon
- Mentoring Can Make the Difference, Andrea Lawrence
- Mentoring and Breaking-in, Valerie Taylor

Session Summary

Although mentoring had been thoroughly discussed in all the preceding sessions, it was still an active topic during the final session.

Jesse Bemley spoke about the role of mentoring outside of academic institutions. He described how community-based programs such as Joint Educational Facilities (JEF, Inc.) can

be effective. Dr. Bemley gave several examples of minority students that he has developed over the years through his efforts at JEF on very little external funding.

Doug Troeger delivered his paper on *Structural Requisites for Undergraduate Mentoring in the Computing Disciplines*. He described his experiences as co-PI of an IIMI grant at CCNY and the requisites for mentoring programs. Some of the impediments he listed are: (1) students are not prepared for college-level courses, (2) many students view college as just a place to take courses, (3) students are almost always unprepared by the lower division for problem solving mentorships, (4) faculty participation in mentoring is optional; it should be required, (5) student participation in mentoring is optional; it should be required, (6) University administrations view mentoring as *easy*; they need to be re-educated, (7) faculty have low expectations of students, (8) faculty do not encourage students to meet with them outside of class, (9) premature placement of students into research projects, (10) the view that the only successful mentorship is one that leads to a graduate school fellowship.

John Foster gave a personal perspective on mentoring. He is currently the Dean of the College of Engineering and Architecture at Prairie View A&M University in Houston Texas. He recounted how he was mentored as an undergraduate at an HBCU by an Indian professor and in graduate school by an Iranian graduate student. He stressed the point that same ethnicity is not critical to good mentoring. Building an effective relationship depends more on commitment than ethnicity. Dr. Foster sees the identification of potential mentors as a major challenge facing institutions. Many Minority Engineering Programs (MEPs) provide mentoring at majority institutions and are staffed only by non-faculty. In order to be effective these programs must include faculty. Substantially more attention needs to be directed at mentoring of new faculty members after they have completed their graduate degrees.

Mary Vernon succinctly summarized the basic issues of good mentoring and then provided some specific suggestions for what minorities and women can do as well as majority men. In her summary she pointed out that a talented individual will succeed if she (1) understands what is possible, (2) believes she can accomplish it, and (3) has access to the requisite education and training. Dr. Vernon addressed the claim that MIs are good at providing all three aspects and that MAs are good at only part 3. Mentoring is definitely a key to helping a student understand what is possible and to giving the student confidence to accomplish it. Although many MIs have nurturing programs for undergraduates, it not clear that this same attitude would extend automatically to newly created graduate programs. Graduate students are generally more mature than undergraduates and the dynamics of interaction with faculty are quite different.

Since mentoring is a key to steps (1) and (2) of student success, Dr. Vernon addressed the characteristics of a good mentor. She explained that a good mentor need not look like, act like, or even have the same values as the mentee. After relating some of her personal

experiences with mentors (who were primarily male), she pointed to the need for different types of mentors at different stages in one's career. Peers, faculty and family play a large role during undergraduate years; peers play a much larger role during graduate school; the faculty advisor is very important near the completion of the graduate degree and during the job interview process; and finally senior members of the discipline and family tend to play a larger role once the career has gotten underway.

Finally Dr. Vernon made some specific suggestions. What can individual women and minorities do? First, "**BE PREPARED**; Luck is when *preparation* meets *opportunity*. Secondly, seek out and appreciate peer mentors. And finally be flexible. She also addressed the issue of what majority individuals can do: Pay attention to the issues and the successes. Mentor women, minorities and majority men all in a professional manner.

Dr. Vernon's final list of suggestions concerned the kinds of programs that are needed: (1) A WWW clearing house for national and model community-based mentoring programs such as JEF, Science-by-Mail, and JAM. (2) A WWW clearinghouse for successful university-based programs such as Richard Tapia's at Rice. (3) Publicize the individual accomplishments and success stories of recent graduates such as Sandra Johnson Baylor, Sandra Ramos Thuel, Valerie Taylor and current graduate students such as Charles Isbell and Alan Shaw. (4) Modify the university reward system to reflect the importance of mentoring. (5) Define "computing professional" to include mentoring. (6) Foster partnerships and collaborations among MIs, MAs and industry.

Andrea Lawrence spoke how mentoring *can* make a difference. She listed five factors which contribute to the underrepresentation of minorities in graduate CS/CE programs which mentoring can possibly ameliorate. The five factors are: (1) scholastic background, (2) negative feedback, (3) hostile environment, (4) financial strain, and (5) time to finish. Dr. Lawrence related each of these to the four stages of a graduate school - entrance, retention, completion, and follow-up. She reiterated the the notion that mentor/mentee need not be of the same ethnicity. She also pointed to email and telephone as viable mechanisms for long distance mentoring.

Valerie Taylor gave the final presentation and stressed the importance of peer and community mentoring as necessary to eliminating the feelings of isolation experienced by many minorities in majority graduate schools. Dr. Taylor also described the qualities needed in a good senior mentor. First of all the senior mentor must be well-established. He or she must be open, sincere and possess wisdom and trust (ed: a tall order for anyone).

Ideas, Issues and Questions raised during discussion:

- Identify mentors, all types of mentor links should be explored. student - student, parent - student, teacher - student, teacher - parent.

- We need to more finely quantize educational classification – academic degrees are not as meaningful as they used to be. People get educated/trained throughout life and need rewards.
- University faculty should be more involved in K-12 teacher training.
- University professors need to understand their full responsibility at all levels of education – more professionalism is required.
- Distance mentoring via telephone or email can be effective.

3 Project Ideas

- A study to evaluate the effectiveness of federal minority programs
- A study to define what is expected in terms of replication of successful programs.
- Develop a master WWW home page for minority institutions. A link would exist for each minority institution to a one page description of the institution’s mission.
- Develop a master WWW page for minority researchers in CS/CE/ENG to support the “remote role models” concept.
- Develop a position paper on the structure of educational revolutions resulting from technological revolutions.
- Develop a position paper on explicit metrics for evaluating graduate and undergraduate programs.
- A study which attempts to quantify the “nurturing” characteristic of HBCUs/MIs which leads to emotionally stronger graduates who survive majority graduate programs at higher rates than minorities who attend undergraduate programs at majority institutions.

The idea of a joint ACM/CRA/IEEE-CS committee on the status of minorities was proposed, but some participants thought it might be difficult to implement. As a result participants were asked to contact Bryant York if they wished to serve on the ACM Committee on Minorities, Robert Cartwright if they wanted to serve on the CRA Committee on the Status of Minorities (CRAM), and Andrew Bernat for IEEE-CS.

Bryant York proposed the establishment of a committee to be formed from the attendees at the workshop to continue the development of the issues raised. The committee would have the following subcommittee structure based upon issue categories raised at the workshop:

- **A National Policy Subcommittee**, composed mostly of deans and administrators, who would keep track of changes in national policy as they affect minority students and minority institutions with respect to the computing disciplines. They would publish a quarterly newsletter on the Internet. The National Policy Subcommittee would appoint an ad hoc working group for the purpose of developing a white paper describing the

roles of minority institutions in developing a diverse computing workforce.

- An **Education Subcommittee** which would explore the curriculum issues raised at the workshop.
- A **Research Subcommittee** which would explore the effects of early research experiences on the retention of minority students, especially the Young Scholars, RAMHSS and REU programs and possible ways to expand them.
- A **Continuum Subcommittee** which would deal with the problem of constructing a *seamless* pipeline K - Life. This includes dealing with all of the social aspects of the problem, such as isolation, identifying mentors, training mentors, etc.

4 Conclusion

Although a great deal was accomplished at the workshop, a number of important questions were not addressed directly. I would very much like to see these questions addressed at some future time, not necessarily in a workshop context.

- Do efforts to level the playing field reduce the overall quality of CS research and education?
- What are the impacts of set-aside programs on the respect for the quality of work done under grants funded through those programs?
- Are set-asides, in general, a good mechanism for leveling the playing field?
- How effective are existing federal programs such as AMP, RCMS, MARC, MBRS, RIMI, MURED, MUSPIN, etc. ?
- How will the NII, digital libraries, multimedia and other technologies affect education and research at MIs?

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Appendix A

List of Abbreviations:

- **National Science Foundation**
 - NSF – National Science Foundation
 - NSB – National Science Board
 - CISE – Computer Information Science and Engineering Directorate
 - EHR – Education and Human Resources Directorate
 - AD – Assistant Director
 - DD – Division Director
 - PD – Program Director (program manager, program officer)
 - CDA – Office of Cross Disciplinary Activities
 - RIMI – Research in Minority Institutions
 - RCMS – Research Careers for Minority Scholars
 - CRCM – Comprehensive Regional Centers for Minorities
 - MRCE – Minority Research Centers of Excellence
 - AMP – Alliances for Minority Participation
 - MIE – Minority Institutes of Excellence
 - PYI – Presidential Young Investigator Award
 - NYI – NSF Young Investigator Award
 - PFF – Presidential Faculty Fellow Award
 - RIA – Research Initiation Award
 - REU – Research Experiences for Undergraduates
 - RAMHSS – Research Assistantships for Minority High School Students
 - MRI – Minority Research Initiation
 - VPW – Visiting professorships for Women Award
 - FAW – Faculty Awards for Women
 - II-MI – Institutional Infrastructure - Minority Institutions component
 - II-RI – Institutional Infrastructure - Research Infrastructure
- **National Aeronautics and Space Administration**
 - NASA – National Aeronautics and Space Administration
 - NASA-MURED – Minority University Research and Education Division
 - NASA-MUSPIN – Minority University Space Interdisciplinary Network
 - NASA- FAR – Faculty Awards for Research
- **Other federal Agencies**
 - NIH – National Institutes of Health
 - DoD – Department of Defense
 - DoE – Department of Energy
 - DoED – Department of Education

- ARPA – Advanced Projects Research Agency (DoD)
- ARO – Army Research Office
- AFOSR – Air Force Office of Scientific Research
- ONR – Office of Naval Research
- NRL – Naval Research Labs
- **Professional Associations**
 - CRA – Computing Research Association
 - ACM – Association for Computing Machinery
 - IEEE-CS – Institute of Electronic and Electrical Engineers - Computer Society
 - BDPA – Black Data Processing Association
 - AAAS – American Association for the Advancement of Science
 - AAI – American Association for Artificial Intelligence
 - SIAM – Society of Industrial and Applied Mathematicians
 - AMS – American Mathematical Society
 - NAS – National Academy of Sciences
 - NAE – National Academy of Engineering
 - NRC – National Research Council
 - CSTB – Computer Sciences and Telecommunications Board
- **National Initiatives**
 - HPCCC – High Performance Computing and Communications Act
 - NII – National Information Infrastructure
 - GII – Global Information Infrastructure
- **National Centers**
 - NCSA – National Center for Supercomputing Applications
 - SDSC – San Diego Supercomputer Center
 - CTC – Cornell Theory Center
 - PSC – Pittsburgh Supercomputing Center
 - DIMACS – Discrete Mathematics and Computer Science (Rutgers)
 - CRPC – Center for Research in Parallel Computation (Rice)
- **Miscellaneous**
 - MI – Minority Institution
 - MA – Majority Institution