REGIONAL CONFERENCE

“Diversity in the Scientific and Technological Workforce”

November 18-20, 1996
Westin Hotel Renaissance Center
Detroit, Michigan
REGIONAL CONFERENCE

“DIVERSITY IN THE SCIENTIFIC AND TECHNOLOGICAL WORKFORCE”

CONFERENCE HIGHLIGHTS

November 18–20, 1996

Westin Hotel Renaissance Center
Detroit, Michigan

National Science Foundation
Directorate for Education and Human Resources
The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants for research and education in the sciences, mathematics and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Web site at:

http://www.nsf.gov

□ Location: 4201 Wilson Blvd. Arlington, VA 22230

□ For General Information (NSF Information Center): (703) 306-1234

□ TDD (for the hearing-impaired): (703) 306-0090

□ To Order Publications or Forms:
  Send an e-mail to: pubs@nsf.gov
  or telephone: (301) 947-2722

□ To Locate NSF Employees: (703) 306-1234
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>PLENARY SESSIONS</td>
<td></td>
</tr>
<tr>
<td>Opening Session</td>
<td>2</td>
</tr>
<tr>
<td>Luncheon Forum</td>
<td>11</td>
</tr>
<tr>
<td>Awards Luncheon</td>
<td>18</td>
</tr>
<tr>
<td>Joint Plenary Session*</td>
<td>22</td>
</tr>
<tr>
<td>AWARD PRESENTATIONS</td>
<td>27</td>
</tr>
<tr>
<td>STUDENT RESEARCH COMPETITION-AWARD WINNING PAPERS</td>
<td>39</td>
</tr>
<tr>
<td>Precollege</td>
<td>41</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>62</td>
</tr>
<tr>
<td>Graduate</td>
<td>70</td>
</tr>
<tr>
<td>LEARNING CENTER/EXHIBITS</td>
<td>75</td>
</tr>
<tr>
<td>CONFERENCE SESSIONS</td>
<td>77</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>79</td>
</tr>
<tr>
<td>Appendix A: Conference Program</td>
<td>79</td>
</tr>
<tr>
<td>Appendix B: List of General Participants</td>
<td>89</td>
</tr>
<tr>
<td>Appendix C: List of Conference Exhibitors</td>
<td>101</td>
</tr>
</tbody>
</table>

* Joint session with the National Alliance of Black School Educators (NABSE)

NOTE: All presentations have been edited.

The views expressed by conference participants do not necessarily represent NSF policy.

The National Science Foundation would like to acknowledge the assistance of the Detroit Public Schools in planning and hosting the conference. Special recognition is given to David L. Snead, General Superintendent, Detroit Public Schools, for hosting the conference and to Juanita Clay Chambers, Director of Mathematics and Science, Detroit Public Schools, and her staff, who worked tirelessly behind the scenes.
INTRODUCTION

The National Science Foundation (NSF) Directorate for Education and Human Resources (EHR) sponsored the First Regional Conference on Diversity in the Scientific and Technological Workforce on November 18–20, 1996, at the Westin Hotel Renaissance Center in Detroit, Michigan. More than 1,000 participants from the academic, corporate, and government sectors attended the conference. The change of venue for the conference was decided upon to broaden the participation of potential supporters and advocates for NSF efforts to ensure a quality educational experience for all students. The conference served as a platform for presenting and discussing EHR’s accomplishments in broadening diversity through its human resource development programs; it also provided a forum for examining national issues, including the assessment of student performance, the reform of graduate education, and the potential roles of community organizations and the private sector in the successful implementation of NSF’s efforts.

The conference began with a panel discussion on issues and questions pertinent to assessing student achievement in the reform of the science, mathematics, engineering, and technology (SMET) education enterprise. The agenda also included a panel discussion with representatives of science and technology corporations on the costs and benefits of our national efforts to diversify the education enterprise in SMET. There were concurrent sessions on the kinds of partnerships necessary for successful education reform. Issue session topics included graduate education, accountability, the role of educational technology in reform, research on student participation in education, parental involvement in education, and community resources.

As in previous conferences, students at the precollege and college levels who participated in NSF-sponsored research activities presented their research in panel and poster sessions. Abstracts of the student presentations are available in a separate document.

The student research competition generated outstanding papers; the winning papers in each category (precollege, undergraduate, and graduate) are presented in this document. The student participants were given an opportunity to discuss issues of import to them in student forums.

Continuing a tradition begun last year, there was a technology center, which housed activities for all conference participants. There were interactive computer exhibits, educational software demonstrations, a videconference, hands-on demonstrations for teachers, and computer workstations with software to search the Internet and create home pages on the World Wide Web.

This conference report presents the highlights of these activities, including the major speeches by national leaders in science and technology education and the award presentations. The appendices contain the conference program, a list of conference participants, and a list of exhibitors.
OPENING SESSION
OPENING SESSION

PRESIDER

David L. Snead
General Superintendent
Detroit Public Schools

Welcome. I am delighted to join you in the Motor City for our first Regional Diversity Conference. I am David Snead, General Superintendent of the Detroit Public Schools.

You can look forward to an exciting and enlightening experience here in Detroit. We have some great opportunities for you to learn new and better ways of delivering mathematics and science education to our youngsters in public schools in America, as well as opportunities for you to enjoy yourselves.

In our school district, we are in the second year of implementing a five-year strategic plan; increasing the number of partnerships we engage in is a major objective of the plan. I am pleased to see that one of the conference goals is to connect with supportive partners from business, industry, higher education, and community-based organizations.

The National Science Foundation has been an extremely valuable resource to us, through the funding of our Urban Systemic Initiative. I would like to acknowledge Dr. Luther Williams in particular for providing leadership to the reform effort in urban schools and public schools in America. Thank you, Dr. Williams.

I would also like to thank his very competent associate, who happens to be, by the way, a graduate with a doctorate from Michigan State University. Welcome home, Dr. Elmima Johnson.

I must also commend Juanita Clay Chambers, our Director of Mathematics and Science, as well as her staff and the Office of Technology, Data Processing, and Telecommunications for the fine job that they are doing in putting on this conference.

Last year our Urban Systemic Initiative received an Award of Excellence from the Michigan Association of School Boards. We are proud of this award, and we are also extremely proud and pleased with the progress that is being made throughout our school district as a result of collective efforts. We appreciate having this opportunity to share the secrets of our success with those of you who have joined us for this important regional conference.

GREETINGS

Honorable Dennis W. Archer
Mayor
City of Detroit

I would like to begin by thanking two people for inviting me to offer words of welcome to you this afternoon: Dr. David Snead, the General Superintendent of Detroit Public Schools, and Dr. Luther Williams, Assistant Director of NSF’s Directorate for Education and Human Resources. As you convene here in Detroit, it is my honor as mayor to welcome you. I welcome the insight and the commitment each of you brings as educators, students, members of scientific associations, mathematics and engineering professionals, business people, and federal and state government officials. But most important is the fact that you convene in Detroit as leaders.

The subject that brings you together today demands outstanding and courageous leadership. When you consider what is going on in the United States, especially in California in relation to Proposition 209 and affirmative action, it is most important that you convene.

NSF’s Regional Conference on Diversity in the Scientific and Technological Workforce is literally helping to determine the future of our nation and our world. We are all aware that the days of high-paying, low-skilled manual labor jobs are long gone. Opportunity today and opportunity tomorrow lie in areas that require high school diplomas. And increasingly, learning the skills necessary to get a job means learning science and math.
 Too many young people of color think that science, math, and technology belong exclusively to people who do not look like them. When you appreciate the fact that in coming decades, according to social scientists and demographers, the majority of American workers will be people of color, such an attitude not only endangers the minority community but indeed the entire nation.

I am very pleased that NSF’s Directorate for Education and Human Resources has taken the initiative on this issue. I would like to congratulate NSF for sponsoring this historic conference. And I would like to thank you for choosing the city of Detroit.

Detroit is making its own comeback. I see a parallel between the challenge of educating more young people in mathematics and science and the current shortage of trained workers for the abundance of construction jobs coming to our city. For example, we have on record a commitment of about $4.1 billion to build new housing, retail establishments, industrial plants, and commercial places of business. But we have run out of licensed plumbers, electricians, carpenters, brick masons, and the like.

We are now engaged in an aggressive apprenticeship program to give our high school graduates and those who have dropped out or who have been “rightsized” or “downsized” professions that will allow them to take care of themselves and their families. What you are doing in science and mathematics is equally important and appropriate, because you will affect the minds of the young. You will affect the minds of the leaders of tomorrow.

NSF’s traditional leadership in improving science, mathematics, engineering, and technology education is well established. Detroit is 76 percent African American; 2 to 3 percent Hispanic; and 1 to 2 percent Arab, Asian, and Chaldean. Our city is 80 percent ethnic minority majority.

What you do here will have a lasting and major influence on the young people who attend our public schools, as well as on those who attend our private and parochial schools. The students will be influenced by the knowledge base that you have. So I want to thank you for coming to Detroit. I am depending on each and every one of you to do your best, to share your views, to share your vision, and to make life better for our children and cities. And to Dr. Snead, Dr. Williams, and the keynote speaker for this afternoon’s lunch, thank you very much for your leadership and your vision. Our country will be so much better as a result of your hard work.

Honorable Irma Clark
President
Detroit Board of Education

Good afternoon, National Science Foundation regional conference attendees. Welcome to Detroit, Michigan. I bring greetings from the Detroit Board of Education, the policy-making body that governs the nation’s eighth-largest public school district. I cannot tell you how pleased I am to have you here today.

In your honor, I wore my Motor City pin, one that was designed for the city when we were recruiting to host another national conference, the Council of Great City Schools, which will meet here in October 1997. Beginning this week, Detroit will also host the National Alliance of Black School Educators. We are expecting between 5,000 and 6,000 people for the conference, which begins Wednesday. So, indeed, Detroit has become a conference center.

I am the Director of Human Relations for Wayne County. My department oversees affirmative action programs in the county. We ensure that all employees have equal employment opportunity and that small and minority- and women-owned businesses receive their fair share of the contracts in Wayne County.

When I began to read the correspondence from Dr. Snead asking me to greet NSF’s First Regional Conference on Diversity in the Scientific and Technological Workforce, I thought to myself, “Hmm. The title sure is a mouthful. I certainly have to attend this gathering.” As I continued to read the correspondence, I learned that the conference would bring together national experts from various institutions and educators interested in strengthening partnerships for education reform. I certainly do welcome that. We believe wholeheartedly that if we are going to compete in the 21st century, we must have education reform that emphasizes math and science. I thought to myself, “How appropriate. A regional conference at which experts discuss, plan, and implement strategies to create new and exciting ways to raise student scientific literacy. I just cannot wait.” I have been looking forward to this conference ever since.

I do not have to tell you that NSF has assumed a leadership role in improving student outcomes in science, mathematics, engineering, and technology. Because this planet continues to evolve, it is vital that our educators, as well as our students, keep abreast of the never-ending technological advancements.

As board president, I can tell you that we in the Detroit public school system look forward to working closely with NSF, and we applaud your desire to work with us. Together we can educate our 172,000 students
in the kind of environment that will propel many of them into a dynamic science and technology workforce. Therefore, on behalf of the Detroit Board of Education, I say to each and every one of you, thank you and enjoy Detroit.

Luther S. Williams  
Assistant Director  
Education and Human Resources, NSF  

I would like to join Mayor Archer, Dr. Snead, and Ms. Clark in extending greetings to all of you. As some of you are aware, the National Science Foundation decided four years ago to assemble in a national forum in Washington, D.C., administrators, students, teachers, and faculty concerned with the Foundation’s kindergarten through graduate school programs, including its technical education programs that support advances by groups underrepresented in the education enterprise or poorly served by it. Thus the creation of the Conference on Diversity in the Scientific and Technology Workforce.

In my judgment, we have held four quite successful national conferences in Washington with participants from many of the school systems and universities represented here. The national conferences did not, however, allow us to involve those who are best served on a regional basis.

We will focus in this regional conference, as we have in the national conferences, on students like those who will make presentations later in the program. I urge everyone here to support the student presentations by their attendance.

Another large component of the conference is the awards ceremony, which will acknowledge individuals who have been pioneers and have made distinctive achievements in this arena. This recognition is, in my judgment, a serious activity and one that is often omitted in meetings such as this one.

A third important part of the program depends on you to make it work. It is the reason for the regional focus. This conference brings together individuals from the corporate sector, parents, school board members, community-based organizations, and private foundations from Detroit and elsewhere in the Midwest. All of us here have a stake in working together to reverse the status quo with respect to educating young people of color in mathematics and science.

Let me stipulate why doing so is important by explaining what NSF is attempting to accomplish in partnership with you. It is not merely to increase the amount of mathematics, science, engineering, and technology education that a few youngsters in the K–12 sector or a few young adults in the undergraduate sector receive before graduation. The objective is more fundamental. We at the Foundation regard substantial study of these subjects as imperative, in fact obligatory, for full citizenship. That is the issue. The study of mathematics, science, and technology is not an activity to be engaged in only by a few students; it is a fundamentally important activity for all young people. All young people should be able to study a high-quality science, mathematics, and technology curriculum.

Thus, in this regional conference, we will share notes, share best practices, and think of ways in which we can pool all of our resources. We must pool resources from private foundations; community-based organizations, including religious organizations; individual parents and parent groups; and especially the private sector, in Detroit and in the Midwest. These groups must work with the individuals who have line responsibility for the educational process in the schools, colleges, and universities to produce a better outcome for all students. That is the objective. And if we share and learn from one another, at the end of the day on Wednesday, we will have had a successful conference.

There is a lot at stake for Juanita Chambers and her colleagues and those of you from Detroit. Yours is the first regional conference. We know how to do it well in Washington. Whether we continue to do it on a regional basis depends on the outcome of this effort—not that you needed additional pressure.

Let me close by sharing with you something about which I am very excited. I was out of the room for a time at lunch responding to an inquiry from members of the press about the following. On Wednesday, November 20, 1996, the next in a series of reports from the Third International Mathematics Science Study will be released. These studies compare the performance of American students with that of students in other countries. The report is embargoed, so I can’t tell you the findings. But the White House has decided that a description of NSF programs, including the Urban Systemic Initiatives program in Detroit and elsewhere, will be an integral part of that overall release to show that, in fact, what we are doing works. So I hope you look for the report.

It is possible that if this conference goes well, there will be some follow-up. Camera crews will visit some of you to determine if what we report from Washington is accurate.
INTRODUCTION OF KEYNOTE SPEAKER

Juanita Clay Chambers  
*Director*
Office of Mathematics and Science, Detroit Public Schools

It is my pleasure to introduce the afternoon’s keynote speaker. Our distinguished educator is the Vice Chancellor of Academic Affairs and Dean of the Graduate Division at the University of California at Los Angeles. Prior to that appointment, Dr. Claudia Mitchell-Kernan was Vice Chancellor of Graduate Programs. She has also served as Director of UCLA’s Center of African-American Studies.

She is an anthropologist and has a joint academic appointment in the anthropology, psychiatry, and biobehavioral sciences departments. She earned her first two degrees at Indiana University before pursuing her Ph.D. at the University of California at Berkeley. She has been a member of the faculty at Harvard University. Our speaker’s early work in the area of linguistic anthropology involved studies in Samoa and Belize. She is widely cited for her seminal research in the sixties and seventies on the speech patterns of African Americans, and she is known as well for her work on Caribbean cultures.

This learned scholar is also a published author. Her most recent book focuses on the decline in marriage rates among African Americans. We also know that President Clinton recently appointed Dr. Mitchell-Kernan, as an outstanding educator, to the NSF National Science Board. It gives me great pleasure to present our keynote speaker, Dr. Claudia Mitchell-Kernan.

PLENARY ADDRESS

Claudia I. Mitchell-Kernan  
*Vice Chancellor*
Academic Affairs and  
*Dean*
Graduate Programs  
University of California at Los Angeles

When people speak of equity in education, they are usually referring to whether the fruits of American education are being distributed equally among our society’s young. Much of my professional life as a university administrator, researcher, and educator has been devoted to the struggle to ensure equity in education in this sense. But I also view the issue internationally. Although the United States may well have more academic resources than other countries to meet the scientific and technological challenges that lie ahead, the record shows that we have not done a good job of sharing these resources with our young or of preparing them to deal individually with the challenges that we face as a nation. Other industrialized countries are doing a better job. In this sense, only the most privileged of America’s youth are receiving the same opportunities as their peers overseas.

The simplest and most straightforward way to ensure that all American students receive the same opportunities for life achievement, regardless of their race, gender, region, or family income, is to provide the best education, judged by universal standards, in all of our schools, both public and private. We have vowed to meet this challenge in the past, and we have failed; if we do not respond effectively now, we may put our nation, not just its children, at risk.

Equity in education may well be the central issue in determining whether the greatness we have achieved as a nation and as a culture can be sustained in the century about to begin. No single course of action could do more to eliminate racial strife, crime, and welfare dependence, to make our nation’s internal economy thrive and to enhance its competitiveness abroad, than success in attaining educational equity.

The Retreat from Equal Opportunity

Let me begin with a brief digression into current events. As many of you know, November 5 was a sad day for those of us concerned about equity and diversity. On election day 1996, California voters passed an initiative,
Proposition 209, that seeks to end all affirmative action in our state. Though the constitutionality of this initiative will be challenged and finally settled in the courts, the arguments were loud and emotional on both sides. This issue is especially vital in California, a state whose population embraces tremendous diversity. But California often sets national trends, and this potential trend against developing the benefits of diversity is likely to have repercussions in many places for generations to come unless we act now.

In considering this unhappy development, I am reminded of the dilemma faced by Socrates as he tried to rationalize his view that citizens of the Republic should be educated and assigned by merit to three classes: rulers, auxiliaries, and craftsmen. Socrates believed that a stable society demanded that these ranks be honored and that citizens accept the status conferred on them. Socrates also recognized that securing acquiescence to this scheme might not be easy, and he found a partial answer in the fabrication of a myth. He proposed telling citizens the following tale: “You are brothers, yet God has framed you differently. Some of you have the power of command, and in the composition of these he has mingled gold, wherefore also they have the greatest honor; others he has made of silver, to be auxiliaries; others again, who are to be husbandmen and draftsmen, he has composed of brass and iron, and the species will generally be preserved in the children. An oracle says that when a man of brass or iron guards the State, it will be destroyed.”

After telling the tale to an interlocutor, Socrates asked, “Such is the tale; is there any possibility of making our citizens believe in it?” His interlocutor replied, “Not in the present generation; there is no way of accomplishing this; but their sons may be made to believe in the tale, and their son’s sons and posterity after them.”

In modern American society, the task of keeping separate the gold from the silver and the silver from the brass and iron has been achieved through a variety of means. Until the period after World War II, for example, it was customary that the gold should be educated apart from the other metals. This fact and this fact alone may help us to understand the suspicion sometimes voiced that the content of the education received by the gold was determined by an artifice designed, like Socrates’ myth, to keep the gold as a class separate and distinct, to rationalize the privileges and benefits of the gold’s elevated status, and to justify the costs this status entailed for others.

Mindful of this history, many of us in California’s higher education community are particularly troubled by the passage of Proposition 209, because we see the same sort of mythmaking at work. The United States was the first country to establish a system of public education aimed at providing elementary and secondary education for all children. It was believed that public education would allow all children the opportunity to seek success. We have also promoted education as the key to health, happiness, and prosperity. In societies such as ours that stress competitive hiring practices, education and technical training provide individuals with skills that allow them to become productive members of the labor force and to transcend the socioeconomic boundaries of their families.

Because of differences in our country’s geography and the great diversity of our population, the success of our public education efforts has varied widely across rural and urban America. Implementing the American dream of quality public education for all has become a daunting task. It is clear that we have not succeeded in providing the same opportunities for all children at the basic level.

Affirmative action was one way, albeit an imperfect one, to try to set the balance straight at the end of the educational process. My colleagues and I as administrators of California’s greatest public university recognize our responsibility to serve the people of our state, and we also recognize that all of our students have potential. If nurtured appropriately, these young people will make contributions to our communities for the rest of their lives. But if we allow the system to provide them with unequal training and education, we will limit their chances in life and abridge their right to achieve as much success as peers who are more privileged by race, gender, or family income.

For these reasons, the University of California has been a strong and vocal advocate for diversity for the past decade. The logic and rhetoric of our efforts have focused on the educational value of diversity, not just on a societal commitment to promote equal opportunity for all citizens. As we have taken stock of our increasingly diverse student body, it has become clear to us that as diversification has increased, so too has the excellence of the education we offer and the research we produce.

The equal opportunity struggle in this country has been characterized by periods of great forward momentum as well as by periods of setback. Some 40 years ago, we set our national sights on ending discrimination and promoting a racially integrated society. At that time, we rededicated ourselves to the task of ensuring equality of opportunity for all. We regarded the extension of educational opportunities as vital to achieving these national goals.

There have been worrisome signs recently—including the passage of Proposition 209—that we may have entered a period of retreat from these noble aspirations, that our societal will has waned, and that we may be
about to close the window of opportunity we opened in the last decades of the 20th century. There are ominous signs that, like Socrates, we are constructing a mythology to rationalize our present social order, including its social and institutional failures. This mythology casts native ability and personal effort as the primary determinants of success and failure. The mythology would like us to believe that except for an occasional aberration, we live in a meritocracy, where the most deserving get the prime rewards and the rest get “what they deserve.” It seems to me that this new mythology is as transparent as that of Socrates. There is a great social cost involved in making many Americans “outsiders” in the pursuit of the American dream. I wonder if those who are most eager to retreat from equal opportunity have taken a good look at that price tag.

Our Failures in Science and Mathematics

The still-unmet challenge of providing equal educational opportunities to all American youngsters is not the only problem facing American education. Perhaps just as ominous is our failure to prepare our children for a future that is coming as soon as tomorrow. As we approach the 21st century and a new era of scientific and technological sophistication, we face a sea change in the fundamental skills needed for future success. Individual success in the next century will hinge on the ability to manipulate information, learn new skills, and adapt to new tasks as jobs evolve and change. In the past, a grade-school or high-school education taught people all of the information they needed to know for an entire career. In today’s world, a basic education is merely the foundation—but one that must be solid—for future education or training. We need to offer continuous education from cradle to grave, so that workers will be flexible enough to adapt to the changing needs of labor markets. As Peter Drucker has said, “Education will become the center of the knowledge society, and the school its key institution. . . . Increasingly, an educated person will be somebody who has learned how to learn, and who continues learning, especially through formal education, throughout his or her lifetime.”

In my career as an educator and advocate for improved education for our children, I have heard countless speeches about the need to go “back to basics.” Part of me believes in that philosophy—but only if the basics are allowed to adapt to changing times. In the past, we heard only about the three R’s. In the future—indeed, in the present—we must add scientific literacy to that list. As science and technology become integral parts of our daily lives, the three R’s will need to expand to include skills of scientific inquiry, complex reasoning, and technological facility. We need to promote these skills on all levels, providing science and mathematics education in our primary, secondary, and postsecondary institutions.

And we need to offer this education to all of our students—not just to those pursuing careers in science and technology, not just to those in the suburbs, but to all students—so that they may all have the opportunity to pursue their goals. Lacking proficiency in scientific concepts and processes, our students will not have the basics needed for the information age.

For some time now, we have heard about the importance of scientific literacy from innovative and prescient educators. Now we are beginning to hear a loud call from business and industry. Some months ago, for example, the Bayer Corporation released the results of a survey of corporate human resource directors and school principals on the topic of science education. Margo Barnes, Senior Vice President of Bayer Corporation, reported that nearly 84 percent of the corporate human resource directors surveyed said that science literacy, already important today, will become a job requirement in the next 10 years. These respondents represented a range of science- and non-science-oriented companies. The majority of school principals surveyed claimed that if given the choice, they would devote more resources to science programs than to any other program. Barnes emphasized that “business will need more and more students skilled in critical thinking, experimentation, problem solving, and teamwork—skills that should be learned at the elementary level through inquiry-based, hands-on science.” Barnes also stated that “the trends emerging sound a real wake-up call to America’s schools. . . . Unless science literacy becomes a core goal for our nation’s schools, we will have a workforce tomorrow unable to meet the new demands of business.”

Such sentiments are being echoed by an increasingly large segment of the business community. The demand for science literacy does not apply only to those who will work in high-tech industries; it is the wave of the future for all workers. Indeed, to a large extent, it is already the wave of the present. As we face this challenge to prepare our children for tomorrow’s world, we are not without resources. The great educational strength of the United States is our system of graduate education, which has produced many of the world’s finest scientists and engineers. But we are beset by two paradoxes. First, although the United States was recently rated as excellent in graduate education and as good in undergraduate education relative to other industrialized countries, our elementary and secondary school systems fail to prepare most American youths, especially those in urban inner-city schools, for integration into our national economy, much less for success in the emerging global marketplace.
Second, our own youngsters are not getting the maximum advantage of America’s premier academic resources in science and mathematics.

Students come to the United States from around the globe to study science and engineering at our universities and to gain advanced training at our research institutions. Foreign students now account for more than 25 percent of all science and engineering graduate students in U.S. research institutions. Similarly, the world envies our success in providing quality undergraduate education.

But while the United States has the highest percentage of people receiving college degrees among all G-7 nations, we also have one of the lowest percentages of students attaining degrees in science and engineering. Just when this percentage should be rising, it continues to decline. Many students not only select other fields as their majors, but they also try to minimize the number of science and mathematics courses that they take. Such students simply will not comprehend these significant languages of the future. Although we are providing a large segment of our population with postsecondary education, we are not focusing students’ efforts on the disciplines that they need to learn to succeed.

This problem is even more pronounced in K–12 education. The weaknesses of American education are most obvious in the opportunities not afforded to most elementary and secondary school students, that is, to those who are not enrolled in honors classes or elite private schools. The “regular kids,” the ones who do not distinguish themselves early enough to be assigned to accelerated academic tracks, are often underserved by our system. In the United States, students spend less time in core academic classes and fewer hours on homework than students from other industrialized countries.

Given the strength of our research universities, it is surprising that our students rank lowest in science and mathematics among youngsters in industrialized countries. In these critical fields, there has been little improvement in performance over the past two decades, leaving American youth at a huge disadvantage. A visitor from another galaxy, hearing about this problem, might assume that ours is a culture averse to science and technology, one in which youngsters have no interest in such subjects.

But depictions of science and technology pervade American media. Our films, television, books, and magazines are filled with exciting and popular representations of science and technology. From science fiction stories to mysteries that are solved with high technology, Americans are enamored of new ideas and inventions. Across the nation, people enjoy interacting with science and technology. Our hands-on, minds-on museums are tremendously popular, and many toys and games aimed at children and adults involve scientific and technological concepts and activities. The lack of interest in science and fear of mathematics seem to be restricted to academic settings, while people remain fascinated by popularized versions of science and technology. We need to look for ways to channel this popular enthusiasm into educational pursuits so that the fun and intrigue of science and technology become valuable tools in the quest for individual and national success.

A Modest Proposal

Principally as a result of the growth of knowledge, we have an unprecedented understanding of our social and natural world and are afforded a more than trivial glimpse into our future. In this sense, we must surely live in the best of times. Yet this same world also challenges us to keep our balance as the pace of change continues to quicken and events occurring virtually anywhere on our planet seem to take place right within our midst. Indeed, so much happens in our technologically expanded field of vision that individual events are typically rendered in soft focus. It can be difficult sometimes to achieve sufficient sharpness of focus to apprehend the significance of a single event. In this sense, while our times may not be the worst of times, they are as frustrating as they are fulfilling and as daunting as they are empowering.

The need to keep our history and goals in sharp focus and to develop and maintain clarity in assessing our progress has never been greater than it is today. Yet insofar as equal opportunity is concerned, we seem bent on denying the actual state of our civilization. In the face of reversals such as Proposition 209, we must work even harder to improve the education that we provide to our children to ensure that they are prepared to face the professional, social, and economic challenges that lie in their futures. To succeed in the 21st century, we must strengthen the opportunities available to all of our youth, focusing our efforts on science and mathematics, the skills that will be most important throughout their lives. The time is right to consider what kinds of reforms we wish to institute in our educational enterprise. Because we are in the beginning stages of this new era of information, we have an opportunity to intervene effectively. As Peter Drucker has said, “Long-range planning does not deal with future decisions, but with the future of present decisions.” The time is right for us to look toward the future, to determine our direction as a nation and as a global society, and to make some powerful decisions about how to prepare our children for success in a new age.
We can deal with our unresolved problems of racial/ethnic and gender inequality and improve opportunities for all of our children by revitalizing the basic education provided between kindergarten and high school graduation. One way to do so is to develop standards for our nation’s schools, such as those supported by the National Science Foundation. The standards reflect, in harmony, the voices of teachers, bench scientists, policy makers, and science educators. The standards promotes the development of curricula that foster hands-on, minds-on learning. Regardless of the size of the school, the demographics of the town, or the socioeconomic status of the community, these are standards that should allow all American children to gain an equitable degree of science literacy and scientific expertise. The standards are designed to level the playing field, so that students receive the same quality of education whether they attend school in Hinton, West Virginia; Two Dot, Montana; Farmington, Maine; Calexico, California; New York City; or Los Angeles. The NSF effort is the type of effort that will prepare the students of today to be competitive in seeking the goals of tomorrow. That is the least we can do for our children.

It is imperative that we recognize the opportunity we have through education not only to address long-term U.S. needs in human resource development but also to tackle issues of inequality—ethnic, racial, and class stratification—in the broader society. Government, industry, academia, and private citizens must join in this great educational enterprise on behalf of our whole community, not just on behalf of people in our immediate neighborhoods. Let us not follow the path of Socrates in creating myths to explain away the persistence of inequality in our society. As the revolution in electronic communication has taught us, local myths will be exploded almost as quickly as they are constructed.

We must not lose sight of the central vision of quality education for all of our citizens. President Clinton’s bridge to the future—a bridge wide enough for all of us to cross together—can provide a basis for improved human relations. Progress in this area is as central to our society’s future as scientific and technological innovation is to our economic competitiveness. Without such progress our social fabric will continue to deteriorate and tensions with and among groups will continue to fester and disrupt our social lives. Let me remind you of a Japanese proverb: Vision without action is a daydream. Action without vision is a nightmare.
I have the pleasure of introducing the luncheon speaker, Dr. James Duderstadt. He received his bachelor’s degree in electrical engineering from Yale University and his doctorate in engineering, science, and physics from the California Institute of Technology. He was subsequently a fellow at Cal Tech and served for a year at Atomic Energy, now the Department of Energy. Afterward, he joined the faculty at the University of Michigan, Ann Arbor, where he moved quite rapidly through the professorial ranks. After only 12 years on the faculty, he was named Dean of the School of Engineering. He served in that position for approximately five years and then became the Provost and Vice President for Academic Affairs at the university. Two years later, he was named President of the university; he served in that post until 1996. He was recently named President Emeritus and appointed University Professor of Science and Engineering. This position is a university-wide post that essentially enables him to do whatever he wants. He teaches, conducts research, and directs the Millennium Institute, an exciting project that speaks to the needs of the 21st century. He founded the Millennium Institute to explore the implications of information technology for the future of higher education.

Dr. Duderstadt’s teaching and research has spanned a range of subjects related to science, mathematics, and engineering, including nuclear energy, manufacturing technology, information technology, and science policy. He has received many awards and honors, including the National Medal of Technology, the highest honor that can be conferred on a scientist or engineer who is a U.S. citizen. As a nuclear engineer, Dr. Duderstadt received the E. O. Lawrence Award for excellence in nuclear research and the Arthur Compton Prize for outstanding teaching. He was named NationalEngineer of the Year by the National Society of Professional Engineers, and he has been elected to an array of honorary societies, most notably the National Academy of Engineering, the American Academy of Arts and Sciences, Phi Beta Kappa, and Tau Beta Phi.

I know Dr. Duderstadt from his two terms as a member of NSF’s National Science Board. NSF is an unusual federal agency in that it is governed by a presidentially appointed board, the National Science Board. Jim was a member of the board for two terms and served as chair for several years.

Dr. Duderstadt also served on several corporate boards and even chaired the board of directors of the Big Ten Athletic Conference for a period of time. He thus bears some responsibility for the unfortunate events that have befallen the University of Michigan football team.
KEYNOTE ADDRESS

James J. Duderstadt
President Emeritus and
University Professor of Science and Engineering
University of Michigan, Ann Arbor

The political climate swirling around the country these days raises serious questions about our commitment to achieving equity and social justice for all Americans. A recent Wall Street Journal/NBC News survey found that two out of three Americans oppose affirmative action. Federal courts are pondering cases that challenge racial preference. And at both the federal and state levels, conservative politicians are taking aim at the nation’s commitment to civil rights. It is almost as though a new form of slash-and-burn politics is abroad in our society—a politics characterized by an angry, postmodernist, deconstructionist spirit that aims to reverse past social commitments and destroy existing social institutions without any sense of what will replace them.

At a time when some people are trying to squelch discussion about diversity on our campuses—labeling the discussion as just another example of political correctness—it seems particularly important that we in academe talk openly, with boldness, about the need for more, not less, diversity. Today it is more necessary than ever to reaffirm the importance of diversity for our institutions and our society.

Our universities are at turning points in their histories. The students we are educating today will spend most of their lives in the 21st century. Theirs will be a very different world from the one we have known. Most of us who are leaders and teachers in the university are products of the 20th century. Furthermore, the structure of the American university as we see it today is a product of the 19th century, and many of its features originated long before that in far different times and places.

It is risky to speculate about the exact shape of things to come because of the accelerating pace of change that we are experiencing. But as of now, three trends dominate the future we foresee in 21st-century America:

America is rapidly becoming a truly multicultural society. In the future, we can expect even greater cultural, racial, and ethnic diversity than we have now.

Our nation will become “internationalized” as every aspect of American life becomes more dependent on other nations and peoples. Through immigration, too, we will become a “world nation,” one that has ethnic ties to every corner of the globe. Increasingly, all of our activities must be viewed in the broader context of our interdependence in the global community.

The United States, along with the world community, will rapidly evolve from a resource- and labor-intensive society to a knowledge-intensive society in which intellectual capital—educated people and their ideas—will become the keys to productivity, prosperity, security, and well-being.

We cannot ignore these trends and their profound implications for our society and our universities. Nor should we react to them passively. Rather, we must act directly to determine our own destiny and to make our ideals a reality.

The Michigan Mandate

At Michigan we became convinced a decade ago that our university’s ability to serve our society, our nation, and the world in the challenging times before us depended in large part on our ability to create and sustain a campus community recognized for its racial, cultural, and ethnic diversity. We decided that diversity would become a cornerstone of our efforts to achieve excellence in teaching, research, and service in the years ahead. To this end, we launched the Michigan Mandate, a strategic initiative designed to link academic excellence and social diversity to enable the institution to more capably serve a changing nation and world.

The Michigan Mandate was based on our belief that embracing and, even more important, capitalizing on our racial, cultural, and ethnic diversity would help the university to achieve excellence in teaching and research and to serve our state, nation, and the world in the years ahead. The purpose of the Michigan Mandate was to guide our university in creating a community that
• supported the aspirations and achievements of all individuals, regardless of race, creed, national origin, or gender;
• embodied and transmitted the fundamental academic and civic values necessary to bond us together as a scholarly community and as part of a democratic society; and
• valued, respected, and, indeed, drew its intellectual strength from the rich diversity of peoples of different races, cultures, religions, nationalities, and beliefs.

Models for changing institutions into genuinely pluralistic, multicultural communities are still difficult to find. However, we were fortunate to be able to draw on the expertise of faculty colleagues with experience in other arenas, including the corporate world, where significant cultural changes have been achieved using strategic approaches and techniques.

A small group of advisers with firsthand corporate experience was assembled to help forge the first outlines of the Michigan Mandate. This group, nicknamed the Change Group, saw the mandate not as a bureaucratic directive, but as an organic and evolving framework for organizational change that would attract and reflect the active participation of faculty, students, and staff at all levels of the university. The Change Group recognized early on that the real goal was institutional change. The objective was to develop a plan, a new agenda, a vision for the future of the University of Michigan that would respond effectively to the imperatives of our times.

But it was also recognized at the outset that the strategic plan would only be a road map. It would indicate a direction and point to a destination, but the journey itself would be a long one, and much of the landscape through which the university would travel was yet to be discovered. As the effort evolved, we attempted to deal with two themes that had heretofore appeared to be incompatible: community and pluralism. Our goal was to strengthen every part of the university community by increasing, acknowledging, learning from, and celebrating the ever-increasing human diversity of the nation and the world.

As president, I believed that it was important to assume personal responsibility for the design, articulation, and implementation of the plan. Credibility required that I be held personally accountable for its success or failure.

The Rationale

Universities are institutions that are persuaded by commitment of the mind rather than the soul. It was therefore essential to develop a compelling rationale for why the university had to change to better reflect and serve an increasingly diverse society. We offered the following rationale for the Michigan Mandate:

• The most compelling reason for it is that it is the morally right thing to do. Plurality, equal opportunity, and freedom from discrimination are the foundations upon which the university—and indeed, our nation—are built. It is more than what we do; it is what we must be if we are to call ourselves a truly public university.
• America of the 21st century will be a nation without a dominant ethnic majority. It will be truly pluralistic. To serve America’s rapidly changing population, our universities must provide the ideas and educated people our society needs to understand and build unity out of diversity.
• We do not believe a university can achieve excellence in teaching and scholarship unless it also benefits from the varied intellectual perspectives and experiences of America and the world in every aspect of its community.
• Diversity is essential for all of our nation’s universities as we approach the new century. Unless we draw upon a vast diversity of people and ideas, we cannot hope to generate the intellectual and social vitality we need to respond to a world characterized by great change.

Diversity and Change

The scientific community has begun to realize how central diversity can be to the survival of many groups. Homogeneous populations are often less able than more diverse populations to respond to changes in their environments. A field of monocultural wheat, for example, can produce well under relatively controlled conditions. But it is in great danger when the climate changes or when new diseases show up. The wheat has a very limited library of genetic material, giving it few options with which to respond.
Universities, of course, are not fields of wheat; they are more complex. Yet the analogy is apt in many ways. While we may, in general, be able to control the conditions in a wheatfield, we are less able to do so in a university. Our world today is characterized by a burgeoning complexity and a rapidly increasing rate of change. Perhaps (and I say this advisedly), our society could tolerate singular answers in the past, when we could still imagine that tomorrow would look much like today. But it is no longer plausible to assume that the status quo will continue. As knowledge advances, we uncover new questions we could not have imagined a few years ago. As society evolves, the issues we grapple with shift in unpredictable ways. A solution for one area of the world often turns out to be ineffectual or even harmful in another. Academic disciplines as different as English and sociology have found their very foundations radically transformed as they have attempted to respond to these dilemmas.

For universities to thrive in this age of complexity and change, they must resist any tendency to eliminate options. Only with a multiplicity of approaches, opinions, and ways of seeing can we hope to solve the problems we face. Universities, more than any other institution in American society, have striven toward a vision of tolerance and intellectual freedom. They must continually struggle to advance this heritage and to become places where a myriad of experiences, cultures, and approaches are valued, preserved, discussed, and embraced. Multiple points of view are easier to incorporate in the social sciences and the humanities than in the hard sciences, but different ways of seeing are also critical in the hard sciences.

But diversity alone is not enough. While we must celebrate differences between people, we must also make every effort to find common ground on which to unite. The multicolored skein that is the modern university must be woven together, becoming a tapestry, with each thread retaining its unique character.

The Approach

The mission and goals of the Michigan Mandate were quite simple:

- **Philosophy.** To recognize that diversity and excellence are complementary and compelling goals for the university and to make a firm commitment to achieving them.
- **Representation.** To commit to the recruitment, support, and success of members of historically underrepresented groups among our students, faculty, staff, and leadership.
- **Environment.** To build on our campus an environment that seeks, nourishes, and sustains diversity and pluralism, an environment in which the dignity and worth of every individual is valued and respected.

Associated with these general goals were more specific objectives:

- **Faculty recruiting and development.** To substantially increase the number of tenure-track faculty in each underrepresented minority group; to increase the success of minority faculty in achieving professional fulfillment, promotion, and tenure; to increase the number of underrepresented minority faculty in leadership positions.
- **Student recruiting and outreach.** To increase the number of entering underrepresented minority students as well as the total enrollment of underrepresented minorities; to establish and achieve specific minority enrollment targets in all schools and colleges; to increase minority graduation rates; to develop new programs to attract back to campus minority students who have withdrawn from the university; to design new outreach programs and strengthen existing ones that have increased the pool of minority applicants to undergraduate, graduate, and professional programs.
- **Staff recruiting and development.** To focus on achieving affirmative action goals in all job categories; to increase the number of underrepresented minorities in key university leadership positions; to strengthen support systems and services for minority staff.
- **Improving the environment for diversity.** To foster a culturally diverse environment; to significantly reduce the number of incidents of racism and prejudice on campus; to increase community-wide commitment to diversity and involvement in diversity initiatives among students, faculty, and staff; to broaden the base of diversity initiatives by, for example, including comparative perspectives drawn from international studies; to ensure the compatibility of university policies, procedures, and practice with the goal of fostering a multicultural community; to improve communications and interactions among all groups; to provide more opportunities for minorities to communicate their needs and experiences and to contribute to the process of change.
The Results

The Michigan Mandate has become a national model for institutions of higher education that are working to increase diversity on their campuses. Let me give you some highlights of the impact of this important effort on the University of Michigan.

- Today, in every degree program, at every level, for every minority ethnic group, we enjoy the highest enrollments in our history.
- We currently enroll 7,927 students of color, who make up more than 24 percent of our student body; these students accounted for 27 percent of this year’s first-year class. The percentage of students of color at the university has increased by more than 60 percent over the past seven years.
- African-American enrollment has also risen by more than 60 percent to 2,715. African-American students now account for 8.5 percent of our student body. The enrollment of Latino students, who now make up 4.7 percent of the student body, has increased to 1,533. We also have 258 Native American students, who account for 1 percent of the student body.
- Our graduation rates for African-American students have risen to 70 percent, the highest rate for any public university in the nation—higher than the graduation rates for white students at most public universities.
- Since the Michigan Mandate began, we have added more than 100 African-American faculty, roughly doubling their number. The quality of these faculty members is evidenced by the fact that they are achieving tenure at a rate of more than 85 percent. Overall persons of color now comprise 13 percent of the faculty.
- Since the University of Michigan ranks among the leading sources of doctorates in the nation, it plays a key role in producing the next generation of faculty for American universities—hence the importance of our commitment to dramatically expand the number of graduate fellowships we provide for underrepresented minorities. We have doubled these fellowships to more than 600, the largest commitment of any university in America.
- So, too, many of our professional schools, including our schools of business, law, medicine, and engineering, have become national leaders in diversity.

Even as the Michigan Mandate gained momentum and our university began to change, we launched other strategic efforts to increase our diversity and achieve social equity and justice. A year ago we launched the Michigan Agenda for Women, aimed at making the university a national leader in overcoming gender discrimination and providing full opportunities for women students, faculty, and staff throughout the university. Although this major initiative is still in its early stages, thus far we have

- allocated resources to establish a number of new faculty lines for senior women faculty;
- overhauled our policies with respect to dependent care, family leave, and flexibility in the workplace;
- launched a major new task force focusing on improving campus safety and eliminating violence against women;
- made a series of appointments of women in key leadership positions, including deans and executive officers; and
- established the Institute for Study of Women and Gender.

And next year Michigan will become the first major university in America to commit sufficient resources to achieving true gender equity in intercollegiate athletics. We will provide the same number of varsity opportunities for women as for men.

We have also moved ahead in some other areas that deserve mention. Our regents have expanded their nondiscrimination policies to prohibit discrimination based on sexual orientation, and last year we extended staff benefits and housing opportunities to same-sex couples. We are also moving rapidly to achieve greater international diversity among our people and programs. For example, during the past two years we have opened major new instructional centers in Hong Kong, Seoul, and Paris; we expect to open a similar program in London this fall.

Seeing Difference Differently

We continue to face great challenges. We must work diligently to create a welcoming community, encouraging respect for diversity in all of the characteristics that can be used to describe humankind: age, race, ethnicity,
nationality, gender, religious belief, sexual orientation, political beliefs, and economic and geographical background.

As the university becomes more multicultural, we see an increasing number of student groups organizing to preserve their ethnic and cultural traditions and to share these traditions with the rest of the campus. Some think of multiculturalism as a melting pot, where group identity is lost, or as Balkanization into separate groups whose members refuse to mingle. It doesn’t have to be that way. Groups can enhance their own cultural identity while inviting others to share in their history and traditions.

We must move in two directions at once. We must stop assuming that people from groups different from ours have the same needs, experiences, and points of view that we do. Yet, at the same time, we must not succumb to the equally pernicious assumption that “they” are all the same. Many in a group may share culture and experiences, but that does not give us permission to treat people as though they conform to some stereotyped image of “white,” “gay,” or “Latino.” We must create a community in which different cultures and ethnicities are valued and acknowledged, but each individual must be free to find her or his own path.

At the same time, we must recognize that not everyone faces the same consequences for their differences. The experience of an Asian-American person is not the same as that of an African-American person, a white woman, or a person with a disability. We cannot forget that issues of difference are inextricably intertwined with issues of power and discrimination and with the specific histories of groups and individuals. As we pursue a pluralistic campus, we must remember that equality will require effort, resources, and commitment to both structural change and education. We must learn to see difference differently.

Moving Forward

As we move into the future, it is becoming increasingly clear that our university’s excellence and national leadership will be determined in large part by the diversity of our campus community. Different ways of conceptualizing and addressing intellectual issues give new vitality to our education, scholarship, and communal life. Excellence and diversity are not only mutually compatible but mutually reinforcing objectives. We draw great strength from our extraordinary multiplicity.

True diversity means accepting new members not only into our classrooms but into our dialogues about how classrooms are structured and what is taught in them. Diversity is not just about “numbers”; it is also about profound structural change. As we have learned to be more open to different ways of seeing, we have discovered that there has always been diversity on our campus, much more than we were aware of. Many of the new programs that were created to support students of color or women have actually improved the opportunities for success for all students. We will not succeed until all who come to our university feel a sense of ownership, until the experiences and points of view they bring are reflected in every aspect of our communal life.

We are far more diverse today that we were 20 or even 10 years ago. Our commitment has improved our reputation throughout the world for academic excellence in every field. We cannot be sure where this journey will take us. Progress toward plurality will involve many different actors in our community. The university is not monolithic and neither is discrimination; both are shifting constantly. We move ahead, knowing that we can never rest.
AWARDS LUNCHEON
INTRODUCTION OF SPEAKER

Elmima C. Johnson
Staff Associate
Office of the Assistant Director, Education and Human Resources, NSF

It is indeed a pleasure to introduce the keynote speaker for this awards luncheon, Derrick Adkins, the 1996 Olympic gold medalist for the 400-meter hurdles. Mr. Adkins, a native of New York, began his sports career at age seven in a youth track club organized by his father and several other parents in his neighborhood. (His father also was a hurdler and competed for Morgan State University in the early 1960s.)

While his sister, Dianne, became one of the area’s top sprinters in her age group, Derrick did not fare as well. His father persuaded him to try the hurdles in seventh grade, and in both his junior and senior years of high school he won the New York State championship in the 400-meter hurdles. He became the nation’s top high school level 400-meter hurdler in 1988 with a time of 50.71 seconds.

Mr. Adkins’s athletic ability was matched by his academic achievements. He was an honor student and ranked 7th of 126 students in his high school class. He chose the Georgia Institute of Technology for its engineering program and its highly rated athletic department. He was also attracted to the warm southern climate. At Georgia Tech, Derrick continued his dual achievements. He was a dean’s list student in mechanical engineering as well as the ACC champion for four years and a two-time NCAA champion in the 400-meter relay. In 1992 he missed making the Olympic team by .28 of a second.

In 1993 Derrick graduated from Georgia Tech with a degree in mechanical engineering and a concentration in bioengineering. As he began to compete professionally, he used his knowledge of biomechanics to adjust his training techniques. In 1994 he was ranked number one in the world in the 400-meter hurdles by Track and Field News. The rest is history. At the 1996 Olympics, he won the 400-meter hurdles with a time of 47.54 seconds. A footnote: Derrick is returning to Georgia Tech in January to begin working part time on his master’s degree in engineering.

Ladies and gentlemen, I am indeed proud to introduce our speaker. But before I do that, Texas Instruments would like to give him a personal organizer to help him keep track of his time.

KEYNOTE ADDRESS

Derrick R. Adkins
Olympic Gold Medalist
400-Meter Hurdles

I would like to thank the city of Detroit for this fine honor. And I would also like to thank the National Science Foundation for inviting me here to speak to you at this Conference on Diversity in the Scientific and Technological Workforce.

I must admit, though, that I feel a little insecure about speaking to you here today. At 26 years old I feel somewhat young, and I consider myself someone who has a lot more to learn during the span of my life. However, at this age I do know some things, and what I know most about is myself. So I am going to talk to you a little bit about myself. I will start with some brief history.

I was born and raised on Long Island in New York. I was raised by my father, who is a physical education teacher in Brooklyn, and my mother, who was a court stenographer in Brooklyn. I am the youngest of three kids. My sister is one year older than I am, and my brother is nine years older.

When I was seven years old, my father and several of the other parents in the neighborhood started a local youth track team. The name of our town is Lakeview, and we called the track team the Lakeview Speedsters. I
can remember that we practiced at the school about three days a week. Every Saturday we would go to the local track and field competition, which was usually somewhere in New York City.

I can remember that I was not that good at that age. My sister became known as the track star in the family, while I became known as more of an “also ran.” Nonetheless, I continued to compete from that early age through junior high school. When I got to junior high school, my father had an idea. He knew that I wasn’t satisfied with my performance level, so he suggested that I start running the hurdles. He said that if I learned to run the hurdles with a superior technique, then my efficiency over the hurdles might compensate for my lack of speed on the ground. That way I might be able to beat athletes who had greater foot speed than I had.

So I started running the hurdles when I was in the seventh grade, and I continued to compete all through high school. I started to win some races, and I was really happy about that. I kept training hard and working hard all through high school. By my senior year I was the New York State champion in the 400-meter hurdles. I also had the fastest time in the nation in the 400-meter hurdles.

During 1988, my senior year in high school, the coach from Georgia Tech called and asked me to attend Georgia Tech on a full track and field scholarship. I visited the school, and I liked it. I had already decided that I wanted to study engineering, because I enjoyed math and science in high school. I also wanted to go somewhere where it was warm, because New York is like Detroit; it’s very cold.

I attended Georgia Tech from 1988 to 1993. I studied mechanical engineering and ran all four years. And as my parents and coaches told me, academics came first, track and field came second, and my social life came third on my list of priorities.

It wasn’t easy competing at the college level. I had some rocky moments my first two years. However, in my junior year my time started to improve dramatically, and I began to see myself as someone with Olympic potential. I tried out for the 1992 Olympic team. However, four days before my first round I twisted my ankle badly. Needless to say, I didn’t make that team. However, I continued to train and compete for the next four years. And, as you all know, in 1996 I made my first Olympic team and won the gold medal.

I guess what I can say about my experience is that it hasn’t been easy. There has been a lot of hard work and a lot of pain, because, as is always the case, with no pain there’s no gain. Sometimes it’s hard getting out there and putting yourself through the hard work and pain when you are not seeing any immediate improvement.

Just a few days ago, I was running up hills, and my coach was saying to me—actually he was shouting to me—that the work that I put in now will pay off in August. The professional track season is mainly in August, and most of our high-intensity training takes place in October, November, and December. The coach was saying that the work that I put in today will pay off next August. Sometimes it seems as if it takes such a long time for hard physical workouts to pay off, but I guess that’s just how it is.

That’s how life is sometimes. Sometimes it takes a long time for our efforts to pay off. I have learned that patience is one of the virtues that I must cultivate in my own personal struggle.

Many people ask me how I managed to graduate with honors in mechanical engineering while competing in Division I athletics. They say, “Derrick, how did you do well in school and run track?” My honest answer is that I don’t think that I would have done as well in school without running track. I honestly feel that the academic and athletic poles of my life perfectly complemented each other and provided me with a total wellness that enabled me to succeed. I believe that academics were good for my athletic success and that athletics were good for my academic success.

In school I felt that the best remedy for mental overload was rigorous exercise. And I believed that the best time to study was when I felt physically sedate after a strenuous workout. I’m the type of person who has trouble sitting down for an extended period, and I see that some of you feel like that too.

My body becomes restless, and my attention span becomes short sometimes. In school, however, after a strenuous workout, I became so physically sedate that I was able to sit down for three, four, or five hours and concentrate on what I was doing and get some quality studying done. On days when academics had me mentally tangled up and stressed out, my physical workout came to the rescue and relieved some of my mental tension.

Studies have been done that prove that during times of stress the body produces an increased amount of human growth hormone. The human growth hormone is a naturally occurring substance in the body that is similar to testosterone and anabolic steroids in that it makes you stronger, it makes you faster, and it increases your stamina. Therefore, during times of stress, whether you know it or not, you become stronger and faster, and your endurance increases.

I’m not saying that I would purposely stress myself out to get stronger and faster, but by working hard in the academic arena, I did experience a type of mental overload, a form of stress, which might have contributed to my physical improvement. I find it ironic that some athletes, especially Olympic athletes, cheat by injecting human growth hormone or other substances into their bodies, while all I was doing was studying.
I am not sure how many of you watched my race during the Olympic games on TV. Those of you who did may have seen NBC do a spot just before my race during which I discussed how my knowledge of biomechanics helped me to alter my training and running techniques. I had been criticized by many of the world’s greatest track and field coaches for doing what is known as “floating” over the hurdles.

It’s commonly accepted that athletes should snap their legs down to the ground as quickly as possible after clearing a hurdle. The idea is that hurdlers should minimize air time, because they can’t run in the air; they can only run on the ground. That’s the common notion. I took exception to that train of thought and began to float over the hurdles, maximizing air time. I felt as though floating was a more relaxed way to run, and it helped me conserve energy during the early part of the race.

Many coaches and others in the sport said that my technique was bad. I was forced to defend my so-called bad technique, using Newton’s first law of motion, which is basically the law of inertia. The best example is that when you throw a baseball, the velocity at which the baseball leaves your hand will be maintained through the air as long as the wind resistance is negligible.

If that’s true, when I’m running on the ground, the velocity at which I’m running will be maintained as I am hurdling or traveling through the air, as long as I don’t add a vertical component to that velocity. And since my velocity can be maintained while I’m in the air, I really don’t see a need to make an extraordinary effort to snap my legs back down to the ground.

Actually, I see the hurdle—now, this might not sound right to you—but I see the hurdle as a split second of temporary rest. When we are running on the ground, our legs are constantly churning and turning over, and the churning is very fatiguing. I actually look forward to the hurdle, because the split second of air time helps me to conserve energy so that I can finish strong.

I included that bit of information because I wanted to give you an example of how thinking like an engineer helped me to train for the Olympics. There’s a difference between being an engineer and getting an engineering education. I have an engineering education, but my engineering education has enabled me to think like an engineer.

When I attended a reception for outstanding Georgia Tech alumni, I sat at the mechanical engineering table. Sitting next to me was the president and chief executive officer of Morey Luggage and Gifts, a large and prestigious company in the southeastern United States. Sitting next to him was a Marine Corps general, then a woman who was a marketing vice president for Microsoft. I found it ironic that even though we were all mechanical engineering alumni, I was there for winning a gold medal, and they were there for being successful in general but not necessarily for having used their engineering degrees.

I have a friend who graduated with me in industrial engineering, and he is going to law school now. And when he becomes a lawyer, he will think like an engineer. I have another friend who will be going to medical school. When she becomes a physician, she will think like an engineer.

Learning how to think like an engineer or a scientist enables one to solve different kinds of problems in a structured manner. I’ve also noticed that getting a degree in engineering leads to instant respect. People just think that you are smart.

I really don’t think that I’m smarter than anyone else because I received a technical education. Math and science came easier to me than did liberal arts; my mind was more suited to math and science. But if society wants to think that I’m smarter because I have a technical degree, I’ll take it.

I believe that society will look upon you with a certain degree of respect if you have a scientific or technical degree. I get interviewed by sports journalists all over the world, and they say, “What did you study in college?” When I tell them engineering, they say, “Wow, you’re smart.” I think that whatever field you enter, you will be respected by your colleagues if you have a scientific background.

I would like to congratulate all of the students who are receiving awards this week for their outstanding achievements in science. And I would like to once again thank the National Science Foundation for inviting me here to talk to you. I wish you all the best in all that you do. Thank you very much.
JOINT PLENARY SESSION
JOINT PLENARY SESSION: THE ROLE OF THE NATIONAL ALLIANCE OF BLACK SCHOOL EDUCATORS (NABSE) IN SUPPORT OF EDUCATION REFORM

PRESIDER

Lawrence Mixon
Superintendent
Columbus Public Schools

INTRODUCTION OF KEYNOTE SPEAKER

Fred D. Johnson
Assistant Superintendent
Shelby County Schools, Tennessee
President-elect
National Science Teachers Association (NSTA)

Before I introduce our speaker, I would like to compliment the National Science Foundation, the Urban Systemic Initiatives represented here, and NABSE for the coalition to reform and improve education nationally for our students.

As president-elect of the National Science Teachers Association which has 53,000 members, I would like to ask you to allow us to join this prestigious coalition that you have formed. I would like to add that the states of Michigan and Ohio are extremely active in NSTA, an organization designed to improve science education for all. Ms. Juanita Chambers and others I could mention really make a difference.

During my tenure, my focus will be to provide services and activities to urban communities. NSTA has done very well historically with suburban and rural communities, but the emphasis during my tenure will be on providing for the needs of teachers and students in urban communities. I solicit your help.

Approximately $1 million is given away annually through NSTA awards for students and teachers. These awards are within reach, and we encourage you to apply as teachers. We also encourage you to involve your students in the competitions that are available.

Now, it is my distinct pleasure to introduce our keynote speaker, Dr. Charlie M. Knight. Dr. Knight was born in Valdosta, Georgia. She graduated from Albany State College in Albany, Georgia. Throughout her high school and college career, she was an accomplished athlete in basketball, tennis, and track and field, and participated in the Pan American games as a sprinter.

Dr. Knight started her teaching career in 1954 as an elementary school teacher in Blakely, Georgia, and also has been a school counselor, teacher, and director of special projects in Monterey, California. She earned a doctorate from Nova University, Ft. Lauderdale, Florida. She has championed the cause of African-American leadership, convening the annual multicultural education conference in Monterey, California; the education summit in Sacramento, California; the Urban Institute in East Palo Alto, California; and other urban education organizations. She is a member of numerous professional organizations.

She is presently the Superintendent of Ravenswood City school district in Linwood, California, and is serving the last two years of her five-year term as President of the National Alliance of Black School Educators, one of the most prestigious professional organizations in this great nation.
When she is in need of support, Dr. Knight calls on what she calls “treasurable, notable personalities,” including Coretta Scott King, Jesse Jackson, Maynard Jackson, Patricia Russell McCloud, Bishop Desmond Tutu, Margaret Collins, and Wilson Riles. This network shows that being able to communicate with other people provides untold strength.

Dr. Knight, we are very pleased to have you present today and wish you Godspeed in your continued work.

KEYNOTE ADDRESS

Charlie M. Knight
President
NABSE

It is a pleasure to be here and to join with Dr. Williams and others in an effort to develop a collaborative to address critical issues confronting public schools, especially urban schools, in our nation. I do not have to tell you the struggle we are facing as urban superintendents. I read about the violence and chaos in public schools and have experienced some of it personally. Public school critics give us absolutely no credit for the world-class students we produce, like Robert [a student who participated on one of the panels]. We must start illuminating the good things about public education rather than presiding over the ruins as critics make daily predictions about our demise.

I must tell you that I am angry about the negative image of the public school system as described by the media and other critics. As President of the National Alliance of Black School Educators, I plan to do something about it.

First, I will begin by convincing Black educators, business and professional organizations, parents, and the community to participate in a long-term process of rebuilding public support for education. Second, I plan to elicit the support of community-based organizations, Urban League affiliates, Panhellenic organizations, and NABSE affiliates to form collaboratives to engage the public in a dialogue on ways to improve public schools. Third, I plan to identify and clarify the roles of vital stakeholders in public education and to discuss the importance of facing the challenges in public schools with unity of focus and continuity of effort.

The NABSE is committed to improving the quality of education for students attending rural and urban schools. We are poised to make a full-court press on poverty, illiteracy, and the dropout rate.

The school district where I am currently employed is a microcosm of school districts all over the nation. I knew the risks when I went in, but I decided that poverty was not new to me. I was not born rich, and I have a good memory of Valdosta, Georgia, in a little section of town called Kill-Me-Quick. It was called Kill-Me-Quick because the mortality rate there was higher than the national average.

Therefore, when I accepted the job in East Palo Alto, which had the dubious distinction of being the murder capital of the world, I knew what those children faced. However, even with all the problems I faced with poverty in little Valdosta, there is no comparison with what the children of East Palo Alto face. The mean streets of East Palo Alto are different from the poverty-ridden streets of Valdosta, Georgia.

I can recall having to share shoes with my brother. We were on double sessions: He attended school in the morning, and I went in the afternoon. We had to meet in the pecan orchard to change shoes. We would have been in style had that happened today because the girls’ shoes look just like the boys’ shoes. But back then, my most difficult challenge was being teased by my classmates for wearing boys’ shoes. Exchanging shoes in a pecan orchard is quite different from confronting drug dealers and passing crack houses on the way to school.

The children in my district are in a situation where, as superintendent, I cannot protect them. The best I can do is say to them, “I cannot control the mean streets, but I can control the quality of education that will be provided in the 10 schools in the Ravenswood City School District.” I can assure them that when they arrive on these campuses, they are going to be safe.

I am also committed to working hard to ensure that every teacher I assign to a classroom is prepared to challenge the students. I want the students to grow up like Robert and still have a passion for learning after spending thirteen years in public schools. That is why we insist that every child in Ravenswood School District understand and acquire life skills. These skills will empower them to take responsibility for their own destiny.

I used public engagement to restore the public’s confidence in the school district’s ability to produce world-class students. In October of 1985, I accepted the position of Superintendent of the Ravenswood City School District in East Palo Alto, California. The district had hired eleven superintendents in 10 years. The district
was mired in a 10-year integration lawsuit and burdened with parental chaos, underpaid teachers, low academic achievement, and lethargic administrators. It was readily apparent that leadership was the major problem. Like many Black administrators, I inherited a district that was Black, Brown, and broke. I knew instantly that I would be either a messiah or a scapegoat. It was imperative that I engage the public in my efforts to rebuild the district. It required risk taking and leadership. Like Ravenswood, many school districts are engaging the public in rebuilding public schools.

Indeed, there are several efforts to reinvent public education. Some educators perceive the introduction of alternative schooling as a deliberate attempt to dismantle public education. Charter schools, vouchers, and a variety of privatization models are being tested nationwide.

There is a definite sign that the paradigm is shifting from magnet schools to charter schools: The president has announced that he will increase the budget for charter schools. Now, in order for us to be sure that charter schools are not used to dismantle public education, we as educators must learn to establish exemplary public charter schools. It is critical that we engage the public in a dialogue regarding public schools, vouchers, and other alternative school interventions.

It appears that offering some form of alternative education to the general populous is inevitable; therefore I urge all public school educators not to expend any time fighting vouchers and charter schools but to use that time to create quality public schools instead.

Schools in the next millennium will be qualitatively different from schools of today. Kindergarten play areas will be transformed from blocks and play centers to desks, computers, and printers. I told one of my principals the other day, “I can remember some 30 years ago, I would observe my kindergarten class and would see a child crying. I would say, ‘Why are you crying?’ The answer would be, ‘Johnny took my blocks.’ If I visit the same class today and ask, ‘Why are you crying?’ the answer will be, ‘Johnny took my disk.’” Things have changed; therefore, I must find the time and money to provide adequate training for teachers to prepare them to meet the challenge, or those youngsters are going to be bored, and they are not going to wind up like Robert, with a passion for learning, because they were turned off.

I have spent a great deal of time trying to find money to hire good science teachers. When David Packard was alive—he died this year—I went to see him to set up a collaboration with the Hewlett-Packard Foundation. I eventually obtained the support of Larry Ellison of Oracle, Cisco Systems, Sun Microsystems, Network General, NASA, and the Hewlett-Packard Foundation. These companies are “critical friends” of the Ravenswood City School District. I am counting on them to ensure that the electronic superhighway will not pass by East Palo Alto.

When I went to David Packard I simply said, “I need your system.” Every year for 10 years, he gave my little district over $200,000 in discretionary funds. That means I did not have to get permission from the Board to use the money. Educators are not often perceived as good managers, and for this reason some companies do not invest in schools; but when David Packard invested his first $200,000, Bill Hewlett followed suit. Next it was John Morgridge from Cisco Systems. They were confident that I had the ability to move that district to another level, so they invested. To make sure that they had a great return on their investment, I put every school in my district online. Every school can access the Internet any time.

Just the other day on the Oprah Winfrey show, there was a handsome fellow named Larry Ellison, the CEO of Oracle, who has designed a computer that can be placed on a student’s desk and used to get on the Internet or to access any information he or she wants. It looks just like a little laptop. During the show, Larry announced that every child in Flood Magnet School, Menlo Park, California, the school that he has adopted, will receive a computer like it.

My teachers are apprehensive about changes like this because they have to change their instructional approach. Adding to their apprehension is something that for me is a dream come true: I never thought I would live to see the day when, in a public school, in kindergarten through third grade, classes would have a teacher-student ratio of 1 to 20. To me that is heaven. The average teacher-student ratio in California is 1 to 33. The governor said he wanted to do something to improve education, and in my judgment his Class Size Reduction Bill is the most significant intervention in education in California in 50 years. Now, teachers and administrators, it is time to put up or shut up. The pressure is on us.

One of my teachers said, “I thought it would be a piece of cake, but teaching 20 kids is challenging because you have more time with them.” The entire instructional approach must change. There is a qualitative difference in what you can do with only 20 kids and what you are presently doing with 30. So that’s our challenge, but it is a great challenge and an opportunity.

I want to ensure that we make full use of this collaboration among the National Science Foundation, NABSE, and the Urban Systemic Initiative. I want to know if I can teach science better, but I also want to know what
science to teach. I want to be sure that my teachers know how to teach reading better. I want to stop worrying about whether or not we should be doing whole language programs as opposed to phonetics. I want our children to read; I don’t care how we get them to read.

The point is that as we begin to collaborate, we must do it with some unity of focus. Before David Packard died, he gave twenty $50,000 scholarships every year to students who attended a traditional Black college in the South and who majored in mathematics or science. He did that for five years, and as a part of his legacy he directed that it continue.

Well, at least we are starting these youngsters with a good foundation in science and mathematics. By the time they get to Fairview or Morehouse or Virginia State, they will be ready to accept David Packard’s challenge. That is, “When you finish this school, we will give you $50,000 for four years to work on your master’s degree and your Ph.D., because we have to train good math professors. We have to train good science professors.” We have to train people who want to come back. We want astronauts, but I want some good teachers with fire in their bellies. I want them to come to school ready to challenge some kids who need to be challenged.

As we move to the next millennium, I want to be sure that we leave no child behind. But I predict that if we do not get some government support for successful practices that have been proven to have a positive impact on pupil achievement, a high dropout rate and poor student achievement will continue to be the order of the day in urban school districts.

Let me talk a few minutes about reform. Although we have something in California called restructuring, we have not had true reform. Among these three organizations we must come up with true reform that will give youngsters a better chance to succeed. We haven’t done very much. We have 180 days to spend with the children. We have not done anything about extending the school year. We are not doing anything even about extending the school day. We have not made any significant changes in the curriculum. Now that we have a second chance to restructure and revitalize education in California, I can assure you that California no longer is surpassed by 43 other states in reading and mathematics. Watch what we do with the new class size reduction. We know that the whole world is watching. As the adage goes, “When California sneezes, the rest of the nation catches a cold.”

So I am pushing for Dr. Williams and others, such as Hugh Price of the Urban League, to come together and say that in the inner cities we’re going to provide a qualitatively different instructional strategy for these youngsters. We want to be sure that we know these students and can challenge them and give them the kind of time necessary. But somewhere down the line, somebody must provide leadership.

In closing, let me offer one challenge. If any of you are in urban areas, if any of you are assigned to urban schools, make a commitment to go in and do your very best. If you are a principal, provide your best leadership. If you are a teacher, do your best teaching, because these are the children who need us the most. If you happen to be someone who says, “Well, I need a loan deferred—or a loan devaluated—so I’m going to go into the inner city to teach for two years and then make my exit,” that is a disservice. If you must come, come and work with us.

There is nothing that succeeds like success. Robert has told us that. He is the perfect example of it. And I am saying to you that we have to start applauding the public schools at every opportunity. We also must be sure that we are not going to collaborate with anybody whose design is to dismantle the public school system, because I think it is the best experiment that has ever happened in the free world. We are a good example of that in this country. There is no other place in the world where someone says, “All who come, we teach.”

And we do it. We do not do it as well as we would like to, but we are going to get better at it, particularly if we are able to form these collaborative relationships to ensure that every child succeeds and that no child is expendable.

I say to you, National Science Foundation, teachers and administrators, and supporters and students, education is a journey. Let’s enjoy the ride.
An integral part of the National Science Foundation’s diversity conferences has been the presentation of awards to outstanding student researchers and to leaders in the field of science, engineering, mathematics, and technology education for minority groups underrepresented in these disciplines.

For this conference, our first Regional Conference on Diversity, we will continue this tradition. We will first present student awards. More than 80 students from the Midwest participated in panel and poster presentations yesterday. NSF funded student projects under four of its programs: the Comprehensive Partnerships for Mathematics and Science Achievement program, the Urban Systemic Initiatives program, the Research Improvement in Minority Institutions program, and the Alliances for Minority Participation program. Disciplines represented included mathematics, engineering, earth science, environmental science, computer science, and the physical, biological, and social sciences.

Students entered the competition by submitting a formal research paper based on their conference presentations. Those papers were reviewed by scientists and science educators from the Detroit school system and area universities, and finalists were selected in each category: precollege, undergraduate, and graduate. The judges attended the presentations of all the finalists, and the winners have been selected.

Before we present the awards, we would like to formally recognize the many scientists and science educators who volunteered their time to review papers and judge presentations. Some of them are here today. If you are present, please stand and be recognized. Special recognition is due to Dr. William Hill, Director, Metropolitan Detroit Alliance for Minority Participation, who served as the coordinator of the student presentations and the research competition.
The Metropolitan Detroit Science Teachers Association is very pleased to participate in this event. Let me tell you a little bit about MDSTA. We are one of the oldest, if not the oldest, science teachers association in the state. We even predate the National Science Teachers Association. We do several things for our teachers. We have a minigrant program, and we offer professional development opportunities, because we know that it is important for teachers to have opportunities to come together and see what is going on in the field. We take pride in these activities.

Several years ago, we decided to honor our own by giving an outstanding science teacher’s award. I am pleased that there are several recipients of that award here today. We give the award in May of each year, and we will continue to do so, because we want to acknowledge the teachers who are in the trenches, who often think that what they are doing is just good practice.

On behalf of our association, our board unanimously wanted to give these awards to the students who participated here, who represent NSF’s Urban Systemic Initiative program and its Comprehensive Partnerships for Mathematics and Science Achievement program. The two programs served more than 500,000 precollege students in 1995. The programs support a wide range of hands-on mathematics and science activities, which have resulted in many science fair and advanced research projects, including the outstanding papers and posters presented at this conference. There are two winners. Each will receive a $100 check.

—Ellen Daniel Jones
PRECOLLEGE STUDENT MATHEMATICS RESEARCH AWARDS

Sponsor: Detroit Area Council of Teachers of Mathematics (DACTM)

Presenter: Irene Norde, President, DACTM

Award Recipient: Tyliitha H. Stewart, Cass Technical High School, 12th Grade, Detroit Urban Systemic Initiative

Title of Paper: “Angiogenesis in Cultures of Rat Hepatocyte Spheroids”

Award Recipient: Christopher E. Abel, Hughes Center, Cincinnati Academy of Mathematics and Science, 12th Grade, Cincinnati Urban Systemic Initiative

Title of Paper: “Molecular Modeling in the Undergraduate Laboratory: Reduction of 4-tert-butylcyclohexanone to 4-tert-butylcyclohexanol”

Tyliitha Stewart, Irene Norde, Christopher Abel

The Detroit Area Council of Teachers of Mathematics has a membership of more than 700 mathematics educators in Macomb, Oakland, and Wayne Counties. We support the classroom teacher in many, many ways. We publish the Factorial, and we have many staff development opportunities. For example, we recently held a joint conference with the Metropolitan Detroit Science Teachers Association. The conference was unique. There were more than 2,000 mathematics and science educators, prekindergarten through college, in attendance.

DACTM awards many grants to teachers, and we have enrichment opportunities for students as well. We feature a conference for high school students called the Myriad of Mathematics; that is unique in itself.

We were therefore not surprised when Juanita Chambers asked us to support NSF’s efforts in giving scholarships to young people. Our executive board unanimously agreed to do so. I am very proud to note that more than 50 presentations at this conference were made by middle and high school students who participated in the Urban Systemic Initiative program and the Comprehensive Partnerships for Mathematics and Science Achievement program, which are funded by the NSF Directorate for Education and Human Resources. These students are our future scientists and mathematicians. There are two winners. Each will receive a $100 check.

—Irene Norde
UNDERGRADUATE STUDENT RESEARCH AWARDS

Sponsor: Phi Beta Kappa

Presenter: Isabel Smith, Past President, Detroit Metropolitan Phi Beta Kappa Association

Award Recipient: Alberto Quintana, Illinois Institute of Technology, Senior, Chicago Alliance for Minority Participation Program

Title of Paper: “Instantaneous Pressure Distribution around an Oscillating Cylinder”

Award Recipient: Linda C. Davis, University of Missouri at Columbia, Junior, Heartlands Alliance for Minority Participation Program

Title of Paper: “The Reversibility of Morphology Changes in Arabidopsis thaliana”

Each spring in this very room, Phi Beta Kappa of Detroit honors up to 2,000 students from metropolitan area high schools with a certificate indicating achievement in all areas of education, particularly liberal arts and the sciences. We look forward to doing that. We have done it for 45 years plus. We hope that many of the students who are honored here today will also be at our awards ceremony.

Phi Beta Kappa is the oldest honorary educational society in the United States. It was founded in 1776 at William and Mary by students who did not agree with the rote learning of mathematics, Latin, and Greek. They created the society to foster free inquiry and investigation, an ideal that Phi Beta Kappa carries to this day.

We therefore think that it is appropriate that we were asked to participate with the National Science Foundation in honoring the students here today. We applaud NSF’s leadership in providing opportunities for minority students to participate in undergraduate research. The Foundation has established an outstanding record of supporting the thousands of minority students who will become the nation’s next generation of scientists.

Of the more than 80 research projects presented at this conference, 30 were made by students in NSF’s premier undergraduate program, the Alliances for Minority Participation. This program provides support to minority students, enabling them to pursue degrees in science, engineering, and mathematics at the undergraduate level. The program is currently assisting more than 200,000 of the next generation’s minority scientists, engineers, and mathematicians. The large number of high-quality papers submitted to this competition reflects this support.

The Phi Beta Kappa Association of Detroit, an affiliate of the Phi Beta Kappa Society, has joined NSF to present the following awards. There are two undergraduate awards, and I am happy to say that there are $500 checks in each of these envelopes.

—Isabel Smith
Sigma Xi is honored to sponsor the award for the outstanding graduate student research paper and presentation at this conference. Sigma Xi was founded in 1886 by a group of Cornell students and a faculty member who believed that the time had come to establish an honor society for scientists and engineers. I might add that it was founded because Phi Beta Kappa didn’t think engineers and scientists were scholars. The purpose of the society was to reward excellence in scientific research, as well as to encourage a sense of companionship and cooperation among scientists in all fields.

In the 100 years following its founding, Sigma Xi grew to include more than 500 chapters and over 90,000 members. Today, there are Sigma Xi chapters throughout the world wherever scientific research is undertaken. Sigma Xi has, however, become an organization whose membership is composed primarily of white male scientists and engineers. The membership of Sigma Xi reflects the composition of the scientific and engineering community, but unfortunately not that of society overall. Sigma Xi recognizes that its survival and the future of science and engineering depend on incorporating the diverse elements of contemporary society into its ranks.

We present this award in recognition of NSF’s leadership in providing quality education for minority students, who are underrepresented in science, mathematics, and engineering. As a reflection of our strong support of the Foundation’s efforts, the graduate students who participated in this competition represent two programs of the Directorate for Education and Human Resources that focus on undergraduate and graduate education respectively for minority students: the Alliances for Minority Participation program and the Research Improvement in Minority Institutions (RIMI) program. The RIMI program provides grants to strengthen the research capabilities and infrastructures of institutions that have substantial minority enrollments and graduate programs in science or engineering. The RIMI program is responsible for a significant increase in the number of minority doctoral candidates and graduates. Mr. Emanuel will receive a plaque and a check for $500 following this meeting.

—Peggy Hollingsworth
The science, mathematics, engineering, and technology education of a diverse student population requires a comprehensive effort involving all segments of the community, including administrators, teachers, parents, and private-sector corporations. Some persons and institutions have a history of involvement in this effort and stand out as leaders in the field of science and education equity; a few persons have devoted their entire professional careers to the effort. NSF has created several awards to recognize and honor these persons, institutions, and organizations for their creativity, dedication, and long-term efforts to expand educational options for all students, focusing on those groups that are underrepresented in science and technology careers. The efforts of these people and institutions have resulted in increased participation by underrepresented groups in the science and technology enterprise.

Dr. Luther Williams was scheduled to present this next group of awards. However, he had to return to Washington and asked several members of his senior staff to present the awards and to offer the honorees his personal congratulations.

[Two awards were presented: an educator award and a corporate award. The award presentations are summarized below. The award recipients each received a hand-lettered, framed certificate signed by the Director of NSF and the Assistant Director of NSF’s Directorate for Education and Human Resources.]
Dr. Dorothy Swearengen Strong began her distinguished professional career teaching elementary and high school mathematics in the Chicago Public Schools. A graduate of the Chicago Teachers College and Nova University, Ft. Lauderdale, Florida. Dr. Strong has assumed a wide array of leadership responsibilities over the years. She has served as president of the National Council of Supervisors of Mathematics, served as a member of the Mathematical Sciences Education Board of the National Research Council, and served on the Board of Directors of the National Council of Teachers of Mathematics (NCTM), where she was intimately involved in the development and publication of NCTM’s *Curriculum and Evaluation Standards for School Mathematics*. While she served in the Chicago Public Schools, Dr. Strong was president of the National Benjamin Banneker Association and co-director of NSF’s Regional Center for Minorities in Chicago.

In 1976 Dr. Strong was appointed Director of Mathematics for the Chicago Public Schools. After 17 years in that post, she came to the National Science Foundation’s Urban Systemic Initiatives (USI) program. She was one of the original officers of the USI undertaking. She later returned to the Chicago Public Schools to serve as the regional coordinator for the USI. She brought to her tenure at NSF, and then to her post as regional coordinator of the USI, a sustained and immutable commitment to the view that challenging, high-quality mathematics and science education is an imperative for all students. This commitment, seasoned with more than 35 years of educational leadership, led to her singular contribution to NSF’s USI endeavor, a contribution that continues to pay dividends throughout the nation.

Dr. Strong is a nationally recognized authority on teaching mathematics in inner-city schools. She has received many awards, including the National Diffusion Network’s Pacesetter Award, the Glen Gilbert Award, the Anderson Medal, and the Phi Delta Kappa Educator of the Year Award. She has also been included in *Who’s Who in the Midwest*.

It is her philosophy that all children can learn mathematics and that all teachers can teach mathematics. She is a strong proponent of teaching algebra to all students; she believes that it provides a foundation for higher mathematics and college success. An outgrowth of her commitment to excellence in mathematics is the Chicago Public Schools’ Algebra Framework and the system’s recent Mathematics Task Force Report. She chaired the task force, which recommended the integrated introduction of pre-algebra concepts in kindergarten through sixth grade and completion of Algebra I by the end of eighth grade.

Throughout her career, Dorothy has adhered to the morally and intellectually symmetrical construct that demands that we provide for all students the mathematics preparation requisite to the pursuit of the broadest possibilities in life. She has done so against a landscape that has sought to consign so many students, nationally and in the Chicago Public Schools, to an economic death march to nothingness. Dorothy Strong’s career attests to determined perseverance in the face of great odds and a profound sense of providential calling to service as a mathematics educator. The best fruits of her labors are still to come in the lives of children in Chicago and throughout the nation.

—Roosevelt Calbert
CORPORATE ACHIEVEMENT AWARD

Sponsor: NSF, Directorate for Education and Human Resources
Presenter: Richard Blouse, President, Greater Detroit Chamber of Commerce
Award Recipient: Texas Instruments, Incorporated

For almost 20 years, Texas Instruments Incorporated (TI) and its employees have worked with teachers and communities to help increase student interest and success in science and mathematics. As an important national partner to NSF’s Urban Systemic Initiative (USI) program, Texas Instruments has provided USI educators in more than 15 cities with resources and tools, access to its educator development culture, support programs, and dedicated personnel. TI believes that it is important to heighten awareness of how teachers can use technology to stimulate students’ minds. TI has therefore developed a variety of communication tools, including newsletters, websites, and e-mail interest groups, to provide instructors with a continuous supply of new and useful ideas.

TI’s commitment spans the K–16 education spectrum. Through the Teachers Teaching Technology program, or T³, that it sponsors in cities nationwide, TI provides hands-on training for educators interested in enhancing teaching and learning through the use of handheld technology. Various TI institutes focus on using technology to connect science and mathematics and on improving chemistry and biology classwork. More than 25,000 teachers have participated in these institutes since the program began in 1988. The students taught by these teachers number in the hundreds of thousands.

Texas Instruments also works with schools to promote education among underrepresented groups. For example, corporate initiatives have included creating a TI computer science laboratory, complete with computers, software, and printers, at Prairie View A&M University. This program allows incoming first-year students to participate in special summer programs focusing on calculus, physics, chemistry, mathematics, and writing. The programs help prepare the students for their first year of college.

TI also supports the Graduate Engineering for Minorities program, which awards graduate school fellowships to underrepresented minorities, and INROADS, a program that awards scholarships and internships to college-age minorities. And TI is an active participant in the National Action Council for Minority Engineering.

TI employees are directly involved in community activities through programs such as Choices, which brings TI employees into minority high schools to talk to students about how the choices they make affect their lives. Career days, plant visits, and co-op education programs are other methods used to expose students to the skills they will need for the workplace of the future.

Believing that early education is the foundation of a child’s future, Texas Instruments also sponsors preschool programs such as the Margaret H. Cone Head Start Center in the predominantly Hispanic West Oak Chief neighborhood of Dallas. Such programs provide children with access to the educational, health, and social services they need to succeed in school and beyond.

TI believes that knowledge can open doors, and education is at the core of everything TI does. For almost two decades TI has been committed to providing teachers with the resources they need to interest, inspire, and encourage students, thus enabling students to open a door on opportunity and growth.

—Richard Blouse
SYSTEMIC REFORM IN EDUCATION AWARD

Sponsor: NSF, Directorate for Education and Human Resources (EHR)

Presenter: Daniel D. Burke, Senior Staff Associate, Office of the Assistant Director, EHR, NSF

Award Recipient: **David L. Snead**, General Superintendent, Detroit Public Schools

---

Daniel Burke and David Snead

This award was initiated last year to recognize outstanding leadership and sustained contributions to national efforts enabling the systemic reform of precollege mathematics and science education for all students.

Dr. Snead received his undergraduate degree in education and kinesiology from Tuskegee University. He received his M.A. in urban education and kinesiology and his Ph.D. in educational administration from the University of Michigan, Ann Arbor. Dr. Snead has worked in the Detroit Public Schools for all of his career. He has served as a teacher, coach, department head, principal, and assistant superintendent, and he is now General Superintendent. During his tenure in the school system, he has created and led a districtwide campaign to improve the learning environment in schools; procured foundation grants of more than $30 million; overseen the deputization of 5,000 school volunteers; led the campaign for the successful passage of a $1.5 billion school bond referendum (the largest in the nation’s history); and led the effort to obtain a five-year, $15 million NSF Urban Systemic Initiative award for reform of K–12 mathematics, science, and technology education.

For the past two and a half years, Dr. Snead has served as the principal investigator of the Detroit Urban Systemic Initiative (USI) award. Under his leadership, the Detroit USI has become one of the most successful USIs. It has made truly remarkable strides in fostering increased student achievement in science and mathematics and serves as a model for school reform. The Detroit USI is guided by David Snead’s vision of establishing achievable standards of excellence for student performance by providing students with quality education in clean, safe, and healthy environments.

Beyond his role in Detroit, Dr. Snead has been a leader in the national systemic reform movement. He has spoken in a variety of national forums and has been an effective advocate for the development of an educational system that will enable all children to enter the technological workforce of the coming century and participate as full citizens in our nation.

I believe that it is Dr. Snead’s desire to see all children reach high levels of achievement that drives him to be such a tireless and effective leader in the school reform movement. Thus, on behalf of all of the K–12 students in the Detroit Public Schools, it is an honor to acknowledge his outstanding leadership in efforts that will truly enhance the quality of life for all the children of Detroit and the nation.

—Daniel Burke
SPECIAL AWARDS

AMP PROGRAM

Awards were presented to the officials from the NSF Directorate for Education and Human Resources responsible for the Alliances for Minority Participation (AMP) program: Luther S. Williams, Roosevelt Calbert, and William McHenry.

Six years ago, the National Science Foundation put out a call for proposals for the AMP program. Five years ago, NSF awarded six grants of $1,000,000 each to the first six AMP projects in the United States. The projects were at the University of Alabama at Birmingham, Jackson State University, Arizona State University, Texas A&M University, the University of Puerto Rico, and the University of California at Irvine. Dr. Luther Williams was the architect of the program, Dr. Roosevelt Calbert was the business manager, and Dr. William McHenry was the contractor or the builder. We came here to present an award to each of them—the architect, the business manager, and the builder of the AMP program. The plaque reads, “In appreciation for visionary leadership and support of the Alliances for Minority Participation 1991 to 1996.”

—Louis Dale, University of Alabama at Birmingham

TEXAS INSTRUMENTS

Texas Instruments, which is actively involved in NSF’s Urban Systemic Initiative program, provided prizes for all student awardees, as well as Derrick Adkins. The awards were presented by Richard J. Schaar, Senior Vice President, Texas Instruments. The precollege students received TI-83 calculators with advanced statistics capabilities. The college-level students were given two products: the TI-92, which has geometry and computer algebra capabilities and is really a mathematics computer, and a calculator-based laboratory system, that allows data analysis in the field. Derrick Adkins and the graduate student awardee received a TI personal organizer, including PC software and a docking cradle that will allow them to keep information on a personal computer and in their pocket.
SPECIAL AWARDS

DETROIT PUBLIC SCHOOLS

Juanita Clay Chambers and David Snead, the General Superintendent of Detroit Public Schools, recognized Terrel Bradford, the high school student from the Detroit School District who designed the logo that appears on the program, bags, and student T-shirts created for the conference.

ALPHA KAPPA ALPHA SORORITY

Schylbea J. Hopkins, President of the Alpha Rho Omega chapter of the Detroit Alpha Kappa Alpha sorority, gave each precollege student winner a plaque that read: “Pre-College Student Achievement Award, presented by the Alpha Rho Omega chapter of the Detroit Alpha Kappa Alpha sorority in recognition of your outstanding research presentation at the National Science Foundation Regional Conference.”
SPECIAL AWARDS

CITY OF DETROIT

Nettie Seabrooks, Deputy Mayor of Detroit, congratulates Derrick Adkins on his achievements on behalf of the city of Detroit.

STUDENT PRESENTERS

Luther Williams and Eboney Smith

At an earlier session, Luther S. Williams was presented with the original art for the conference poster signed by the student research presenters.
STUDENT RESEARCH PRESENTATIONS
STUDENT RESEARCH PRESENTATIONS
Abstract: In the study of monolayer cell cultures and cell adhesion in bioreactors, CHO-K1 cell or Chinese Hamster Ovary cells are used for cultivation and testing. The objective of this study was to find additives that prevent cells from adhering to air bubbles in sparged bioreactors. Additives tested in this study were surfactants, molecules that adsorb at interfaces, altering to a marked degree the properties of those interfaces. Using a bubble tensiometer, the variation of surface tension with surfactant concentration was measured for various surfactants, including Pl03, L64, F127, F87, F88, DDAO, BD4SY, and BL7SY. These data will help determine which surfactants can be used, and at what concentration, to prevent cell adhesion. Toxicity studies were also performed to determine whether surfactants cause damage to cells.

INTRODUCTION

This research was designed to find additives that would prevent cell/bubble adhesion in sparged bioreactors. CHO-K1 cells are used in microcarrier cultures, such as sparged bioreactors, to make possible the practical high yield culture of anchorage-dependent cells. Cells are currently used to produce many pharmaceutical products. In these bioreactors a system of sparging is used in order to supply oxygen to the cells. In these sparged bioreactors, cells and microcarriers adhere to the rising gas bubbles. Eventually, these bubbles burst and damage the cells.

Additives such as surfactants have a characteristic structure consisting of a structural group that has very little attraction for the solvent, known as the hydrophobic group, together with a group that has a strong attraction to the solvent, called the hydrophilic group. The structure of a surfactant is key in preventing cells from adhering to air bubbles. The surfactant’s hydrophobic tail adheres to the bubble and prevents the cell from adhering.

The critical micelle concentration (CMC) is very important, especially in determination of the most useful surfactant. The critical micelle concentration is the solution concentration of a surfactant when it begins to form micelles. When the surfactant forms micelles, the hydrophilic group (polar head) is toward the aqueous phase, and the hydrophobic tail is away from it. In the sparged bioreactors these micelles can damage the cells immensely. Micelles may solubilize or dissolve the cell membrane, and thus kill the cell. Therefore, CMC becomes vital in determining the surfactant in which the cells will be the most viable in suspended cell cultures.

PROBLEM

Which surfactant(s) can be used in a sparged bioreactor with the proper surfactant concentration and will not be harmful to the cells?

HYPOTHESIS

Currently, studies have shown Pluronic F68 to be the most widely used surfactant in industry. We proposed that these studies would support current findings and that after testing all the surfactants we would be able to determine other surfactants that are similar to F68. It is also important to find those surfactants that will be harmful to the cells.

OBJECTIVES

1) To determine the surfactants that will be best to use in sparged bioreactors from the surface tension versus surfactant concentration measurements.
2) To identify those surfactants that the cells will be most viable in.

3) To gain knowledge about the best techniques for cultivating monolayer cell cultures.

MATERIALS AND METHODS

Materials for this research included several T-75 flasks of CHO-K1 cells, incubator (37°C), centrifuge, and media (nutrients for cells). These materials were needed for feeding and splitting cells. To count cells a hemocytometer, microscope, and hand counter were used. For recording surface tension measurements we used the bubble tensiometer, 100ml flask, nitrogen gas tank (bubbled), calibration system program, stock solutions of surfactants, pipettes, and journal for recording concentration and surface tension. We also used computers and Microsoft Excel for plotting points.

The first part of the research began with cultivation of the cells. Cultivation of the cells includes feeding, splitting, and counting cells. The cells were checked daily for confluency and were fed at least once a week. The pH indicator in the media informed us when media needed to be changed. Normally it would change from a pink-orange to a yellow. Splitting occurred between one week and three days. We normally split the cells when we noticed that the entire growth surface was covered with cells. Counting took place at the same rate as splitting. We counted cells in order to average the number of cells per flask. This data was used for toxicity tests.

The second part of the research involved the actual testing of the surfactants. The first step was to make a stock solution of the surfactant, which often involved dilution of the surfactant. When using the bubble tensiometer a 100ml flask that contained about 45–50ml of media had nitrogen gas bubbled into it. This system was connected to the calibration system where the surface tension was measured through a probe in the solution. The surfactant was titrated into the system and allowed to equilibrate between 5–10 minutes and the surface tension was recorded.

These steps were followed for each surfactant. The collected data was plotted on a semi log plot using Microsoft Excel (surface tension vs. concentration).

RESULTS

Our results show surface tension curves for a variety of surfactants. The ideal surfactant is one in which low surface tensions are obtained at relatively low surfactant concentration, below the CMC. To minimize cell damage, we do not want to use concentrations greater than the CMC, so these results help define the range of surfactant concentrations that can be used in the bioreactor.

From the graphs, Pluronic F68, Pluronic F127, Pluronic F87, and Pluronic F88 show characteristic graphs of what we hoped to see. The graphs of all the surfactants show the surface tension versus the concentration of the surfactant. From these measurements we determined the CMC’s of each surfactant according to the break and the leveling off of the curve.

Figure 1 shows the surface tension versus the concentration of one surfactant, Pluronic P103. The surface tension of the surfactant gradually decreases as the concentration of the surfactant increases. The surfactant reaches a breaking point where the curve levels off—this break point is the critical micelle concentration. From the graph we can conclude that the

![FIGURE 1. SURFACE TENSION OF PLURONIC P103 SOLUTIONS](image-url)
The surface tension of Pluronic Pl03 is about 40 dyne/cm at the CMC. This plot is a representation of several surfactants tested. Most of the graphs of the other surfactants resembled the same type of curve with a breaking and leveling point.

Figure 2 shows the consistency of experimental procedure and data. In this graph the surface tension versus concentration of the surfactant (Pluronic F68) is plotted. In both trial 1 and trial 2 we obtained essentially the same results. This proves that experimental procedures are reproducible and that differences between surfactants are significant and not just due to random or experimental error. Pluronic F68 is also the surfactant that is currently used in industry.

Figure 3 shows the surface tension versus concentration of all the Pluronic surfactants tested. This graph shows a comparison of all the surfactants as it relates to surface tension and critical micelle concentration.

CONCLUSION

During our research several tests were done on Pluronic F68 to assure consistency of data. Pluronic F68 gave the same results each time it was tested. Pluronic F68 lowers the surface tension extremely well and also has a relatively high CMC, which is desirable. Further research could give more information about the toxicity of the surfactants on the cells as could further testing on Pluronic F127, F88, and F87.
ACKNOWLEDGMENTS

I would like to thank Trish Bauer, Dr. Rathman, and Dr. Chalmers at The Ohio State University Chemical Engineering Department for all the guidance and help and for providing me the opportunity to intern for them. I would also like to thank Columbus Alternative High School Internship Program advisor, Tom Albaugh, for all the support.

BIBLIOGRAPHY


Abstract: Earthworms are annelids that are bilaterally symmetrical, move by bristles pushing against the ground, and have a crop and gizzard and a closed circulatory system. All annelids are segmented worms and invertebrates, which means they have no backbone. They live underground and move through the soil; this action makes spaces that help aerate (purify by exposing to air) the soil and that also improve water drainage.

Pesticides are chemicals used to control or eliminate pests. The four most widely used types of pesticides are insecticides, herbicides, fungicides, and rodenticides. Pesticides differ according to their effect on various organisms. Pesticides that are toxic only to the targeted pest are called selective pesticides. Nonselective pesticides can harm or even kill organisms that are not considered pests. Pesticides are sprayed on plants and weeds and they also get into the soil where many organisms live.

Fertilizers are substances that are added to soil to help plants grow. My objective in this experiment is to examine the behavior between earthworms that have been exposed to pesticides and fertilizers and earthworms that have not been in contact with pesticides and fertilizers in order to better understand their potential effects on people and other large animals.

INTRODUCTION

Earthworms are in the phylum Annelida. Some characteristics of annelids are bilaterally symmetrical, have a hydroskeleton, move by bristles pushing against the ground, and have a crop and gizzard and closed circulatory system. All members of the phylum Annelida are segmented worms. The term annelid means “tiny rings.” It refers to the external segments visible on members of this phylum.

Annelids are the first group possessing all five of these physical traits: right-left bilateral symmetry, cephalization, a gut tube, a body cavity, and segmentation.

In an earthworm, blood is transported through two blood vessels—the dorsal blood vessel and the ventral blood vessel. They have five pairs of enlarged tubes called aortic arches. The aortic arches function as a heart. Blood flows anteriorly in the dorsal blood vessel from the aortic arches, then is pumped into the ventral blood vessel. Earthworms have a closed circulatory system because their blood is always in their blood vessels.

Food enters through the earthworm’s mouth and passes through the pharynx and then to the esophagus. The esophagus pushes the food to the crop. In the crop, food is stored until it is pushed to the gizzard. Here, food is ground up by soil taken in by the worm. Next, food passes through intestine. Undigested materials are expelled through the anus.

In earthworms, gases dissolve in the moisture on the skin. Oxygen diffuses inward to the blood. Carbon dioxide diffuses outward from the blood through the skin and to the soil. When it rains, they can not live in the soil or they will drown. After the rains, some earthworms die because they cannot make it back to the soil before they dry out from exposure from the sun.

Earthworms are hermaphrodites, which means they have male and female sex organs. Earthworms have a clitellum, which serves a good purpose to the worm. When they lay eggs, they are laid in the inside of the clitellum where they will develop.

PROBLEM

Since pesticides are toxins that are often non-specific, their effects often reach beyond the intentions of the user.

HYPOTHESIS

Pesticides, and to a lesser extent fertilizers, are chemical substances that are toxic or may become toxic when used in concentrations beyond those rec-
ommended by the manufacturer. Any organisms that come in contact with them, whether intentionally or accidentally, may suffer adverse effects due to this toxicity. Earthworms are a common part of the ecosystems in which humans also exist and live in the soil that is often the recipient of excess amounts of chemical substances used by humans. I propose that pesticides and fertilizers, intended for other uses, often become involved in the human ecosystem in ways that are not intended with effects not intended by the user. The stress seen in earthworms to these substances can be an indicator of the types of changes that may be seen on a larger scale within the ecosystem.

MATERIALS AND METHODS

1. Creating a similar living environment for the earthworms
   a.) Filling ten containers halfway full of soil
   b.) Placing three earthworms in each container
2. Three different kinds of pesticides were used
   a.) Raid (House and Garden Bug Killer)
   b.) Orthenex (Insect and Disease Control)
   c.) Camicide (Insect Killer)
3. Schultz-Instant Liquid Plant Food was used as a fertilizer
4. Out of ten containers there were two controls, two fertilizers, two Raid pesticide, two Orthenex pesticide, two Camicide pesticide
5. Labeled the containers
6. Sprayed containers every day with the assigned chemical
   a.) 1 foot above the soil
   b.) spraying time, 3–5 seconds
7. Observed the earthworms every other day
8. Recorded data daily
9. No testing on weekends

RESULTS

During the two week period that I performed this experiment, the earthworms underwent many changes. Changes in the worms started occurring a few days after I began the experiment. When I got the worms they had brownish skin, their skin was slimy, and they had active movement. During the first week all the pesticide worms lost pigmentation in their posterior end (see Tables A & B).

During the first week the skin of the worms in the Camicide container became less moist than the controlled worms. The second week their movement began to change. By the end of the experiment the

| TABLE A |
|-----------------|-----------------|-----------------|-----------------|
| Chemical Effects On Worms (October 4, 1996) |
| Camicide | Orthenex | Raid | Fertilizer |
| A | no change in color | no change in color | no change in color | no data |
| | very slow movement | fast movement | barely no movement | |
| B | no color change | no change in color | no change in color | |
| | very fast movement | barely any movement | barely any movement | |
| | did not want to be held | | | |

| TABLE B |
|-----------------|-----------------|-----------------|-----------------|
| Chemical Effects On Worms (October 8, 1996) |
| Camicide | Orthenex | Raid | Fertilizer |
| A | translucent end | translucent end | translucent end | no data |
| | very slow movement | very slow movement | fast movement | |
| | dry skin | | | |
| B | translucent end | translucent end | translucent end | |
| | fast movement | slow movement | fast movement | |

46
worms were moving slightly or not at all. The greatest change that occurred was the tumors growing on one of the worms. 

The major problem that occurred in the worms in the Orthenex containers was that the worms became very sensitive to touch. When I picked the worms up, their body became very hard and tight. When I touched the worms they moved very aggressively.

When I touched the worms they reacted in some type of movement. During the second week, I noticed the worms in the Raid containers did not respond to touch. One day I thought one of the worms was dead. It just lay motionless. When I looked closely at the worm, I could see a heartbeat (see Tables C & D).

I received my fertilizer close to the end of the experiment. Four days went by and I saw no change in the worms. From my observations, I concluded that the fertilizer had no effect externally on the worms (see Tables D & E).

At the end of the experiment, I was supposed to dissect the earthworms. Being attached to the worms and putting the worms through so much torture prevented me from performing the dissections. I let the worms go on October 20.

**CONCLUSION**

From the data I collected it was very apparent that all of the pesticides produced effects that were indiscriminate of there intended usage. The Camicide was more dangerous than the Raid and Orthenex. If you are trying to get rid of pests, among the three pesticides, Camicide would be the best to use. The fertilizer, on the other hand, did not seem to create any type of negative reaction with the test organisms.

It should be noted then that any use of pesticides around the home should be viewed cautiously because of the far reaching and unintended results of their application to organisms not intended for treatment.

**REFERENCES**

Oram, Raymond F., 1979, Biology of Living Systems; Bell & Howell Company.

**TABLE C**

Chemical Effects On Worms (October 10, 1996)

<table>
<thead>
<tr>
<th></th>
<th>Camicide</th>
<th>Orthenex</th>
<th>Raid</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>translucent end</td>
<td>fast movement</td>
<td>slow movement</td>
<td>no data</td>
</tr>
<tr>
<td></td>
<td>fast movement</td>
<td>translucent end</td>
<td>translucent</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>angry when touched</td>
<td>no response</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>sensitive to touch</td>
<td>when touched</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>translucent end</td>
<td>slow movement</td>
<td>slow movement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>slow movement</td>
<td>translucent</td>
<td>translucent</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>sensitive to touch</td>
<td>no response</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>angry when touched</td>
<td>when touched</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE D**

Chemical Effects On Worms (October 14, 1996)

<table>
<thead>
<tr>
<th></th>
<th>Camicide</th>
<th>Orthenex</th>
<th>Raid</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>noticed one of the worms has no clitellium</td>
<td>extremely sensitive to touch</td>
<td>no response when touched</td>
<td>no change</td>
</tr>
<tr>
<td>B</td>
<td>clitellum is changing, maybe it laid eggs</td>
<td>extremely sensitive to touch</td>
<td>no response when touched</td>
<td>no change</td>
</tr>
</tbody>
</table>
## TABLE E

Chemical Effects On Worms (October 17, 1996)

<table>
<thead>
<tr>
<th></th>
<th>Camicide</th>
<th>Orthenex</th>
<th>Raid</th>
<th>Fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>color: yellow movement: none tumors are growing on body</td>
<td>extremely sensitive to touch</td>
<td>no response when touched</td>
<td>no change</td>
</tr>
<tr>
<td>B</td>
<td>color: end of worm is translucent movement: slight</td>
<td>extremely sensitive to touch</td>
<td>no response when touched</td>
<td>no change</td>
</tr>
</tbody>
</table>
INTRODUCTION

Due to the large number of liver failures an adequate liver support must be established (8). For over thirty years, people have attempted to create a means of bioartificial liver support. One previous means of liver support was a non-woven fabric bioreactor created at the University of Tokyo that uses a bioartificial liver composed of non-woven fabric to fulfill the liver’s functions when the liver is not properly functioning (2).

In order to achieve a successful bioartificial liver, its support system capillarity must be increased from that presently achieved. The assistance of angiogenic factors should aid in the formation of new capillaries through the process known as angiogenesis, the growth of new blood vessels, or capillaries, from existing blood vessels (7). Endothelial Growth Factor (EGF) has been used as a factor that promotes angiogenesis in vitro to increase capillarity.

Hepatocyte spheroids, or aggregates of liver cells, have a tendency to cluster, or aggregate, together and form larger spheroids in which the interior hepatocyte spheroids can receive little to no oxygen. When hepatocytes do not get oxygen, they begin to die. Because of this, capillarity must be increased, possibly by co-culturing endothelial cells with hepatocytes. By doing this, oxygen can flow through the angiogenically generated capillaries thus delivering oxygen to the hepatocytes. The purpose of this study is to develop a successful method for increasing the capillarity, or number of capillaries in hepatocyte-endothelial co-cultures through the production of angiogenic capillaries. We have investigated the relationship between the co-culture conditions and the degree of capillarity.

MATERIAL AND METHODS

The capillarity was tested, in four different co-culture conditions: random, layered, pole, and co-aggregation (Table 1). Endothelial cells were obtained from Cell Systems Corporation and cultured in Rat Microvascular Endothelial Cell Medium for one week to allow them to grow. The medium was changed every three days during this week in sterile conditions to prevent the invasion of bacteria. Hepatocytes were isolated from a rat’s liver. The day before the isolation, two fifteen milliliter flasks were coated with 2% albumin solution in Hepes buffered saline solution and incubated overnight at 37°C.

The liver was isolated and removed according to accepted laboratory protocol. Under general anesthesia, the rat was placed in the supine position and the peritoneal cavity opened with a midline incision. The portal vein was catheterized, and physiological saline and heparin were infused. The remaining hepatoduodenal ligament, containing the proper hepatic artery and the common bile duct, was ligated and divided. The inferior vena cava was simultaneously divided in the cephalad and caudal directions of the liver for dehematization. After the entire liver had been resected the inferior vena cava was catheterized through the cephalad stump and ligated at the caudal stump to complete the perfusion circuit (2). Percoll density gradient centrifugation (PDGC) was done to remove other less dense cells from the hepatocytes. PDGC is a process of centrifuging cells in a solution in which the less dense matter floats to the top and the more dense hepatocytes sink to the bottom. The less dense cells are then removed by aspirating the liquid off.

While Percoll density gradient centrifugation was done, the endothelial cells were subcultured and prepared for co-culturing. The endothelial cells, shown in figure 1, were washed with Hepes buffered saline solution, and removed from the dish using five milliliters of trypsin enzyme.

After the cells were loosened from the dish, the cells were pipetted into a 10 mL (milliliter) sterile centrifuge tube, and 5 mL of 2% albumin solution was added to inhibit the trypsin activity. The cells were centrifuged in a 4°C environment at 1300 revo-
solutions per minute for five minutes. Then the cells were counted using a hemocytometer. Enough milliliters of cell containing medium was taken out to yield a total cell count of one million endothelial cells. The cells were labeled following the directions on the package insert using PKH26 Red Fluorescent Cell Linker Kit (Sigma Biosciences) for general cell membrane labeling. After labeling, the endothelial cells were placed in the refrigerator until needed. The single hepatocyte cells were counted using a hemocytometer and cell medium containing a suspension of two million hepatocyte cells was taken and placed in a ten milliliter centrifuge tube. These cells are shown in figure 2.

The 2% albumin coated flasks were taken out and placed into a sterilization hood. The one million endothelial cells were taken out of the refrigerator and placed in the sterilization hood along with the hepatocytes and the albumin coated flasks. The endothelial cells and hepatocytes were suspended together in ten milliliters of serum containing medium. The albumin was removed from the flask and the mixed cell containing medium was placed in the flask. Ten milliliters more serum containing medium was added to the flask. Sterile oxygen was blown into the cell containing flask until the medium turned an orange color.

While the cells were being placed in a 95% oxygen environment, an incubator shaker device was set up. This device and its components are shown in figure 3.

The cell containing flask is then placed inside the portable incubator shaker and shaken for thirty seconds at twenty minute intervals for fifteen hours.

During the fifteen-hour incubation shaking period, twenty milliliters of collagen gel was made by combining sixteen milliliters of collagen solution with

| TABLE 1.  |
| Co-Culture Experiments |
| Condition 1 | Condition 2 | Condition 3 | Condition 4 |
| Samples | 10 Samples (a-j) | 10 Samples (a-j) | 10 Samples (a-j) | 10 Samples (a-j) |
| Culture type | Mixed Culture | Mixed Culture | Mixed Culture | Mixed Culture |
| Arrangement | Random | Layered | Pole | Co-aggregates |
| Ratio (hepatocytes to endothelials) | 2:1 | 2:1 | 2:1 | 2:1 |
| Angiogenic Factor | EGF | EGF | EGF | EGF |
| Temperature | 37°C | 37°C | 37°C | 37°C |

Each condition had a total of ten trials after two runs of the experiment. In all trials, the environmental conditions remained constant.
four milliliters of 10X of Dubbeco’s Modified Eagle’s Medium (DMEM) (Sigma Chemical). The solution was kept at $\approx 15^{\circ}C$ while being made. The spheroids were taken out of the incubator shaker and then removed from the flask and placed in a centrifuge tube. The cells were centrifuged into a pellet, the medium was removed, the pellet was loosened, and the cells were resuspended in the collagen solution. The solution was mixed well by pipetting up and down carefully to prevent bubbles. Two milliliters of hepatocyte-endothelial spheroid containing collagen was plated in each of ten 3.5 centimeter dishes. These dishes made up condition four.

The other three types of co-cultures were done in a different way from the co-aggregation. In the random, layered, and pole approaches, spheroids were made out of hepatocytes alone. The endothelial cells were still labeled using the PKH26. Collagen was prepared in the same way, but the cells were plated in three different ways.

In the randomly seeded dishes of condition one, a layer of collagen containing hepatocyte spheroids and endothelial cells was seeded onto each of ten tissue culture dishes. In seeding the layered dishes of condition two, hepatocytes were placed in the collagen solution alone and then seeded on dishes. After the collagen solidified, endothelial cells were cultured on top of the collagen gel. The dishes in condition three were seeded at poles. Endothelial cells were placed into collagen alone and seeded at a $45^\circ$ angle on one side on the dishes. After the gel solidified, the other side of the dishes was seeded in the same manner using collagen containing hepatocyte spheroids.

In all four conditions, after the collagen solidified, another thin layer of collagen gel was placed on top of the cultures to ensure the longevity of the structure of the spheroids. One milliliter of serum containing medium was placed on all cultures after the collagen solidified and the dishes were incubated overnight.

Fresh culture medium was made containing angiogenic factor EGF. The base medium was DMEM, supplemented with 10% fetal bovine serum, 0.5 units/mL insulin, 20 µg/mL EGF, 7.5 µg/mL hydrocortisone, 50 µg/mL gentamicin, and sodium bicarbonate buffer. The supplemented DMEM medium on the cells was changed every other day and the cells were observed every day.

To determine if capillarity increased, the cells were embedded in paraffin wax. In all conditions, trials a through e were embedded after the collagen was digested with collagenase. This was done by placing collagenase into the dishes, and the collagen was allowed to dissolve. The liquid containing cells was then removed, centrifuged, and embedded. Trials f through j in all conditions were embedded without digesting the collagen with collagenase. In all trials, the cells were then fixed with 2% gluteraldehyde solution, dehydrated with an ascending series of ethanol (50%, 70%, 80%, 85%, 90%, 95%, and 100%), cleared with benzene, and embedded in paraffin wax. After these steps were performed the sample was placed in a mold and allowed to harden. Then the sample was sliced with a microtome using a diamond knife. After the slices were placed on glass slides, the wax was removed using Xylene solution. The cells were stained for 3 minutes with Harris’

**FIGURE 3. HEPATOCYTE AND ENDOTHELIAL CELL CO-AGGREGATION**

Diagram of the incubator shaker device used in the co-aggregation used to get endothelial-hepatocyte spheroids.
Hematoxylin and for 1 minute with 1% aqueous eosin solution. The slides were viewed under 40X magnification using a Nikon light and fluorescence microscope.

RESULTS

The seeding of the cells in all conditions was successful except for trial 4, samples a through e. However, after four days the collagen did not adhere to the dish in trials 2b and 3a, and the dishes were discarded. The remainder of the dishes in all four conditions were cultured successfully for eight additional days. After the eighth day, in trial 1 (samples a through e), an overwhelming growth of fibroblast was seen. No endothelial cells were seen in trial 3a through e, when observing the cells under a light microscope. Also after observation using fluorescence microscopy, no fluorescence could be seen. These dishes were discontinued, embedded, and stained.

The co-aggregation experiments lasted for a day or two longer than the random, layered, and pole co-cultures. The hepatocytes in trial 4 (samples f through j) were an unhealthy batch as determined by the live-dead cell count before seeding. Because of this, the cells did not aggregate in the co-aggregation portion of the experiment. The hepatocytes in trial 4 (samples a through e) were healthier cells as determined by the live-dead cell count. A picture of this culture is show in figure 4.

However, ten days into the incubation, bacterial growth was detected from an unknown source in all remaining trials. The remaining trials were then embedded and sectioned to determine if capillarity had been increased.

In all conditions, the embedding was more successful in dishes a through e in which the collagen was digested with collagenase. The trials f through j were embedded using the other method in which the collagen was not digested. In all conditions, dishes a to e contained a collagen membrane that shrank after dehydration, clearing, and heating.

The embedding and sectioning worked well for all samples f through j. However, during staining the samples floated off the slides into the various solutions used because they were not sufficiently secured to the slide. In all conditions, trials a through e the staining technique was successful because the samples were heat fixed to the slides. Figure 5 shows the results of the hepatocyte-endothelial spheroid.

FIGURE 4.

Hepatocyte-endothelial co-aggregation

FIGURE 5.

To the left is a sample of undigested collagen. To the right is a sample of digested collagen.
The definition of the collagenase digested sample is clearer than the sample where the collagen was not digested.

**DISCUSSION**

Increasing capillarity is expected to be the means for oxygenating cultures of hepatocytes as shown in the ideal structure in figure 6. This is expected to occur regardless of the type of co-culture with the assistance of the angiogenic factor EGF. However, it is necessary to show the differences between the four types of co-cultures in order to determine if capillarity was affected by the type of co-culturing performed.

Spheroid formation allows the cultures to last longer, because the spheroids are more stable than single cells. However, the difficulty in the spheroid formation is that cells are lost either by death or by non-aggregation in the aggregation process. Dishes of hepatocyte spheroids were compared to single hepatocyte cells to determine which possessed a greater longevity. Also, spheroids are easier to work with in comparison to single cells. Although all cultures became infected, the co-aggregation condition seemed to have the greatest longevity and was the simplest culture to seed and handle. This result was unexpected because all conditions were perceived to be capable of yielding equal capillarity.

The two embedding methods tested revealed that the best method for analyzing co-cultures is to digest the collagen using the collagenase solution. However, it is not known whether digesting the collagen destroys the structure of the specimen inside of the gel. Another method has been discovered using laser confocal microscopy to separate the layers of the collagen gel with a laser without destroying the structure of the specimen contained by the collagen.

**CONCLUSION**

The results of this study were inconclusive. No detectable capillarity was observed under any of the four culture conditions, using either light microscopy or after embedding and staining methods.

The bacteria that infected the dishes could have come from many sources, including an aged culture medium, unsterile storage conditions, unsterile isolation techniques, or unsterile culture conditions. Since the isolation technique was done by someone else, there was no control over the conditions by which the hepatocytes were obtained and their treatment prior to delivery for use in these experiments.

**FUTURE WORK**

We intend to repeat these culture conditions, making corrections to prevent contamination and to introduce a further culture condition using a new type of artificial capillary. This capillary would be made of a type of polymer or carbon based material that is porous and microscopic enough to be cultured with hepatocytes. A scaffold would have to be made to produce a capillary from this material small enough for hepatocyte spheroids to aggregate around it. A diagram of this is shown in figure 7.
REFERENCES


Diagram of future work with artificial capillary made of carbon of polymer tubing
Abstract: This investigation was part of a project designed to develop laboratory experiments to be used with a computer program called “MM3.” The computer program was designed to predict products of various chemical reactions and make calculations which can be used to determine the $K_{eq}$ and trans/cis ratio of the product(s). After using the computer program to make predictions, the reduction of 4-tert-butylcyclohexanone to 4-tert-butylcyclohexanol, using two different reagents, was carried out in the laboratory. Theoretical yields were then compared with actual yields. The Molecular Modeling 3 computer program proved to be effective in predicting the experimental trans/cis ratio of the products.

INTRODUCTION

This experiment is one part of a project to develop lab experiments for use with a computer program called MM3. This particular program can be used to predict “real results” of chemical reactions. The calculations obtained from the program can then be used to determine the $K_{eq}$ and trans/cis ratios of the products.

The particular reaction studied in this project was the reduction of 4-tert-butylcyclohexanone to 4-tert-butylcyclohexanol using either LiAlH$_4$ or Al(OC$_3$H$_7$)$_3$. Cis or trans products can be produced in this reaction, depending on the reaction conditions (Figure 1). Because functional groups exhibit characteristic infrared absorption bands, infrared spectroscopy was used to verify the presence of the products (Figures 2 and 3). Nuclear magnetic resonance spectroscopy was used to determine cis/trans ratios (Figure 4). Comparisons of the theoretical or computer generated results with the actual, experimental results were then used to ascertain the utility of the MM3 program.

EXPERIMENTAL METHOD FOR LiAlH$_4$

Reaction 1. In the reaction with LiAlH$_4$, 153g of 4-tert-butylcyclohexanone was dissolved, using 5 ml of ether under a nitrogen atmosphere, in a two-neck, round bottom flask. After the cyclohexanone completely dissolved, the flask was placed in an ice bath. One ml of LiAlH$_4$ solution was added dropwise, slowly, while stirring rapidly. The reaction stirred for 15 min, then 5 ml of 1M HCl was added to help identify the layers. The layers were then separated and the ether was dried with Na$_2$SO$_4$. The ether was evaporated and the product was obtained (.097g, 63%): $^1$H NMR (CDCl$_3$) $\delta$ 4.056, 3.6324; IR, 3300cm$^{-1}$.

Reaction 2. In the second reaction with LiAlH$_4$, 1 g of 4-tert-butylcyclohexone was dissolved in 2–3ml of ether under a nitrogen atmosphere, in a two-neck, round bottom flask. After the cyclohexanone completely dissolved, the flask was placed in an ice bath. .65 ml of LiAlH$_4$ solution was added dropwise, slowly, while stirring rapidly. The reaction was stirred for 15 minutes, then 3ml of 1M HCl was added to help identify the layers. The layers were then separated and the ether was dried with Na$_2$SO$_4$. Then the ether was evaporated and the product was obtained ($.028g$, 28%): $^1$H NMR (CDCl$_3$) $\delta$ 4.056, 3.6324; IR, 3300cm$^{-1}$ (Figures 5 and 6).

EXPERIMENTAL METHOD FOR Al(OC$_3$H$_7$)$_3$

Reaction 1. For the Al(OC$_3$H$_7$)$_3$ reaction, .153g of 4-tert-butylcyclohexanone was dissolved in 10 ml of isopropyl alcohol, under a nitrogen atmosphere, in a two-neck, round bottom flask. After the cyclohexanone completely dissolved, the flask was placed in an ice bath. .204g of Al(OC$_3$H$_7$)$_3$ was then added and the reaction refluxed for 1 hour. The solution was rotary evaporated, stopping at the
FIGURE 1. CIS AND TRANS ISOMERS OF 4-TERT-BUTYLcYCLOHEXANOL

This diagram shows that trans or cis products can be made, depending on the reaction conditions.

FIGURE 2. 4-TERT-BUTYLcYCLOHEXANONE:
INFRARED SPECTRUM
FIGURE 3. 4 TERT-BUTYLCYCLOHEXANOL: INFRARED SPECTRUM

FIGURE 4. 4 TERT-BUTYL CYCLOHEXANOL: NMR SPECTRUM SHOWING CIS/TRANS ISOMERS
This diagram represents the reaction between 4-tert-butylcyclohexanone and lithium aluminum hydride. On the left is 4-tert-butylcyclohexanone. When it is reacted with the LiAlH₄ in a 1 M ether solution, 4-tert-butylcyclohexanol is formed.

This mechanism represents how the reactions with LiAlH₄ take place. First the hydride bonds to the carbonyl carbon to form an alkoxide. Then the proton bonds with the oxygen to form the alcohol.
This mechanism represents how the reaction with $\text{Al(OC}_3\text{H}_7)_3$ takes place. First the hydride bonds to the carbonyl carbon to form an aluminum alkoxide and acetone. The isopropyl alcohol protonates the alkoxide forming the alcohol. The isopropyl anion rejoins with aluminum salt, regenerating the $\text{Al(OC}_3\text{H}_7)_3$.
paste stage. When the stage was acquired, 50 ml of water and 20 ml of ether were added to identify the layers. The ether layer was separated using a separatory funnel. The ether was then evaporated and the product was isolated (.113g, 73%); 1H NMR (CDCl3) 4.056, 3.6324; IR, 3300cm⁻¹.

Reaction 2. In the second reaction with Al(OC₃H₇)₃, .153g of 4-tert-butylcyclohexanone was dissolved in 10 ml of isopropyl alcohol, under a nitrogen atmosphere, in a two-neck round bottom flask. .051g of the Al(OC₃H₇)₃ was added and the reaction was then refluxed for 1 hour. The solution was evaporated, stopping at the paste stage. When the paste stage was reached, 45 ml of water and 15 ml of ether were added to identify the layers. The ether layer was separated by way of separatory funnel. The ether was evaporated and the product was isolated. Only starting material was recovered (.09g, 58%); IR, 1700cm⁻¹.

Reaction 3. The reaction with Al(OC₃H₇)₃ was run on a microscale basis using 100 mg of the 4-tert-butylcyclohexanone dissolved in 10 ml of isopropyl alcohol, under a nitrogen atmosphere, in a two-neck round bottom flask. .133g of Al(OC₃H₇)₃ and 1 ml of acetone were added. The reaction was refluxed for 1 hour. The solution was rotary evaporated, stopping at the paste stage. When the paste stage was reached, 40 ml of water and 15 ml of ether were added to identify the layers. The ether layer was separated by way of a separatory funnel. The ether was evaporated and the product was isolated (.11g, 110%): 1H NMR (CDCl₃) 4.056, 3.6324; IR, 3300cm⁻¹.

Reaction 4. This reaction with Al(OC₃H₇)₃ was again run on a microscale basis; dissolving 100 mg of the 4-tert-butylcyclohexanone in 10 ml of isopropyl alcohol, under a nitrogen atmosphere, in a two-neck, round bottom flask. .133g of Al(OC₃H₇)₃ and 1 ml of acetone were added. The solution refluxed for 2 hours. The solution was rotary evaporated, stopping at the paste stage. When the paste stage was reached, 40 ml of water and 15 ml of ether were added to identify the layers. The ether was evaporated and the product was isolated (.09g, 89%): 1H NMR (CDCl₃) 4.056, 3.6324; IR, 3300cm⁻¹ (Figures 7 and 8).

RESULTS

Using the first reduction method, LiAlH₄ completely reacted with 4-tert-butylcyclohexanone to produce an alcohol. In the first reaction using this method, .001 moles of each substance was used, which resulted in a yield of 63%. The second reaction was run on a microscale basis; 100 mg of the starting material was utilized. A yield of 28% was obtained. The product was identified using infrared spectroscopy and NMR spectroscopy was used to determine the trans/cis ratio of the product. The calculated trans/cis ratio of 11.2 was way off the theoretical value of 3.2, obtained from the MM3 computer program. This information indicated that the reaction was irreversible and would not equilibrate (Figure 9).

The reduction reactions using aluminum isopropoxide yielded much better results. With this reagent, a 73% yield was obtained and the trans/cis ratio was determined to be 1.6, a value much closer to the computer generated value of 3.2.

The second reduction, using only 25% the amount of aluminum isopropoxide as in the first reaction, was performed to determine if the aluminum isopropoxide could be used as a catalyst. Only the starting material was recovered, indicating that stoichiometric quantities of aluminum isopropoxide must be used to produce the alcohol.

The third and fourth reductions were performed on a microscale level, but acetone was also used. The acetone was added in an attempt to produce a better trans/cis ratio, by pushing the reaction to equilibrium. The first microscale reaction, which was refluxed for 1 hour, resulted in a yield greater than 100%, probably due to wet product. This may have been caused by absorbed water vapor during the ether evaporation process. The calculated trans/cis ratio was 2.3, compared with the theoretical value of 3.2 (Figure 9).

To determine if the equilibrium had been reached, another microscale reaction was performed, this time refluxing for 2 hours. The additional time was added to allow more time for the reaction to equilibrate.
This method resulted in an 89% yield and a 2.12 trans/cis ratio. It appeared that the equilibrium point had been reached (Figure 9).

CONCLUSION

During this project, two lab experiments involving the reduction of 4-tert-butylcyclohexanone to 4-tert-butylcyclohexanol were developed. Two separate reagents, lithium aluminum hydride and aluminum isopropoxide, were used in these reductions. Using the MM3 program to develop these lab experiments helped to prove that the program could closely predict “real results” for chemical reactions. In performing the two reductions, it was also learned that the reaction involving the lithium aluminum hydride was an irreversible one and that the reaction involving the aluminum isopropoxide was reversible, but had to be run using stoichiometric quantities.

ACKNOWLEDGMENTS

I would like to thank the Hughes Institute for giving me the opportunity to work on this project, the National Science Foundation for the grant to get the computer with the MM3 program, Dr. Benjamin Gung of Miami University for coming up with the lab experiment idea, and Dr. James Hershberger of Miami University for being a great mentor. Also, a special thanks to Ben Williams for help in the lab and to Kenneth Chan for producing great NMR spectra.

BIBLIOGRAPHY

Abstract: The goal of this project is to analyze the fluctuating pressure around an oscillating cylinder in crossflow and relate it to vortex shedding effects. The effects to be analyzed include the changes in unsteady lift and drag. Lift vs. Displacement maps were mainly used to understand these effects. To measure the fluctuating pressure, several hearing aid microphones were placed on the circumference of the cylinder and a potentiometer was employed to measure the amplitude of the cylinder oscillation.

INTRODUCTION

The Navy tows instrument packages from their ships and submarines. Flow induced vibrations can cause damage to the instruments, affect their readings, and cause failure in the tow cable. Therefore the goal of this project is to develop a model of flow induced vibration in towed cables. The objective of the current experiments was to measure the energy transfer between the flow field and the cylinder. This was accomplished by measuring the instantaneous pressure with the array of microphones. Then from the pressure measurement the fluctuating lift and drag were computed.

EXPERIMENTAL SETUP

The experimental setup consisted of the following: a cylinder, an aluminum ring, two end plates, 18 microphones, and a servo motor. The cylinder is made out of aluminum and its dimensions are 1.5 inches diameter and about 25 inches long. The aluminum ring is located at half the length of the cylinder and contains the 18 microphones. The 18 microphones are the EM-3068 from Knowles Electronics Inc. The end plates are made of 1/8 inch Plexiglas and their use is to reduce the boundary layer effects. The servo motor is connected to the cylinder via the use of a linkage that converts rotational motion into translational motion. The way the cylinder is arranged can be observed in Figure 1.

The calibration of the microphones was performed by submitting the two microphones to a noise signal, and recording their voltage outputs. The noise signal for the calibration was produced by a Gaussian noise generator, a power amplifier, and a 12 inch speaker. In performing the calibration, two multimeters were used to measure the voltage output from each microphone. Both the Larson-Davis microphone and the Knowles microphone were placed in front of the speaker and the voltages for each one were recorded. This procedure was repeated for each of the 18 microphones. The outputs of the Knowles microphones were compared to the standard. Since the calibration for the Larson-Davis microphone is known, a relationship was established between the output of the Knowles microphones and the pressure. Figures 1 and 2 show the location of the different components with respect to the cylinder. The motion of the cylinder is perpendicular to the flow.

The components of lift and drag were calculated by integrating the pressure around the azimuth of the cylinder. This can be approximated by the integral of the pressure coefficient times the sine of the azimuthal position ($\theta$) for the lift and the cosine for the drag ($\text{Lift} = \int C_p \sin \theta d\theta$ and $\text{Drag} = \int C_p \cos \theta d\theta$).
The following figures show some of the results obtained. The bare winding number stands for the ratio between the frequency at which the cylinder is forced to oscillate and the vortex shedding frequency.

Figure 3 is a phase plot at a bare winding number of 1. The x-axis of the plot is the lift at time t and the y-axis is the lift at a sampling period later.

Figure 4 and Figure 5 show two lock-in cases. Figure 4 is at a bare winding number of one and Figure 5 is at bare winding equal to 0.5. Bare winding number of 5 indicates that the cylinder is being forced to oscillate at half the vortex shedding frequency. The abscissa is the cylinder displacement and the ordinate is the unsteady lift. Looking at the two plots it can be observed that there is a definite correlation between the lift and the cylinder displacement.

Figure 6 is the same as Figures 4 and 5, but at a bare winding number of 0.83. Observe that there is no correlation between the lift and the displacement. This case corresponds to bare winding number where...
lock-in does not occur. Notice the rather random trajectory.

CONCLUSION

The setup was able to measure the fluctuating components of lift and drag. The microphones acquired the pressure and then using the relationship stated before the lift and drag was computed.

The other important conclusion derived from this project is that the correlation between lift and displacement indicates lock-in. At lock-in a definite relationship exists as indicated by the trajectory, but when the system is not at lock-in the results are as shown in Figure 6.

FUTURE WORK

The next step in this project is to analyze the behavior of a free oscillating cylinder. The free oscillating cylinder will consist of the same cylinder held at the ends by two springs. In this way the cylinder will be free to oscillate due to the vortex shedding. The data acquired from the free oscillating case will be compared to the results obtained in the forced case.

REFERENCES


Blackburn, Hugh, Henderson, Ron. *Wake Dynamics in Flow Past an Oscillating Cylinder*. 
Abstract: In efforts to understand the mechanism of morphogenesis, previous studies in the Baskin Lab and elsewhere have identified a number of compounds that disrupt root morphology. My experiment asked whether or not the effects of some of these inhibitors are reversible. Seedlings of the model plant Arabidopsis thaliana were exposed to the inhibitor for two days and then grown on fresh media without the inhibitor. Root diameter and elongation were then measured and the data from these measurements were analyzed. The effects of some of the compounds were reversible, which indicated that these specific compounds are not toxic. On the other hand, the effects of other compounds were not reversible, indicating that these may be exerting toxic effects in addition to their effects on root morphology. I have expanded the study in an experiment that is now in progress involving temperature-sensitive mutants in Arabidopsis thaliana whose phenotype is an altered root morphology. This experiment asks whether any of the mutant phenotypes are reversible. To do this, 1 week old seedlings were transferred to 30 degrees for three days to elicit maximum change in morphology, and the seedlings were shifted back to 19 degrees (normal growth temperature). Root elongation and diameter were then measured over the following week at daily intervals. So far, I have found lines which recover and other lines which do not.

INTRODUCTION

An important problem is understanding how plant morphology is controlled. One useful approach to this problem is through the use of herbicides and other compounds that disturb the morphology of higher plants (Hess et al., 1987; Vaughn and Lehnen, 1991). These compounds are diverse chemically and have different targets. Recent research in the Baskin Lab has involved characterizing the effects of some of these compounds on the morphology of roots of Arabidopsis thaliana (Baskin and Bevins, 1995; Baskin and Wilson, 1997; Baskin et al., 1994; Smith et al., 1994). We use roots because they grow rapidly and are convenient for assessment of morphology by measuring elongation and diameter. However, our lab has not examined whether the effects that these compounds exert on the roots are reversible. In this paper, I report results of our first experiments of this kind, examining the reversibility of several compounds with different targets. In addition, I have expanded the research to include temperature-sensitive root morphology mutants, which also disrupt the morphology of the root (Baskin et al., 1992).
plates were used for each treatment. The seedlings were exposed to the compound for two days. On the second day, the plates were observed under a microscope and the diameter of the seedlings was measured on a computer interfaced to the microscope. On the control seedlings, the measurement was taken where the first root hair appeared, but on the treated seedlings the measurement was taken where the largest swelling appeared.

Next, the seedlings were transferred from the treatment plates onto plates with fresh agar medium that did not contain the compound. To measure elongation, tick marks were made on the back of the plate at the position of each root tip. The plates were ticked at the time of transplanting and 24 hours later, and the plates were photocopied 48 hours later, so elongation over the first and second day of recovery could be measured. The diameter was once again measured as above. Then, from the photocopies, the elongation rate was measured with a digitizing tablet.

The root morphology mutants were plated onto normal agar nutrient media, ten to fifteen seeds per plate, two plates per mutant type. After seven days, the plates were transferred to 30° C to express the mutant phenotype for two days. The mutants were then returned to 19° C for five additional days. On each day a tick mark was also made at the tip of each root. On the fifth day, the plates were photocopied and the diameters of 10 roots per treatment were measured at each tick mark as described above. From the photocopies of the roots, elongation rates were measured.

RESULTS

In the experiment with the root morphology mutants, there were some mutants that didn’t recover well in both elongation and diameter. For example, in mutant rsw\textsubscript{2.3} there was only some recovery in elongation but full recovery in diameter. However, for other mutants there were signs of recovery in both elongation and diameter. For instance, for mutants rsw\textsubscript{4}, rsw\textsubscript{6}, and rsw\textsubscript{7} there was complete recovery in both elongation and diameter.

In experiments with inhibitors, I have found that for some of the compounds, such as oryzalin (low concentration) and DCB, the effects on diameter were reversible (Table 1). On the other hand, I have found that for higher concentrations of oryzalin as well as for colchicine, cantharidin, and staurosporine, root diameter did not recover and in some cases actually increased (Table 1). In contrast to root diameter, elongation rates did not recover for any treatment (Table 2). Oryzalin and DCB had an inhibited elongation that did not recover during the experiment—even though for DCB and for the low concentration of oryzalin the diameter did recover (Table 2).

In a few of the experiments with the compounds, seedlings were allowed to grow for two to three more days and the same measurements as above were taken. In these cases, there was still no recovery observed.

DISCUSSION

In experiments with inhibitors and mutants, effects on elongation rate are separable from the effects on diameter. Both the mutants and compounds cause root diameter to increase over a certain amount of time, and both cause elongation rate to decrease over the same time. However, during the recovery period, these changes seem to be reversed in some treatments. In other words, the diameter becomes smaller and elongation rates increase, both of which appear to be closer to normal than before. However, in all cases the effects on diameter recover sooner or more completely than effects on elongation. These observations lead me to conclude that there is possibility of reversibility in temperature-sensitive root morphology mutants and in roots treated with certain compounds.

In these experiments we chose compounds that have different targets. Oryzalin and colchicine both disrupt microtubules (Hugdahl and Morejohn, 1993), DCB inhibits the synthesis of cellulose (Montezinos and Delmer, 1980), and cantharidin and staurosporine are inhibitors of protein phosphorylation (MacKintosh and MacKintosh, 1994). Additionally, the root morphology mutants used have lesions in distinct targets although these have not been identified in all cases. The similar results on reversibility suggests that the physical disruption of morphology may itself impede recovery.

ACKNOWLEDGMENTS

I would like to acknowledge Jan E. Wilson for providing services during my experiments and I would also like to acknowledge Allison M. Dennings for providing the root morphology mutants.

This work was supported in part by the Cooperative State Research Service, U.S. Department of Agriculture, under agreement No. 92-37304-7868 to Tobias I. Baskin, University of Missouri at Columbia Department of Biological Sciences.
TABLE 1.
Reversibility of Root Diameter

**ROOT DIAMETER (in microns)**

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>2ND DAY ON</th>
<th>2ND DAY OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTROL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(average of 12 plates ± SE)</td>
<td>152 ± 3.0</td>
<td>170 ± 4.2</td>
</tr>
<tr>
<td><strong>ORYZALIN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300nM P1</td>
<td>275 ± 27.3</td>
<td>167 ± 20.8</td>
</tr>
<tr>
<td>300nM P2</td>
<td>305 ± 28.2</td>
<td>170 ± 27.4</td>
</tr>
<tr>
<td>1µM P1</td>
<td>483 ± 65.6</td>
<td>557 ± 70.8</td>
</tr>
<tr>
<td>1µM P2</td>
<td>462 ± 59.9</td>
<td>533 ± 66.8</td>
</tr>
<tr>
<td><strong>DCB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300nM P1</td>
<td>386 ± 41.6</td>
<td>125 ± 21.7</td>
</tr>
<tr>
<td>300nM P2</td>
<td>353 ± 41.6</td>
<td>123 ± 16.8</td>
</tr>
<tr>
<td>1µM P1</td>
<td>361 ± 37.5</td>
<td>129 ± 27.3</td>
</tr>
<tr>
<td>1µM P2</td>
<td>341 ± 26.8</td>
<td>98 ± 21.5</td>
</tr>
<tr>
<td><strong>COLCHICINE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150µM P1</td>
<td>543 ± 34.9</td>
<td>612 ± 55.9</td>
</tr>
<tr>
<td>150µM P2</td>
<td>575 ± 22.9</td>
<td>652 ± 53.7</td>
</tr>
<tr>
<td>250µM P1</td>
<td>585 ± 41.7</td>
<td>675 ± 44.4</td>
</tr>
<tr>
<td>250µM P2</td>
<td>579 ± 41.9</td>
<td>670 ± 46.6</td>
</tr>
<tr>
<td><strong>CANTHARIDIN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30µM P1</td>
<td>220 ± 25.4</td>
<td>218 ± 34.9</td>
</tr>
<tr>
<td>30µM P2</td>
<td>223 ± 28.5</td>
<td>220 ± 29.1</td>
</tr>
<tr>
<td><strong>STAUROSPORINE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1µM P1</td>
<td>277 ± 50.1</td>
<td>217 ± 74.9</td>
</tr>
<tr>
<td>1µM P2</td>
<td>238 ± 28.3</td>
<td>266 ± 39.3</td>
</tr>
</tbody>
</table>

This table shows the root diameter in each experiment. The column labeled “2nd day on” gives the diameter after two days of exposure to the tested compound. From this column it can be seen that each compound caused root swelling. The column labeled “2nd day off” gives the diameter after two days of recovery. Data are means of 8–10 seedlings ± standard deviation.
### TABLE 2.

**Reversibility of Root Elongation**

*ROOT ELONGATION RATE (in cm/day)*

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>1ST DAY OFF</th>
<th>2ND DAY OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTROL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(average of 12 plates ± SE)</td>
<td>1.41 ± 0.09</td>
<td>1.22 ± 0.10</td>
</tr>
<tr>
<td><strong>ORYZALIN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300nM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.14 ± 0.31</td>
<td>0.16 ± 0.06</td>
</tr>
<tr>
<td>P2</td>
<td>0.12 ± 0.02</td>
<td>0.14 ± 0.07</td>
</tr>
<tr>
<td>1µM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.18 ± 0.04</td>
<td>0.11 ± 0.09</td>
</tr>
<tr>
<td>P2</td>
<td>0.15 ± 0.05</td>
<td>0.04 ± 0.07</td>
</tr>
<tr>
<td><strong>DCB</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>300nM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.38 ± 0.22</td>
<td>0.28 ± 0.23</td>
</tr>
<tr>
<td>P2</td>
<td>0.33 ± 0.12</td>
<td>0.22 ± 0.12</td>
</tr>
<tr>
<td>1µM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.27 ± 0.04</td>
<td>0.14 ± 0.08</td>
</tr>
<tr>
<td>P2</td>
<td>0.22 ± 0.04</td>
<td>0.11 ± 0.05</td>
</tr>
<tr>
<td><strong>COLCHICINE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500nM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.04 ± 0.01</td>
<td>0.03 ± 0.02</td>
</tr>
<tr>
<td>P2</td>
<td>0.06 ± 0.04</td>
<td>0.00 ± 0.00</td>
</tr>
<tr>
<td>1µM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.01 ± 0.02</td>
<td>0.05 ± 0.02</td>
</tr>
<tr>
<td>P2</td>
<td>0.00 ± 0.00</td>
<td>0.10 ± 0.02</td>
</tr>
<tr>
<td><strong>CANTHARIDIN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30µM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.06 ± 0.02</td>
<td>0.06 ± 0.01</td>
</tr>
<tr>
<td>P2</td>
<td>0.06 ± 0.03</td>
<td>0.01 ± 0.02</td>
</tr>
<tr>
<td><strong>STAEOPOSPORIN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1µM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>0.06 ± 0.01</td>
<td>0.07 ± 0.02</td>
</tr>
<tr>
<td>P2</td>
<td>0.05 ± 0.02</td>
<td>0.01 ± 0.02</td>
</tr>
</tbody>
</table>

This table shows the root elongation rate in each experiment. The elongation rate was not measured while the roots were on the drug. The two columns show elongation that was measured on the first and second day off the drug. Data are means of 8–10 seedlings per plate ± SD.
REFERENCES


Hugdahl, JD; Morejohn, LC (1993): Rapid and reversible high affinity binding of the dinitroaniline herbicide oryzalin to tubulin from *Zea mays* L. Plant Physiol. 102, 725–740.


Abstract: The unimolecular kinetics of cyclobutylcarbinyl radical reactions have been studied by laser flash photolysis (LFP). The pyridine-2-thione-N-oxy-carbonyl (PTOC) esters 12 and 13 were precursors of alkyl and \( \alpha \)-ethoxycarbonyl radicals. The unimolecular kinetic design permits evaluation of the effect of substituents on the rate of rearrangement. In a seemingly counterintuitive manner, the radical stabilizing ester group accelerates the rearrangement.

INTRODUCTION

The radical stabilizing effect of an alkoxycarbonyl group is well recognized. On the basis of bond dissociation energies, an alkoxycarbonyl stabilizes a radical center by about 3 kcal/mol in comparison to an alkyl group. \(^1\) Stabilization of incipient \( \alpha \)-alkoxycarbonyl substituted radical products is generally regarded as the major contributor to the acceleration of radical addition reactions that form these products in comparison to the analogous reactions that give simple alkyl radical products.

It might seem that one should observe an opposite kinetic effect when stabilized radicals participate in a reaction, that is, that \( \alpha \)-alkoxycarbonyl substituted radicals will react less rapidly than alkyl radicals, but this is not the case in general. Intermolecular additions of the (\( \text{tert-} \)butylocarbonyl)methyl radical to simple alkenes \(^2\) are faster than additions of the methyl radical to the same alkenes, \(^3\) and cyclizations of \( \alpha \)-ethoxycarbonyl substituted radicals \( 1 \) are faster than cyclizations of secondary radicals \( 2 \). \(^4\)

These results may be explained by considering the total energies of the reactions and the fact that the transition states for reactions (which do not differ greatly for the alkoxycarbonyl- and alkyl-substituted cases) of alkoxycarbonyl-substituted radicals can be polarized. We report here the direct kinetic studies of the ring opening of cyclobutylcarbiny1 by laser flash photolysis methods that show that \( \alpha \)-ethoxycarbonyl-substituted radicals fragment faster than their alkyl-substituted analogs, apparently due to polarized transition states.

EXPERIMENTAL

The PTOC precursors employed in this study were prepared by a common route as shown in Scheme 1. \(^5\) Alkylation of diethyl malonate 3 with cinnamyl chloride 4 gave the diester 5. Treatment of the diester with HBr gave the brominated diester 6. The brominated diester was treated with NaH to effect cyclization to produce 7 followed by saponification of the ester to give the substituted cyclobutane diacid, which upon heating decarboxylates to the mono acid 8. The mono acid is a mixture of cis and trans isomers. Separation of the two isomers can be achieved by recrystallization of the cis isomer from of the mixture. The trans isomer is formed by treatment of the acid with concentrated sulfuric acid and isobutylene yields the hindered t-butyl ester 9. This ester upon treatment with base is epimerized to the thermodynamically favored trans isomer 10. The ester can then be converted to the trans acid 8 by treating the ester with formic acid. Treatment of the acid with oxalyl chloride followed by addition of diazomethane and exposure to UV light in ethanol leads to the homologated cyclobutane ester 11. This ester could be alkylated to give the mono or dimethylated
adducts. Also this ester 11 was used to prepare the carboethoxy derivatives by treatment of the ester with LDA followed by ethyl cyanoformate. The malonate was hydrolyzed to the monoester, mono acid which could then be used to prepare the PTOC 13. In the preparation of the PTOC ester, the cyclobutane ester 11 was converted to the corresponding acid then to the acyl chloride and then to the PTOC ester 12 by reaction with the sodium salt of N-hydroxypyridine-2-thione. The crude reaction products were purified by silica gel chromatography. The acids were characterized by NMR and high resolution mass spec and the PTOC esters by NMR.

The substituted cyclobutyl derivatives provide a facile entrance into radical kinetics. The radicals are fast enough that complicating side reactions do not occur, but slow enough they can be measured by our LFP system. The experimental design followed the general method shown in Scheme 2. PTOC esters were used as radical precursors for studies conducted with a 2 ns resolution kinetic spectrometer. The PTOC radical precursors 12 have a long wavelength absorbance λ_max at 350–370 nm and are cleaved by 355 nm light from a Nd-YAG laser to form an acyloxy radical 14 and the 2-pyridylthiyl radical 15. Rapid decarboxylation of acyloxy radical intermediates gave radicals that ring opened to 16. The rate of formation of the alkyl radical was followed by monitoring the absorbance of the benzylic radical products 16 at λ_max 318 nm. The 2-pyridylthiyl radical 15 absorbs at λ_max 490 nm.

RESULTS AND DISCUSSION

Direct kinetic studies of the ring opening of radicals were obtained with THF solutions of PTOC ester flowing through a cell in a laser based kinetic spectrometer. The growth of the signal from the benzylic radical species at 320 nm was monitored. The resulting signal was then solved with a single exponential that gave the rate of formation. A typical kinetic trace and time resolved spectrum can be seen in Figure 1. The time resolved spectrum shows the growth of the signals arising from 2-pyridylthiyl radical 15 and benzylic radical 16. The growth can be seen as peaks around 320 nm and 490 nm respectively.
The radicals were studied at temperatures between –20°C and 50°C. The precision of the measured rate constants deserves comment. Each kinetic value is an average of multiple, typically 15, individual measurements. The individual measurements often had uncertainties at 2σ and were below the 5% of the value. The experimental rate constants at 20°C are given in Table 1. From Table 1 the expected rates of rearrangement for 17a, 18a, and 19 were predicted by considering the thermodynamic stabilities of the radical. Tertiary radical 19 is more stable than the secondary radical 18a which in turn is more stable than primary radical 17a. The more stable a radical is the slower it is to rearrange. Our observed rates of rearrangement are in agreement with the thermodynamic prediction. However when considering radical 17b and 18b, the secondary radical 18b is faster than the primary 17b. In this situation an unfavorable steric interaction occurs that causes the rearrangement to be accelerated. We were interested in studying the effect of substituents and not steric interactions, so we choose to not continue use of the cis compounds.

The α-carboethoxy PTOC were much more reactive than the corresponding alkyl PTOC. The correlation between thermodynamic stabilities and rate of
rearrangement should continue in this system as well. The secondary α-carboethoxy 20 ring is expected to ring open at a rate faster than our instrument responds. Consequently, we are in the process of making modifications that will allow us to determine the rate. The tertiary α-carboethoxy 21 is sufficiently slow that we can measure the rate of rearrangement. The tertiary α-carboethoxy is an order of magnitude faster than the corresponding alkyl derivative.

The rate constant for fragmentation of radical 18a was not affected by solvent identity. The absence of solvent effect is the first direct observation of this phenomenon for a small ring radical fragmentation reaction. However, it has been generally assumed that radical kinetics are insensitive to solvent, especially in the case of simple alkyl radical reactions, and an indirect study of cylopropylcarbinyl radical ring opening kinetics in various solvents indicated no appreciable solvent effect.9

The rate constant for the ring opening of radical 21 were more interesting. Not only did this radical fragment more rapidly than its alkyl radical counterpart 19, but also a solvent effect on the kinetics was apparent, and this effect clearly seems to be related to solvent polarity. The solvent effect on the rate of ring opening of 21, especially when 18a demonstrated no
such effect, strongly implicates a polarized transition state for 21. A polarized transition state is also suggested by the fact that 21 rearranges more rapidly than 18 because the ring opening of 18a is more exergonic than that of 21 by about 1.5–2 kcal/mol.

CONCLUSION

In conclusion, despite an intuitive notion that the radical stabilization afforded by an α-alkoxycarbonyl group might slow reaction of these species, kinetic accelerations in reactions of ester-substituted radicals in comparison to alkyl radicals reactions have now been demonstrated for intermolecular addition to alkenes,2,3 cyclizations,4 and fragmentations. The less favorable reaction exergonicites for the substituted radicals are offset in the transition states by favorable polarizations, and solvent effects, an acceleration in solvents with high dielectric constants, should be expected for most ester substituted radical reactions.

ACKNOWLEDGMENT

This work was supported by grants from the National Science Foundation and the National Institutes of Health. I would like to thank my group members for their unselfish assistance and my advisor Dr. Martin Newcomb for his guidance.

REFERENCES AND NOTES

5. Compound 8 was originally prepared by Beard & Burger.6
8. All of the values in Table 1 are in THF at 20°C unless otherwise noted.
LEARNING CENTER/EXHIBITS
CONFERENCE SESSIONS
CONFERENCE SESSIONS
REGIONAL CONFERENCE

DIVERSITY IN THE SCIENTIFIC AND TECHNOLOGICAL WORKFORCE

November 18-20, 1996
Westin Hotel Renaissance Center
Detroit, Michigan

CONFERENCE PROGRAM

NATIONAL SCIENCE FOUNDATION
DIRECTORATE FOR EDUCATION
AND HUMAN RESOURCES
MONDAY, NOVEMBER 18, 1996

7:30 a.m. - 5:00 p.m.
Ontario Foyer

CONFERENCE REGISTRATION

12 noon - 6:00 p.m
Cabot/Mackinac Ballroom

EXHIBIT HALL OPEN/TECHNOLOGY LEARNING CENTER OPEN

12 noon - 1:45 p.m
Columbus

OPENING SESSION

Presiding: David L. Snead, General Superintendent, Detroit Public Schools

Greetings: Honorable Dennis W. Archer, Mayor, City of Detroit

Greetings: Honorable Irma Clark, President, Detroit Board of Education

Overview: Luther S. Williams, Assistant Director, Education and Human Resources (EHR), National Science Foundation (NSF)

Keynote Speaker: Claudia I. Mitchell-Kernan, Vice Chancellor, Academic Affairs, and Dean, Graduate Division, University of California, Los Angeles

Conference Program: Juanita Clay Chambers, Project Director, Urban Systemic Initiative and Director, Office of Mathematics and Science, Detroit Public Schools

2:00 p.m. - 3:30 p.m.
Cartier

PANEL: ASSESSMENT IN EDUCATION REFORM

Presiding: Hanley Abramson, Associate Dean of Pharmacy, Wayne State University, Principal Investigator Metropolitan Detroit Alliances for Minority Participation Project

Moderator: Sharon Lewis, Assistant Superintendent Department of Research, Development and Coordination Detroit Public Schools

Panelists: Edward Roeber, Director, Student Assessment Programs, Council of Chief State School Officers

Sharif Shakkani, Branch Chief, National Center for Educational Statistics

Adrienne Bailey, Senior Consultant, Council of Great City Schools

Sylvia Johnson, Editor-in-Chief, Journal of Negro Education and Professor of Psychoeducation, Center for Research on the Education of Students Placed at Risk, Howard University
**Monday, November 18, 1996 -- continued**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
</table>
| 3:45 p.m. - 5:00 p.m. | FOLLOW-UP SESSIONS: ASSESSMENT ISSUES  
North Central Regional Educational Laboratory (NCREL), Staff Facilitators  
- Assessing the Constructivist Curriculum  
  Performance Assessment  
- LaSalle  
  New Directions: Assessment In Support of Student Learning  
- Brule  
  Equity In Assessment  
- Nicolet  
  Components of the Assessment |

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
</table>
| 3:45 p.m.- 6:45 p.m. | STUDENT ORIENTATION AND DINNER  
(Reduced for all student presenters) |

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
</table>
| 5:00 p.m. - 7:00 p.m. | DINNER  
(On your own) |

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
</table>
| 7:00 p.m. - 8:00 p.m. | TOWN MEETING (Televised) CANCELLED  
**Moderator:**  
Darryl Wood, Channel 56  
**Participants:**  
Luther S. Williams, Assistant Director, EHR/NSF  
Jane Butler Kahle, Condit Professor of Science Education, Miami University  
David L. Snead, General Superintendent, Detroit Public Schools  
Richard Blouse, President, Greater Detroit Chamber of Commerce  
Ramona Edelin, President and CEO, National Urban Coalition |

<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
</tr>
</thead>
</table>
| 8:00 p.m. - 10:00 p.m. | STUDENT MIXER  
**Riverfront Ballroom** |
7:30 a.m. - 8:30 a.m. CONTINENTAL BREAKFAST
Columbus

8:00 a.m. - 6:00 p.m. CONFERENCE REGISTRATION
Columbus Foyer

8:00 a.m. - 6:00 p.m. EXHIBITS/TECHNOLOGY LEARNING CENTER OPEN
Cabot/Mackinac Ballroom

8:30 a.m. - 10:15 a.m. PANEL: A DIVERSE SMET* WORKFORCE - THE RETURN ON INVESTMENTS: A BUSINESS PERSPECTIVE
Cartier

Presiding: Elmima C. Johnson, Staff Associate, Office of the Assistant Director, EHR/NSF

Moderator: Luther S. Williams, Assistant Director EHR/NSF

Panel Members: Raymond Beyers, Jr., Manager, Contributions Programs, Ford Motor Company
Diana Garcia Prichard, Research Scientist, Photocience Research Division, Eastman Kodak Co.
James R. Bray, Vice President, Data Collections Systems, National Computer Systems
Richard J. Schaar, Senior Vice-President, Calculator Products, Business Manager, Texas Instruments
Lynwood L. Battle, Manager, Diversity, The Procter and Gamble Company

10:15 a.m. - 10:30 a.m. BREAK

10:30 a.m. - 12 noon STUDENT POSTER PRESENTATIONS
Cabot

10:30 a.m. - 12 noon STUDENT RESEARCH PRESENTATIONS

*Science, Mathematics, Engineering, Technology
**See Schedule of Student Presentation
12:30 p.m. - 2:00 p.m.
Columbus

LUNCHEON

Presiding:
Roosevelt Calbert, Division Director, Human Resource Development (HRD), EHR/NSF

Greetings:
Honorable Margaret L. Betts, M.D., Vice President, Detroit Board of Education

Introduction of Speaker:
Luther S. Williams, Assistant Director, EHR/NSF

Keynote Speaker:
James J. Duderstadt, President Emeritus and University Professor of Science and Engineering, The University of Michigan

2:15 p.m. - 3:45 p.m.
CONCURRENT SESSIONS: PARTNERS IN EDUCATION REFORM

Richard
Session I
Community Organizations

Presiding:
Nancy Mincemoyer, Project Director, Michigan Statewide Systemic Initiative

Presenters:
Carole Levine, Regional Coordinator, Communities in Schools, Inc.

V. Lonnie Peek, Community Leader, Detroit

Joliet
Session II
Foundations

Presiding:
Marian Wilson Comer, Director, Chicago Alliances for Minority Participation Project

Presenters:
John Ziraldo, Program Officer, The Skillman Foundation

Peter Gerber, Consultant

Duluth
Session III
Higher Education Institutions

Presiding:
Steve Ilmer, Associate Dean, College of Education, Wayne State University

Presenters:
Burnis Hall and JoAnne Holbert, Assistant Deans, Wayne State University

Howard Adams, Director, GEM National Institute on Mentoring, Georgia Institute of Technology

Norman Fortenberry, Executive Director, GEM Consortium
Tuesday, November 19, 1996 -- continued

**Cadillac**

**Session IV Business/Industry**

**Presiding:** William E. Hill, Director, Metropolitan Detroit Alliances for Minority Participation Project

**Presenters:** Smallwood Holloman, Development Associate, Dow Chemical
Bob Henson, Manager, Education Initiatives, Dow Chemical

**Greco**

**Session V School Administrators**

**Presiding:** Betty Hines, Principal, Southwestern High School, Detroit Public Schools

**Presenters:** Joe Greene, President, American Federation of School Administrators
Ernest Jones, Superintendent, Normandy Public Schools
St. Louis, Missouri

3:45 p.m. - 4:00 p.m. **BREAK**

4:00 p.m. - 5:30 p.m. **CONCURRENT SESSIONS: PARTNERS IN EDUCATION REFORM (REPEATED)**

4:00 p.m. - 5:30 p.m. **CONCURRENT STUDENT SESSIONS: PREPARATION FOR SUCCESS**

**Marquette A/B**

**Session I Pre-College Students:**

Dorothy S. Strong, Consultant and former Regional Coordinator, NSF Urban Systemic Initiative

Kenneth Hill, Executive Director, DAPCEP, Detroit Public Schools

Billy Jo Evans, Professor of Chemistry, The University of Michigan

**LaSalle**

**Session II Undergraduate/Graduate Students**

Norman Johnson, Office of the Provost, Georgia Institute of Technology

6:00 p.m. - 8:00 p.m. **FORMAL RECEPTION**

*Riverfront Ballroom* Co-Sponsored by The GEM Consortium/NASA

7:00 p.m. - 8:00 p.m. **STUDENT MIXER**

*Cartier* Conversations With Scientists
CONTINENTAL BREAKFAST

7:30 a.m. - 8:30 a.m.
W1-51/W1-52

JOINT PLENARY SESSION: THE ROLE OF THE NATIONAL ALLIANCE OF BLACK SCHOOL EDUCATORS (NABSE) IN SUPPORT OF EDUCATION REFORM

8:30 a.m. - 10:15 a.m.
W1-51/W1-52

Presiding: Lawrence Mixon, Superintendent, Columbus Public Schools

Greetings: Teressa Staten, Chief Deputy, Michigan Department of Education

Introduction of Speaker: Fred D. Johnson, Assistant Superintendent, Shelby County Schools, Tennessee and President-Elect, National Science Teachers Association (NSTA)

Keynote Speaker: Charlie M. Knight, President, NABSE

BREAK

10:15 a.m. - 10:30 a.m.

ISSUE SESSIONS

10:30 a.m. - 12 noon
W2-70

Session I Participation of All Students in SMET, K-16: What Research Shows

Moderator: Daryl E. Chubin, Division Director, Research, Evaluation and Communication (REC), EHR/NSF

Presenters: Bernice Anderson, Program Director, Evaluation, REC/EHR

Carol E. Malloy, Assistant Professor, School of Education, University of North Carolina-Chapel Hill

W2-69

Session II Not a Silver Bullet, But Maybe A Bronze: Technology in Education Reform

Co-Moderators: Charlotte K. Frank, Vice President, Research & Development, The McGraw-Hill Companies

Eric Hamilton, Program Director, Division of Educational System Reform, EHR/NSF

* Transportation will be provided from the Westin Hotel
Wednesday, November 20, 1996 -- continued

**Presenters:** Clifford Cox, Deputy Superintendent, Information Services, Detroit Public Schools

Terry Bercovitz, Project Manager, Department of Learning Technologies, Chicago Public Schools

**W2-68 Session III Accountability: Gateway to Program Integrity**

**Co-Moderators:** Roosevelt Calbert, Division Director, Human Resource Development, EHR/NSF

Zoe Barley, Co-Director, Science and Mathematics Program Improvement (SAMPI), Center for Research on At-Risk Students, Western Michigan University

**W2-67 Session IV Parental Involvement**

**Co-Moderators:** Eleanor Linn, Family Math and Science Program, University of Michigan

Linda Kolnowski, Supervisor, Office of Mathematics and Science, Detroit Public Schools

**W2-66 Session V Community Resources**

**Moderator:** Bernard Charles, Senior Executive, The McKenzie Group

**Presenters:** William Beckham, President, New Detroit

John King, Director, Equal Employment Planning, Detroit Medical Center

Janet Johnson, Head of Education, Cranbrook Institute of Science

**W2-61 Session VI Contemporary Issues in Graduate Education**

**Moderator:** William A. Lester, Jr., Senior Fellow for Science and Engineering and Assistant to the Director for Human Resources, NSF

**Presenters:** Peggie J. Hollingsworth, Research Scientist, Department of Pharmacology, The University of Michigan

William McHenry, Program Director, AMP, Division of Human Resource Development, EHR/NSF

Louis Dale, Associate Vice President for Minority and Special Programs and Professor of Mathematics, University of Alabama at Birmingham

Lisa A. McCauley, Manager, Software/Systems Engineering Group, Battelle Memorial Institute
12:15 p.m. - 2:15 p.m.  
AWARDS LUNCHEON**

Presiding: Juanita Clay Chambers, Director, Office of Mathematics and Science and Project Director, Urban Systemic Initiative, Detroit Public Schools

Greetings: David L. Snead, General Superintendent, Detroit Public Schools

Introduction of Speaker: Elrima C. Johnson, Staff Associate, Office of the Assistant Director, EHR/NSF

Speaker: Derrick R. Adkins, Olympic Gold Medalist, 400 Meter High Hurdles

Awards Presentations: Student Awards (Sponsors)

Texas Instruments*

Pre-college Student Awards

Detroit Area Council of Teachers of Mathematics (DACTM)

Metropolitan Detroit Science Teachers Association (MDSTA)

Alpha Kappa Alpha Sorority

Undergraduate Student Award

Phi Beta Kappa

Graduate Student Award

Sigma Xi

Chapters: Eastern Michigan University, Ford Motor Company, General Motors R & D Center, Midland, Oakland University, University of Michigan, Wayne State University and Michigan State University

NSF Science and Technology Education Leadership Awards

Educator Achievement Award

*Texas Instruments will provide prizes for all student winners.

**Co-sponsored by Harcourt Brace School Publishers and Scott Foresman/Addison Wesley
Corporate Achievement Award

Systemic Change Award

2:15 p.m. - 2:30 p.m.  BREAK

2:30 p.m. - 4:00 p.m.  WORKSHOPS: IMPLEMENTING EDUCATION REFORM

W2-66  Workshop I:  Alliances for Minority Participation (AMP) Program
        Presiding:  William E. McHenry, Program Director, AMP, HRD/EHR

W2-67  Workshop II:  Alliances for Minority Participation (AMP) Program
        Presiding:  William A. Sibley, Program Director, Centers of Research Excellence in Science & Technology, HRD/EHR

W2-68  Workshop III:  Comprehensive Partnerships for Mathematics and Science Achievement (CPMSA) Program
        Presiding:  Betty Ruth Jones; Alexandra I. King, Program Directors, CPMSA, HRD/EHR

W2-69  Workshop IV:  Research Improvement in Minority Institutions (RIMI) Program and Centers of Research Excellence in Science & Technology (CREST) Program
        Presiding:  Rodolfo Tamez; Bobby L. Wilson, Program Directors, CREST Program, HRD/EHR

W2-70  Workshop V:  Systemic Reform of K-12 Mathematics and Science Education
        Presiding:  Daniel D. Burke, Senior Staff Associate, Office of the Assistant Director, EHR/NSF

        Remarks:  Paula B. Duckett, Program Director, Division of Educational System Reform, EHR/NSF

4:00 p.m. - 4:30 p.m.  CLOSING SESSION

W2-62  Presiding:  Elmima C. Johnson, Staff Associate, Office of the Assistant Director, EHR/NSF

        Remarks:  David L. Snead, General Superintendent, Detroit Public Schools

END OF THE FORMAL PROGRAM
APPENDIX C

CONFERENCE EXHIBITORS

Cheryl Allen-Williams  
Michigan Consolidated Gas Company  
500 Griswold Street  
Detroit, MI 48226

Jean-Anne Baker  
Minorities in Science/CSY, Inc.  
The Learning Tree  
52188 Van Dyke, Suite 104  
Shelby Township, MI 48316

Gaynelle Bowden  
American Association for the Advancement of Science  
1200 New York Avenue, NW  
Washington, DC 20005

Juanita Clay Chambers  
Marvie Hackney  
Detroit Public Schools - USI  
932 Schools Center Building  
Detroit, MI 48202

Moira Donovan  
Edunetics Corporation  
1600 Wilson Boulevard  
Suite #710  
Arlington, VA 22209

Doris Greenwood  
RP Exhibit Service, Inc. Booth #1 (NSF)  
1761 Olive Street  
Capitol Heights, MD 20743

Doris Greenwood  
RP Exhibit Service, Inc. Booth #2 (NSF)  
1761 Olive Street  
Capitol Heights, MD 20743

Fredrick Hamilton  
Meharry Medical College School of Graduate Studies  
Division of Biomedical Sciences  
Nashville, TN 37208

Virgil Harris  
Holt, Rinehart and Winston, Inc.  
901 North Elm Street  
Hinsdale, IL 60521

William Hill  
Metropolitan Detroit Alliance for Minority Participation  
4107 FAB  
Wayne State University  
Detroit, MI 48202

Donna Johnson  
The GEM Consortium  
P.O. Box 537  
Notre Dame, IN 46556

Janet Johnson  
Cranbrook Institute of Science  
P.O. Box 801  
Bloomfield Hills, MI 48303

John Kay  
Chrysler Corporation  
800 Chrysler Drive East  
Auburn Hills, MI 48326

Rachel Martinez  
VideoDiscovery Inc.  
1700 Westlake Avenue North  
Suite 600  
Seattle, WA 98109-3012

Patricia Powers  
Apple Computer  
3205 Harvard Avenue  
Cleveland, OH 44105

Debbie Schumacher  
Detroit Zoological Institute  
P.O. Box 39  
Royal Oak, MI 48068

Edward Sims  
Glencoe/McGraw-Hill  
17531 Mansfield Avenue  
Detroit, MI 48235

Paula Watson  
Texas Instruments Inc.  
P.O. Box 650311  
Mail Station 3908  
Dallas, TX 75625

Leroy Wilds  
Harcourt Brace & Company  
1401 Elijah McCoy Drive  
Detroit, MI 48208

Al Yarbough  
Scott Foresman-Addison Wesley  
3675 West Outer Drive  
Detroit, MI 48221

Scholastic Inc.  
555 Broadway  
New York, NY 10012
Questions not addressed in this publication may be directed to the Directorate for Education and Human Resources by writing to:

Diversity Conference Coordinator  
Office of the Assistant Director  
Directorate for Education and Human Resources  
National Science Foundation  
Room 805  
4201 Wilson Boulevard  
Arlington, VA 22230

The National Science Foundation provides awards for research and education in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and for preparation of the results for publication. The Foundation, therefore, does not assume responsibility for the research findings or their interpretation.

The Foundation welcomes proposals from qualified scientists and engineers, and strongly encourages women, minorities, and persons with disabilities to compete fully in any of the research and education-related programs described here. In accordance with federal statutes, regulations, and NSF policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, denied the benefits of, or be subject to discrimination under any program or activity receiving financial assistance from the National Science Foundation.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF projects. See the program announcement or contact the program coordinator at (703) 306-1636.

The National Science Foundation has TDD (Telephonic Device for the Deaf) capability, which enables individuals with hearing impairment to communicate with the Foundation about NSF programs, employment, or general information. To access NSF TDD, dial (703) 306-0090; for FIRS, 1-800-877-8339.

This document is a summary of a conference supported by the National Science Foundation. It contains remarks by guest speakers and conference participants, some of whom are not members of the NSF staff. Any opinions, conclusions, or recommendations expressed by such persons are those of the authors and do not necessarily reflect the views of the National Science Foundation.