Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges:

Best Practices of Physics Programs

by Mary Beth Monroe, Thomas L. O'Kuma, and Warren Hein

Edited by Melanie J. Norton

With support from:

The National Science Foundation
American Association of Physics Teachers
Lee College
Southwest Texas Junior College

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A Program of the American Association of Physics Teachers

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SPIN-UP/TYC

A project of the American Association of Physics Teachers

Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges

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About this document

During the last two decades, introductory physics education has experienced much change in how physics is taught and even what topics are taught. The physics community is now advocating "physics for all," while at the same time trying to identify successful practices that improve the attraction and retention of physics majors, particularly from underrepresented groups. Toward this end the National Task Force for Undergraduate Physics (NTFUP), a collaborative effort of the American Association of Physics Teachers (AAPT), the American Institute of Physics (AIP) and the American Physical Society (APS), conducted 20 site visits of successful physics departments at four-year colleges and universities.* The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges (SPIN-UP/TYC) is a parallel and cooperative effort to identify successful practices among the 1200 community colleges within our country.

The summary of the findings from the SPIN-UP/TYC Project can be found in the Executive Summary. The Editor's Comments refer to the impact of this report on the larger community.

Although two-year colleges enroll just under half of all first-time college students in the United States, many Americans are not aware of the characteristics that set them apart from four-year colleges and universities. **Chapter 1** introduces the two-year college (TYC), its similarities and differences with four-year colleges/universitis, and the advantageous position these local colleges have in taking physics to the populace.

In **Chapter 2**, the different phases of the 18-month project are described: (1) the development of the instruments for identifying successful TYC physics programs and selecting successful physics programs to visit; (2) the training of the four-year college and two-year college faculty in conducting TYC site visits; (3) the visitation and reporting process employed by each of the 10 teams; (4) the development of the 10 Case Studies; and (5) the review of the Case Studies and the AIP Background Survey leading to the identification of factors contributing to the success of these exemplary physics programs.

During a special Writing and Planning Conference in July 2003, nine of the project faculty, representing both two-year and four-year institutions, critiqued the Case Studies and the AIP Findings from the 2003 Background Survey for the purpose of identifying common factors contributing to the academic success of the visited physics programs. These factors, which can be replicated by other physics and science programs, and additional conclusions, are discussed in **Chapter 3**.

As described in Chapter 2 of this major report, two-year colleges actually comprise three constituencies: community colleges, junior colleges and technical colleges. While the 10 physics programs visited during 2002–2003 characterize successful academic programs at community and junior colleges, these programs do not serve strong technical education components. Therefore the project leadership identified and organized site visits to two technical programs with demonstrated excellence in physics education. These two visits are a major first effort by the physics community to better understand the functional differences between physics programs targeting academic studies and those serving technical/vocational education. The last section of

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* Strategic Program for Innovations in Undergraduate Physics (SPIN-UP) was a project sponsored by AAPT, AIP, and APS with a generous grant through the ExxonMobil Foundation to conduct 20 site visits to successful undergraduate physics programs. The complete report can be downloaded from: http://www.aapt.org/Projects/ntfup.cfm.

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Chapter 3 reports these findings.

Chapter 4 reports the activities at the visited two-year colleges, addressing two critical issues being reviewed by many physics departments, the American Association of Physics Teachers, and the American Physical Society:

(1) the science preparation of future K-12 teachers, and

(2) the recruitment and retention of members from underrepresented groups to physics studies.

The SPIN-UP/TYC initiative is a major first-effort of the physics community to document reasons for programmatic success and to assess the impact of reforms implemented in physics teaching at two-year colleges. Many outstanding TYC physics programs responded to our Site Selection Instrument. From these, 10 were selected as exemplary based on the criteria of our study. Their Case Studies, representing a sample of the many successful physics programs at two-year colleges in our country, are reported in **Chapter 5.** During the term of the SPIN-UP/TYC project, the Statistics Research Division of AIP administered a background survey of the two-year colleges nationwide. The findings of this survey can also be found in Chapter 5.

Special Acknowledgments

We thank the National Science Foundation, the American Institute of Physics, and our home institutions—Lee College, Southwest Texas Junior College, and the American Association of Physics Teachers—for their support of our activities. We are grateful to the members of our Advisory Committee, our project evaluator, and the editor of this document for helping us gain the insight we needed to train the visiting teams, identify the indicators for exemplary practices, and report the findings of our site visits to a broad and diverse audience.

Most importantly, we extend a very special thanks to the physics faculty at each visited campus, their administrations, science faculties, support staff, and students, and the physics faculty serving as members/consultants for the SPIN-UP/TYC visiting teams. Their contributions of time, expertise, and money, described in detail in Chapter 2, were key in helping us identify and communicate best practices among two-year colleges for recruiting and retaining physics students.

We list below the colleges visited, their site hosts, and the members of the physics faculty teams who conducted the visits and prepared the site visit reports.

Training Site Visits

Two training site visits were conducted in July 2002 as a major component of the SPIN-UP/TYC Training and Planning Conference. These visits were crucial in training the visiting teams to prepare for, conduct, and report their findings.

Coastal Bend College – Beeville, Texas
Date Conducted: July 26, 2002
Site Host: *Ken Stevenson*
Site Visit Teams: See Appendix B for list

San Antonio College – San Antonio, Texas
Date Conducted: July 26, 2002
Site Host: *Jerry O'Connor*
Site Visit Teams: See Appendix B for list

Ten Primary Site Visits to Exemplary Physics Programs

Through the selection process described in Chapter 2, 10 two-year colleges were visited to study their exemplary physics program. Each visit produced a Case Study that was written by the project leader participating in the site visit.

Primary Site Visits

Estrella Mountain Community College — Avondale, AZ
Date Conducted: Dec. 5–6, 2002
Site Host: *Dwain Desbien*
Site Visit Team:
Mary Beth Monroe, Southwest Texas Junior College in Uvalde, TX - Leader
Len Jossem, The Ohio State University in Columbus, OH
Tom O'Kuma, Lee College in Baytown, TX
John Enger (Editor), Northwest College in Powell, WY

Green River Community College — Auburn, WA
Date Conducted: Feb. 27–28, 2003
Site Host: *Keith Clay*
Site Visit Team:
Martin Mason, Mt. San Antonio College in Walnut, CA - Leader;
Andy Wallace, Angelo State University in San Angelo, TX
Tom O'Kuma, Lee College in Baytown, TX

Howard Community College — Columbia, MD
Date Conducted: March 20–21, 2003
Site Host: *Russ Poch*
Site Visit Team:
Marvin Nelson, Green River Community College in Auburn, WA - Leader
Chuck Robertson, University of Washington in Seattle, WA
Warren Hein, American Association of Physics Teachers in College Park, MD

Rose State College — Midwest City, OK
Date Conducted: March 27–28, 2003
Site Host: *Jim Gilbert*
Site Visit Team:
John Griffith, Linn-Benton Community College in Albany, OR - Leader
Conley Stutz, Bradley University in Peoria, IL
Tom O'Kuma, Lee College in Baytown, TX

Mount San Antonio College — Walnut, CA
Date Conducted: March 27–28, 2003
Site Host: *Martin Mason*
Site Visit Team:
Maria Bautista, Kapi'olani Community College in Honolulu, HI - Leader
Ruth Howes, Marquette University in Milwaukee, WI
Mary Beth Monroe, Southwest Texas Junior College in Uvalde, TX

Notes

Primary Site Visits (*cont.*)

Amarillo College — Amarillo, TX
Date Conducted: April 3-4, 2003
Site Host: *Art Schneider*
Site Visit Team:
Denise Wetli, Wake Technical Community College in Raleigh, NC - Leader
Sandra Harpole, Mississippi State University in Starksville, MS
Mary Beth Monroe, Southwest Texas Junior College in Uvalde, TX
Karen Johnston, Momentum Group in Ft. Worth, TX - External Evaluator

Delta College — University Center, MI
Date Conducted: April 3-4, 2003
Site Host: *Scott Schultz*
Site Visit Team:
Bill Waggoner, Creighton University in Omaha, NE - Leader
Tim Dave (Advisor), Chabot College in Hayward, CA
Warren Hein, American Association of Physics Teachers in College Park, MD

Gainesville College — Gainesville, GA
Date Conducted: April 13-14, 2003
Site Host: *J.B. Sharma*
Site Visit Team:
Todd Leif, Cloud County Community College in Concordia, KS - Leader
Bill Kelly, Iowa State University in Ames, IA
Tom O'Kuma, Lee College in Baytown, TX

Lord Fairfax Community College — Middletown, VA
Date Conducted: April 27-28, 2003
Site Host: *Bill Warren*
Site Visit Team:
Bill Hogan, Joliet Junior College in Joliet, IL - Leader
Marie Plumb, Jamestown Community College in Jamestown, NY
Warren Hein, American Association of Physics Teachers in College Park, MD

Miami Dade College, Wolfson Campus — Miami, FL
Date Conducted: May 29-30, 2003
Site Host: *Guillermina Damas*
Site Visit Team:
Rick Swanson, Sandhills Community College in Pinehurst, NC - Leader
Shannon Hart, Applied Materials in Austin, TX
Mary Beth Monroe, Southwest Texas Junior College in Uvalde, TX

Additional Site Visits

Based on a recommendation made at the Writing and Planning Conference, SPIN-UP/TYC conducted additional site visits during the fall of 2004. The purpose of these visits was to acquire additional information regarding the roles of physics programs at technical community colleges and in recruiting and retaining students from underrepresented groups at all two-year colleges.

Additional Site Visits

Prince George's Community College — Largo, MD
Date Conducted: Oct. 27-28, 2004
Site Host: *Scott Sinex*
Site Visit Team:
John Griffith, Linn-Benton Community College in Albany, OR - Leader
Warren Hein, American Association of Physics Teachers in College Park, MD

Florence-Darlington Technical College — Florence, SC
Date Conducted: Nov. 4-5, 2004
Site Host: *Joshua Phiri*
Site Visit Team:
Marvin Nelson, Green River Community College in Auburn, WA - Leader
Tom Olsen, Lewis and Clark College in Portland, OR
Tom O'Kuma, Lee College in Baytown, TX

Wake Technical Community College – Raleigh, NC
Date Conducted: Nov. 4-5, 2004
Site Host: *Rob Kimball*
Site Visit Team:
David Weaver, Chandler-Gilbert Community College in Mesa, AZ - Leader
Ruth Howes, Marquette University in Milwaukee, WI
Mary Beth Monroe, Southwest Texas Junior College in Uvalde, TX

As you read this document, you will learn that at each site visited, the success of the physics program can be attributed to faculty and administration who are willing to embrace academic change when the needs of their students will be better served. While our site visits reveal many different models for successful physics programs, we realize that these are not the only models for success. It is our hope that this report, along with the report from the SPIN-UP project, will produce a cooperative community-wide initiative in physics higher education to improve the learning and appreciation of physics among STEM (Science Technology Engineering and Mathematics) majors and our society as a whole.

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Executive Summary

The National Task Force for Undergraduate Physics, upon the completion of its SPIN-UP project (Strategic Programs for Innovations in Undergraduate Physics), asked leaders within the two-year college (TYC) physics community to conduct a parallel site visit study of exemplary physics programs in two-year colleges. With funding from the National Science Foundation, Lee College, and Southwest Texas Junior College and under the auspices of the American Association of Physics Teachers (AAPT), the two-year college community identified and described 10 TYC physics programs that are shaping the future with initiatives that:

- Encourage students to pursue degrees in physics or in other STEM (Science Technology Engineering and Mathematics) areas,
- Encourage women and underrepresented populations to study physics,
- Encourage students to pursue teacher preparation programs in physics or related science disciplines, and
- Successfully implement instructional and programmatic innovations.

Two-year colleges (TYCs) enroll just less than half of all first-time college students in the United States and there are approximately 50% more community colleges in our country than there are four-year institutions that grant bachelor degrees in physics.* Two-year colleges make higher education an accessible and viable option for many Americans, particularly nontraditional students. Over the last century, these colleges have evolved in service to their local communities, maturing as institutions that readily respond to the changing needs of its student populations.

The Training and Planning Conference held at Trinity University in San Antonio, TX, in July 2002 addressed three major points in preparing physics faculty for the SPIN-UP/TYC site visits:

- Diversity is a hallmark of two-year colleges due in part to the close ties of these colleges with their local communities and in part to their open-door admissions policy. In an effort to engage faculty in contemplating such diversity and its impact on physics programs, Jack Hehn, AIP Education Director, developed four scenarios depicting different, but representative, community colleges for the SPIN-UP/TYC Training and Planning Conference. Through collective dialogue, eight faculty teams, each composed of three physics faculty from both two-year and four-year institutions, examined the scenarios for clues as to institutional goals and governance, the role of the physics programs with respect to the college mission, typical profiles of students collegewide versus those enrolled in physics, and faculty profiles.
- The conference participants actually experienced a "mini-site visit." During the second

* *Strategic Programs for Innovations in Undergraduate Physics: Project Report* by Robert C. Hilborn, Ruth H. Howes and Kenneth S. Krane, AAPT (2003). *Roster of Physics Departments with Enrollment and Degree Data, 2003*, by Starr Nicholson and Patrick J. Mulvey, AIP, R-394.10, 9/04.

part of the three-day working conference, four faculty teams conducted a trial site visit to Coastal Bend College in South Texas, and four teams visited San Antonio College, one of four colleges in the Alamo Community College District. Coastal Bend College is a small, rural institution and at the time of the visit had no full-time physics faculty and two part-time physics faculty. In contrast, San Antonio College, located on a large campus near downtown San Antonio, employs three full-time physics faculty members as well as several adjunct faculty to teach physics. Both colleges serve large Hispanic populations.

Guided by the SPIN-UP/TYC Core Research Questions and Indicators of Success, each visiting team prepared written and oral reports identifying exemplary features of each physics program and factors contributing to this success. Again employing collective dialogue, the conference participants prepared a list of lessons learned to aid them in preparing for and conducting site visits and the writing of the site visit reports.

- There are fundamental differences between two-year colleges and four-year colleges as revealed by a study of the TYC scenarios and the trial visitations. The unit of change at the four-year institution is typically the physics department. Physics faculty at most two-year colleges do not comprise an autonomous department. The implementation of academic change at the community college requires the collaboration of the physics faculty and college administration and, in some instances, the chair of an integrated science department or division.

The Training and Planning Conference successfully grounded site-visit teams in an understanding of the organizational structure and institutional differences likely to be encountered during the site visits and information-gathering techniques to be employed to identify and substantiate the factors contributing to the success of visited TYC programs. Equally important, the conference produced cohesion among all project faculty enhancing their skills as team members throughout the term of the project. Input from the conference participants helped design the Site Visit Manual used by teams in preparation for the site visits and in writing their site visit reports.

The selection of two-year college sites was made slowly and deliberately over a four-month period, beginning in October 2002. Seventy-two colleges responded to the Site Selection Instrument prepared by the project directors. From these, the project directors identified 10 colleges for site visits based on the following selection criteria:

- Diversity as to the size of the physics department,
- Diversity as to the size of the campus student enrollment and/or college district,
- Diversity as to geographic locations,
- Success in recruiting and retaining physics and other STEM students,
- Success in recruiting and retaining future teachers of science and math,
- Success in recruiting women and other underrepresented populations,
- Success in implementing innovations, and
- Success in addressing the needs and learning styles of special student populations.

The first site visit was conducted in December 2002, and the last was conducted in May 2003. Each visiting team consisted of three members: a two-year physics faculty serving as team leader, a university physics faculty member, and one project director. Site Visit Reports, prepared by the visiting team with input from the physics contact person at each visited site, served as the basis for the development of the 10 Case Studies.

The SPIN-UP/TYC project additionally contracted with the AIP Statistical Research Center to conduct a background survey to a representative sample of all community colleges within the country. Their report contrasted the characteristics of all surveyed colleges to the 72 colleges that applied for site visits and the 10 sites selected for visitation. The AIP findings substantiated the site visit teams' findings of successful physics programs characteristics. (The report of the AIP findings is presented in **Chapter 5.**)

During the Writing and Planning Conference in June 2003, six of the project faculty and the project directors reviewed the Case Studies and the AIP Survey Findings. Factors identified as contributing to programmatic success fell into three categories.

1. Focus on Students. A comparative review of the Case Studies and the AIP Survey Findings revealed that outstanding physics programs provide students with a strong laboratory and hands-on experience in the classroom and a physical environment conducive to outside-of-class interactions between faculty and students. The exemplary physics programs visited displayed:

- A nurturing classroom environment,
- A welcoming social environment,
- Co-curricular activities that support the academic program,
- A support system including faculty and peer mentors/tutors,
- A plan to assess student learning and program improvements, and
- A plan for student advisement that includes career and transfer advising.

2. Focus on Faculty. Successful physics programs are defined by committed and energetic faculty. This is amazing since half of the visited physics programs had only one physics faculty member. However, one-person departments are typical of two-year colleges. AIP reported in 2002 that most two-year colleges have a small number, one or less, of full-time physics teaching faculty. The visiting teams also reported that the successful physics programs displayed:

- Campuswide collegiality,
- Sustained faculty leadership,
- Reform at the local level,
- Attention to pedagogy,
- Recruitment and retention activities,
- Opportunities for professional development, and
- Scholarship and networking.

3. Working Relationship between Faculty and Administration. The Case Studies revealed that each exemplary physics program enjoyed a strong working relationship with the college administration. Establishing and maintaining such a relationship requires frequent visits between physics faculty and administrators as well as an acceptance of ongoing responsibility by both faculty and administrators. The Case Studies revealed specific areas of understanding that the physics faculty had established at the administrative level:

- Physics activities are in alignment with the institutional mission/strategic plan.

- The physics courses realize a stable or growing student enrollment.
- Physics faculty regularly visit with the college administration, describing the activities occurring within the program and how these activities impact student learning and the changing needs of the institutional student body.
- The sphere of influence of the TYC physics program extends to other disciplines and instructional programs on the TYC campus or at the transfer institution.

Likewise the Case Studies revealed that administrators on the visited campuses:

- Encourage and support professional development, both on and off campus.
- Are receptive to and support academic change.
- Allocate physical resources to provide for academic change.
- Provide services enhancing the student pipeline from public school to the community college and from the community college to the university and/or workplace.
- Promote interactions among STEM faculty.

The three-day writing conference produced a draft of the SPIN-UP/TYC report to the physics community as well as recommendations for the next appropriate activities of the TYC physics community.

In response to one of these recommendations, the project directors organized three additional site visits to two-year colleges. During the fall of 2004, SPIN-UP/TYC teams visited two technical colleges and a community college serving a student population with 75% enrollment by African Americans. The reports from these visits provide more in-depth information regarding the impact that two-year colleges have on the recruitment and retention of underrepresented groups as well the training of students to enter the workforce.

The 13 sites visited by SPIN-UP/TYC teams included campuses with large percentage enrollments of African Americans, Hispanics, and Asians. The team reports show that a two-year college located in a community where the population is predominantly African American, Hispanic, or Native American will also have a student population that reflects that demographic. However, the total percentage of minority students enrolled at the two-year colleges is larger than the four-year college and university. Therefore the two-year college provides an important portal to these populations within the students' first two years of college. The site visit reports indicate that these 13 colleges are successful in recruiting females into physics courses. Each campus visited reported about 40% enrollment in physics by women; this in contrast to the average 30% enrollment for all introductory physics courses nationwide.

The review of the visited physics programs with a technical component exhibited the following features attributing to their success:

- The physics faculty interact often with the faculty in the technology/technical education programs.
- The physics faculty are open to change and often initiate instructional change.
- The physics faculty maintain an awareness of the academic needs and career goals of their students.
- The physics and technology faculty have the strong support of their college administration and support staff.
- The physics programs have strong involvement from industry and workplace employers.
- The physics faculty regularly attend workshops and conferences for the purpose of

review and training in new content and pedagogies appropriate to their programs of study.

The SPIN-UP/TYC site visits also sought to determine the colleges' involvement in the science preparation of K-12 teachers. Approximately 90% of the visited campuses reported activities specifically targeting teacher preparation, aside from outreach to in-service teachers and their students. Some of the colleges have developed individual courses for future teachers. Four of the visited physics programs have a comprehensive series of courses providing the students with a seamless transfer into teacher preparation studies at the state universities.

Special presentations concerning the SPIN-UP/TYC findings and their impact on physics education have been made at AAPT national meetings and meetings of other STEM societies. With the editorial help of Melanie J. Norton, University of Southern Mississippi, this SPIN-UP/TYC report has been prepared for wide dissemination, including all two-year colleges, select representatives of the four-year college/university physics community, and select leaders of funding organizations and professional organizations. Findings from the SPIN-UP/TYC Case Studies of two-year colleges combined with findings from the SPIN-UP study of thriving physics departments at four-year institutions provide a composite picture of best practices in physics higher education. More importantly the two reports provide insight regarding how academic change in physics higher education is implemented and maintained.

Editor's Comments

Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges (SPIN-UP/TYC), a program of the American Association of Physics Teachers, is another step in the long path that leaders in the two-year college physics community have undertaken to highlight the value of two-year college physics education to the larger science and science education communities. From their initial efforts to strengthen visibility and create a larger network of two-year college physics faculty with TYC21, to this latest enterprise to explore the best practices in two-year college physics programs, evidence has accumulated to show that the work of the TYC physics programs plays a vital and successful role in education.

Two-year colleges have specific characteristics that make them more student-centered such as:

- The ability to be flexible in scheduling to serve students' needs;
- The capacity to change quickly in response to the needs of the community or region;
- The opportunities, because of class size and organizational structure, for faculty to have a greater interaction with students both in and outside of class; and
- The creation of a community of students who are striving to learn.

These characteristics are what permit two-year colleges to be such powerful vehicles and resources for students, both traditional and nontraditional. The best way to describe two-year colleges is inclusive. The basic premise of open access to afford educational opportunity to all who seek it reflects the best intentions of our society in striving for the future. More Hispanic and American Indian or Alaskan Native students enroll in two-year colleges than four-year institutions; whereas, more other minorities or Caucasian students enroll at four-year institutions than two-year colleges. Of students who completed a science or engineering baccalaureate degree in 1997/1998, 15% of women students, 17% of Black non-Hispanic students, 18% of Hispanic students, and 37% of American Indian or Alaskan Native students had first completed a degree at a two-year college. Two-year colleges serve 44% of the undergraduate science, mathematics, engineering, and technology student population (women, minorities, and persons with disabilities in science and engineering: 2002, NSF 03-312). National Science Foundation research reports that of the doctorates awarded in science and engineering fields between 1996 and 2000, a higher proportion of Hispanic and American Indian or Alaskan Native (11% and 17%) attended a two-year institution than did Caucasian recipients (9%) (NSF 04-315, May 2004). Two-year colleges are a resource that serves students who might otherwise miss the opportunities that education affords.

This study supports what we have intuitively known about successful education: students benefit from access to faculty in the classroom and in less regimented environments where they can have personal communication; faculty must be engaged and supported by colleagues and administration to be effective and innovative; education does not occur in a vacuum but rather within a context that students and faculty can identify with in order to facilitate the essential exchange of content.

The educational demands of our society are evolving as technology becomes ubiquitous and economic competition becomes global. The ability to grasp concepts based on science, technology, engineering, and math is now critical to both professional and personal survival. Education is the key to continued development for both the individual and society. In the last century, Americans came to recognize the value of diversity and the need for an inclusive educational culture to assure the future. However, providing access to education to obtain economic benefit is not sufficient. It is in supporting students to enable them to successfully pursue education and seek their own goals in life that is vital.

Students with varying cultural, educational, and economic backgrounds require different educational support. Two-year colleges recognize the regional characteristics of their students as well as their educational challenges. Students aspiring to transfer to four-year colleges or universities, as well as students seeking remediation or vocational specialization are served by two-year colleges. Students are supported by faculty who are engaged—faculty who are involved with both classroom and practical experiences and are focused on providing education. Faculty who are active communicants and who are supported by colleagues and administration are able to provide students with relevant academic and practical skills. This study details the investigation of two-year college physics programs to expose the best practices that support a successful and inclusive educational culture.

To attend to changing learning requirements and styles, educators must adapt. Educators must become accustomed to change to keep current with the technological, cultural, and economic revolutions in society and their classrooms. Practical research to address this transformation for future students and employers is under way. Examining programs to identify best practices in the field quickly reveals key aspects to fully serving the educational needs of our society. But the implementation of best practices relies on the ability to respond quickly to change. Three key characteristics that engender the capacity for change in education are: first, faculty openness to change, the mere willingness to investigate alternatives the standard; second, organizational structures that permit change to occur; and third, the willingness to undertake change. These three characteristics also underlie the best practices identified in the AAPT SPIN-UP/TYC research presented here.

True to form, the SPIN-UP/TYC leaders utilized the project as a method to network. The visiting teams all included two-year and four-year college faculty for each site visit. They were engaged in the project in the role of students as well as investigators. Meetings to plan and train for the visits provided an opportunity to introduce the faculties from two-year and four-year colleges to each other's worlds.

Follow-up work to compare the results of this project to those of other best practices studies should yield information about similarities and differences among the various STEM programs. The importance of interaction with colleagues, administration, and students was found in both the SPIN-UP site visits to four-year colleges conducted by the National Task Force for Undergraduate Physics and the SPIN-UP/TYC site visits conducted by AAPT. What does this imply about the importance of collegiality and collaboration in making STEM programs successful? How can this information be translated into action to develop better programs? How can this information be used to assist faculty and students at other institutions or in other disciplines? The implications for collaboration among two-year and four-year faculty are significant and certainly should be explored further.

Chapter 1
The TYC Story

Two-year colleges hold a unique place in the American education system. Beginning as post-secondary schools to serve specific regional populations, they have evolved to become today's junior colleges, technical colleges, and community colleges. The 1960s witnessed tremendous growth in two-year colleges as an intermediate level between secondary education and four-year studies. As of 2000, 42% of students begin higher education for the first time at a two-year college.[1] Perceptions of two-year colleges vary as much as the individual colleges themselves. Some would say that a two-year college is merely an alternate choice of post-secondary education.[2] Others would argue that it is an institution designed to provide workforce training, serve non-traditional students, and be a source for lifelong learning.[3,4] Also, there still exists the view that two-year colleges serve as remedial schools outside the mainstream of higher education.[4,5]

The subordinate role for two-year colleges in education is fading, as governments, business, industry, and social institutions are turning to two-year colleges and increasing the expectations of what two-year colleges can and should provide.[6] The overall mission of the two-year college is difficult to agree upon, even among two-year college stakeholders. Many consider the role two-year colleges now play in our local and national communities to be crucial for economic competitiveness. Organizational flexibility, local relevance, and attention to markets allow two-year colleges to address rapidly changing technologies and identify and serve basic literacy issues. Some primary functions of the two-year college are: acting as a bridge between high school and further post-secondary studies, providing a return route for those who left the education pipeline, providing a means for vocational training and re-certification to future and current workers, and acting as a resource for adult education regardless of academic background or goals.[7,8]

It is the very nature of the two-year college that allows and requires it to adapt. The assets enjoyed by two-year colleges include accessibility, local orientation, flexibility, and environments that provide "studies on a human scale."[9] They often do their work with a relatively small amount of resources and dedicated faculty, staff, and administrators who are committed to providing opportunities for effective learning. Two-year colleges' unique histories, locations, and populations create distinctive hierarchs within disciplines or technical areas. For example, mathematics may be part of a science department, or engineering may itself be a larger technical division. Individual colleges can also offer one-of-a-kind programs. Students at Central Piedmont Community College in Charlotte, NC, can earn a Welding Certificate with specialization in race car welding, while at Brevard Community College in Cocoa, FL, they can earn an Aerospace Technology degree with a dual enrollment option for high school students. Recognizing the opportunity to provide access to work venues specific to the region is an important contribution to the local economy and characteristic of the adaptability of two-year colleges.

No longer neglected, two-year colleges have the important opportunity and responsibility to become proactive in making changes that serve their populations' needs. The ability to multi-task to produce positive outcomes for technical and academic studies, two-year colleges are expected to achieve goals from many "agendas." Because of their sandwiched nature between high school and four-year institutions, they are well positioned to build, maintain, or strengthen existing partnerships in both of these directions. Their ties to local business and industry provide a rich resource for bringing current applications into the classroom, for career advising, and for employment opportunities for their graduates. They also are in stronger positions than ever to seek out and receive additional funding from government agencies to improve their ability to provide quality education and gain the respect of peers from all academic levels.[10]

Students

Enrollment at a two-year college is seen as a viable option for a significant number of students graduating from high school and enrolling in higher education programs. The latest statistics on high school outcomes for 18-year-old students from the U.S. Department of Education[11] show that nearly as many students are enrolled in two-year colleges as four-year colleges in a given year (approximately 1.2 million). Although the typical two-year college physics department is small, when added up the approximately 119,000 two-year college students taking physics in a given year account for about 25% of the total number of students taking introductory physics nationwide.[12] The two-year colleges play a major role in higher education in general and specifically in physics.

Students choose to attend two-year colleges for a number of reasons. First, tuition and fees for a course at a two-year college is a small fraction of the cost to take the same course at most four-year institutions (typically 20 to 25%).[13] The student frequently chooses to live at home, which further reduces the cost of attendance. This factor alone may make it possible for a student to begin or resume a college education without incurring a large amount of debt or producing financial hardship for their family. As long as the courses transfer to four-year institutions or satisfy the student's career objectives, choosing to attend a two-year college can be a viable option for many students.[14]

Students also choose to attend two-year colleges because of smaller class sizes and more welcoming environments. Class sizes of 25 to 40 are typical for introductory courses at two-year colleges, whereas the same courses at four-year institutions might have 200 to 300 students. A typical introductory physics course at a two-year college will have 24 students in the class, and the same faculty member will teach both the lecture and the laboratory, often in an integrated setting. The faculty members are readily accessible outside of the classroom and get to know their students as individuals, making it easier to develop true learning communities. In contrast, many introductory physics courses at four-year institutions are taught in large lecture sections of 100 or more students. The faculty member serving as lecturer for the course may be less accessible outside of class, and the laboratory accompanying the course is often taught by a teaching assistant who may not be aware of what is occurring in the lecture portion of the course and may have little interest in the student learning that takes place in the laboratory.[15]

The location of the two-year college in the local community and the welcoming and non-threatening environment typically found at the two-year college makes it an especially good option for non-traditional students, women, and underrepresented minorities (Native Americans, Hispanics, and African American students). In their recent book, Phillippe and Patton illustrated why location is so attractive to women:[16]

> "Women with young children, for instance, put a premium on convenience because they frequently take classes around their own and their spouses' work schedules, and babysitters' availability. For women entering the workforce for the first time or reentering after a hiatus, community colleges' proximity eases their transition to work."

Phillippe and Patton also give a rationale for why two-year colleges are so attractive to underrepresented minorities:[17]

> "Community college's commitment to being actively involved in local communities also helps attract minority students. Collaborations with businesses and social service agencies extend community colleges' presence beyond their architecture. In this way they are familiar, more approachable institutions, especially for people whose families do not have experience with higher education. In family-centered cultures that like to keep teenagers and young adults close to home, community colleges provide the opportunity for people to advance their education at places they know firsthand while retaining their family ties."

Those returning to school after some time in the workforce, or after serving as caregivers, are able to pursue a post-secondary degree without quitting their jobs or leaving their families. An associate's degree or certificate program at a two-year institution may be adequate education for their career goals. Others will go on to pursue a baccalaureate degree with less impact on their families than if they had completed their entire education at a four-year institution.

Two-year colleges generally award only an Associate of Arts degree, an Associate of Applied Science degree and/or an Associate of Science degree. In recent years, some community colleges have established discipline-specific degrees, which ultimately lead to baccalaureate degrees in the identified disciplines at the university level. However, these are few in number. Underrepresented minorities attending local two-year colleges can take advantage of their families and other support mechanisms to bridge the transition into post-secondary education. Minority students may actually be in the majority population, as in the case of Native Americans attending tribal colleges, Hispanic students attending Hispanic-serving institutions, or African Americans attending African American-serving institutions.[18] The lack of peer support by members of their own ethnic community is one of the main reasons underrepresented students drop out of four-year institutions during their first two years of attendance. However, the number of underrepresented students who complete their study whether for an associate, bachelor, master, or doctorate degree, decreases proportionally as you increase the number level of education.[19] Because two-year colleges generally have a more welcoming environment and supportive learning community, those two-year colleges that serve large numbers of underrepresented minorities can and should play a major role in recruiting these students as Science, Technology, Engineering, and Mathematics (STEM) majors.

Organizational Issues: Departments, Programs, and Faculty

In order to understand how academic change is typically implemented at two-year colleges, one needs to understand their organizational structure. A mere review of organizational charts can be misleading as both two-year and four-year institutions commonly use the same names for organizational units, even though the units function differently. For example, "department" has implications at the university level that are not suitable for most two-year colleges in the United States.

University Organizational Structure

A typical university uses the department as the basic functional unit. Departments are generally organized around a specific discipline, often with a research focus, with a departmental chair and associated budget lines. Departments at many state universities have four or more faculty along with multiple graduate research and teaching assistants. Most significantly, the university physics department generally has a large degree of autonomy in affecting academic change impacting its sphere of influence.

University Faculty Roles and Rewards

University faculty generally teach several lecture classes each year with the rest of their time devoted to research, publication, and directing undergraduate majors and graduate students. Some of this allocation of time is possible merely because of the number of physics faculty at four-year and university institutions and the availability of undergraduate majors and graduate students.[20] Teaching assistants teach most of the labs and some of the lectures. In science departments, introductory/service course lectures are often large and there is frequently a sequencing challenge between topics covered in lecture and those in lab. Getting research grants and/or gaining national and international recognition for research is generally rewarded at universities.[20] University reward structures may include a merit-pay system and most use a rigorous and highly competitive tenure-track system to gain permanent positions. Most universities use a differential title/pay structure (e.g. Associate and Full Professor).

Instructional Flexibility at the University

With the large number of students, faculty, and TAs involved, curricular change is challenging at many universities. Furthermore, the university-wide curricular structure makes creating (or eliminating) courses and, moreover, entire programs of study very time consuming. Departmental committees, college councils, and university-wide governing bodies may have to consent to changing course titles, numbering or content. Proposing a new course at the university level may involve several committees and related time delays such that it could take a year to get new courses approved. Universities have necessarily complex policies and procedures for scheduling the many courses they offer, so there is limited flexibility in providing courses based on when groups of students may wish to take them. Size-related institutional inertia makes it difficult for universities to offer many courses off campus at various sites and in various formats.

Two-Year College Organizational Structure

Many two-year colleges have adopted the use of "department" used in the older, four-year college/university system, but they share little similarity as to their governance or how they implement instructional reform. Because of the comprehensive nature of two-year colleges, TYC faculty tend to be housed with faculty teaching related disciplines within a larger organizational unit, such as the division of science and math, or the department of physics and engineering. In some two-year colleges, the term "physics department" is not even used.

The most analogous TYC functional unit to the university department structure is what is called a "program of study." The individual programs within a TYC organizational unit usually have little budget autonomy.

Physics programs differ from one two-year college to another, and the programs likely include different activities, in part due to the diversity of institutional missions and physics teaching faculty. Such activities include, but are not limited to:

- Delivery of physics courses,
- Club (physics or any STEM type) or Society of Physics Students activities,

- Advising/counseling,
- Supplemental instruction,
- Tutoring,
- Formal/informal interactions between physics faculty and students,
- Articulation with public schools or four-year colleges/universities,
- Outreach (e.g. science fairs, science shows, career day, etc.),
- Independent student projects supervised by physics faculty,
- Mentoring of adjunct faculty,
- Student tutors/mentor activities,
- Active membership in professional organizations,
- Participation in professional development activities, and
- Recruitment and retention activities by physics faculty.

Two-Year College Faculty Roles and Rewards

Since TYCs generally do not have a research focus, faculty are responsible for teaching two to three times as many courses as their university colleagues (typically without the assistance of lab or teaching assistants or graders). The larger teaching load and smaller class size usually means that TYC faculty teach both lecture and lab for most science courses. Smaller class size also typically results in a much closer student/faculty relationship.

The 1996 AIP survey of two-year colleges indicated that most of these institutions have only one physics faculty member.[21] Many of these physics faculty teach additional subjects (such as chemistry, mathematics, and engineering) as part of their full-time teaching responsibilities, thus the need to distinguish between full-time physics faculty and full-time physics teaching faculty.

National recognition for extra-curricular activities such as academic research or professional service is often not rewarded or recognized at TYCs when determining pay raises or tenure. Tenure, or continuing contracts and pay increases, are usually linked to longevity at the TYC.

Instructional Flexibility at the Two-Year College

Tighter integration between lecture and lab as well as greater curricular flexibility are possible benefits of the smaller class and program sizes found in TYCs. If TYC faculty decide that a class needs more time on a specific topic, they can often modify their lecture and lab schedules to accommodate that decision. Changing texts, labs, and even entire pedagogical approaches is usually far less challenging in the TYC environment. The overall TYC structure is such that the creation/deletion of courses and entire programs of study is a fairly streamlined process. Furthermore, there is usually a great deal of time, space, and format flexibility with course offerings. However, curricular changes at TYCs are restricted by factors such as articulation agreements that affect credit transfer to a four-year institution, workforce needs, and funding limitations.

Table 1.
Some Contrasts between Four-Year Institutions and Two-Year Colleges

	Four-Year Institution	Two-Year College
Organizational Structure		
Functional Unit	Department	Program
Budget autonomy	Yes	No
Unit size	4+	~1
Faculty Roles and Rewards		
Faculty Roles (other than committee work)	Teach ~4 lectures/yr [w/ grading & teaching assistance (TA)], research, direct grad students, publication	Teach 6 lectures and 6 labs per year and sometimes overload courses
Faculty emphasis on teaching	No	Yes
Teaches lectures	Faculty, Lecturers, some TAs	Full-Time (FT) and Adjunct Faculty
Teaches labs	TAs	FT and Adjunct Faculty
Intro/service lecture size	Large (100+)	Small (~24)
Merit pay	Yes	No, usually
Tenure process	Rigorous and competitive	Usually based on longevity if present
Flexibility		
Flexibility for curricular change (within a course)	Limited	Usually flexible
Create/delete courses and programs	Very difficult	Not very difficult
Flexibility in course offerings (time and space)	Limited	Usually flexible

Even though it appears that TYC physics faculty have more flexibility in course offerings and implementing instructional reform, a significant distinction between two-year colleges and four-year institutions concerns the location of decision-making responsibilities. The responsibilities of TYC physics faculty vary significantly from one two-year college to another. It is difficult to point to the unit of change at the two-year college. At the four-year institution, the unit responsible for change is most likely the department. However, at many two-year colleges, change is affected by key faculty and one or two key administrators. For the two-year college with a small number of science faculty, the decision-making responsibilities leading to change will most likely reside with the physics faculty and one administrator, typically the instructional dean or vice president. For two-year colleges with large science-math divisions, the personnel responsible for change could typically be the physics faculty, the divisional chair, and the college administrator supervising instruction.

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Chapter 2
Project Overview

The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges (SPIN-UP/TYC) project was initiated in 2002 as a cooperative effort between the American Association of Physics Teachers (AAPT) and the National Task Force on Undergraduate Physics (NTFUP).[1] At that time, NTFUP was completing its initiative, called SPIN-UP,[2] conducting site visits to determine why some physics departments at four-year institutions were successful in revitalizing their academic programs. In addition, SPIN-UP tried to determine why some physics departments were more successful at recruiting and retaining physics majors and related majors of science, math, and engineering. The members of the national task force wanted to learn about "best practices" at community colleges. The task force suggested that findings from site visits to community colleges combined with the findings from the SPIN-UP project would provide a comprehensive picture on how colleges and universities implement academic change. Two surveys conducted by the American Institute of Physics in 1996 and 2001 revealed that two-year colleges enroll almost half of all undergraduate students in the United States.[3,4] Of the students enrolled in introductory physics at two-year colleges, 31% are female and 23% are minorities. Comparatively, at four-year institutions, 25% of introductory physics students are female and 15% are minorities. Therefore the members of the task force anticipated that the site visits to two-year colleges would also identify reproducible strategies to increase the number of successful physics majors from underrepresented populations.

Brief Background History

In 1989, AAPT, with funding from the National Science Foundation (NSF), conducted the first conference for two-year college (TYC) physics faculty.[5] At this conference a number of critical issues common to community colleges were identified. These issues included the feeling of isolation experienced by many TYC physics faculty, the need to network with other TYC faculty, a need to remain current in pedagogical approaches to teaching physics, a need to know how many students take physics at two-year colleges, and what encompasses a physics program at TYCs. In response to the recommendations emanating from this TYC conference, two major TYC efforts evolved.

The first initiative involved two projects to communicate and provide first-hand experience with new physics teaching innovations based on the findings of the physics education research (PER) community. The Two-Year College Workshops project[6] (1991-2006), under the leadership of Curtis Hieggelke and Tom O'Kuma and with funding from the NSF, developed a series of curricular-innovation type workshops for community college physics faculty that were held at various TYCs around the country. The Physics Enhancement Project for Two-Year College (PEP-TYC) physics faculty[7] (1991-2005), under the leadership of Robert Beck Clark and Tom O'Kuma and with funding from the NSF, conducted a series of professional development programs to enhance the participants' knowledge of teaching strategies as well as new discoveries in modern physics.

The second initiative was the Two-Year Colleges in the Twenty-First Century: Breaking Down Barriers (TYC21)[8] project under the leadership of Mary Beth Monroe and Marvin Nelson. The TYC21 vision proposed to develop a self-sustaining national network of TYC physics faculty under the auspices of AAPT. This six-year AAPT project began in 1994 with initial funding from AAPT, and in 1995 the AAPT project was awarded funding for five years by the NSF. By the end of the project term, a national network of 15 regional networks involving more than 500 TYC physics faculty was formed. The AAPT Committee on Physics in Two-Year Colleges now provides the leadership for the national network.

In parallel with the TYC21 activities, the Statistical Research Center of the American Institute of Physics (AIP) in 1996[3] conducted the first-ever survey of physics activities at two-year colleges. The results of that national survey gave the physics and larger science community an initial understanding of what physics was being taught at TYCs and the type of students enrolled. AIP conducted a second survey in 2001[4] that provided additional insight regarding physics activities at two-year colleges.[9]

SPIN-UP/TYC Project

Projects funded by the NSF during the 1990s identified a number of characteristics about physics offerings, physics faculty, and physics students at two-year colleges.[3,5,8] They, however, did not address the comprehensive physics programs at two-year colleges, nor what factors contribute to a successful TYC physics program.* Consequently, conversations between NTFUP members and AAPT/TYC leadership produced an effort paralleling that of the SPIN-UP project but targeting the two-year college community. Between June 2002 and June 2003, the SPIN-UP/TYC project conducted 10 site visits and surveyed the physics programs at two-year colleges nation-wide for the purpose of collecting information that would:

1. Identify and describe two-year college physics programs that are shaping the future with initiatives that:
   - Encourage students to pursue degrees in physics or in other science, technology, engineering, and mathematics (STEM) areas;
   - Encourage women and minorities to study physics;
   - Encourage students to pursue teacher preparation programs in physics or related STEM programs; and
   - Encourage two-year colleges to implement programmatic change.
2. Contribute to a report containing a set of Case Studies of Exemplary Two-Year College Physics Programs that could be widely distributed in the higher education community.

The project was funded by the Advanced Technological Education program of the National Science Foundation, the American Association of Physics Teachers, Lee College (Baytown, Texas), and Southwest Texas Junior College (Uvalde, Texas).

* Physics programs at a community college most closely correspond to physics departments at the four-year college/university level. It refers to the collective physics activities that facilitate the learning and appreciation of physics, including physics outreach to community and local schools. For more discussion refer to Chapter 1, The TYC Story.

Project Leadership

The SPIN-UP/TYC Project was led by Tom O'Kuma of Lee College, Mary Beth Monroe of Southwest Texas Junior College, both TYC physics faculty, and Warren Hein, Associate Executive Officer of AAPT and former Physics Department chair of South Dakota State University. Karen Johnston of Momentum Group served as external evaluator for the project.

Advisory Committee and Site Visit Team Members

Members of the Advisory Committee provided guidance and oversight individually and collectively throughout the project. Partial Advisory Committee meetings were held at the summer and winter meetings of AAPT during the period 2002–2005. A complete Advisory Committee meeting was held in April 2003 in between completion of the site visits and preparation of Case Studies of the exemplary TYC physics programs. Additionally, two members of the Advisory Committee served as resource personnel for the two conferences organized by the project leadership, and one member of the committee served as a site-visit team member. Committee members were also sent electronic status reports during the term between meetings. The members of the Advisory Committee are listed below.

Advisory Committee Members

Alexander Dickison	Seminole Community College
J.D. Garcia	University of Arizona
Carolyn Haas	Salem Community College
Jack Hehn	American Institute of Physics
Ruth Howes	Marquette University
Bernard Khoury	American Association of Physics Teachers
Jim Palmer	Illinois State University
Fred Stein	American Physical Society
David Wilkinson*	Princeton University
Susan Wood	J. Sargeant Reynolds Community College

By design, each site visiting team (SVT) consisted of a physics faculty member from a two-year college (also serving as team leader), a physics faculty member from a four-year institution or an industrial physicist, and one of the project principal investigators. Twenty-four physics faculty from both two-year and four-year institutions were recruited as potential visiting team members and subsequently attended the Training and Planning Conference (TPC) held in June 2002 (See Table 2). Four "extra faculty" provided flexibility in the assignment of teams and the scheduling of site visit dates.

The Purpose of Site Visits

The SPIN-UP/TYC site visits were designed to collect and report in-depth information identifying and describing practices contributing to success in implementing and maintaining programmatic change at two-year colleges. Interviews with faculty, students, administrators, and alumni helped to verify and provide insight apart from institutional documentation concerning indicators for academic success. The reports prepared by the site visit teams (SVTs) formed the basis for the development of Case Studies of Exemplary Programs at Two-Year Colleges.

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* We note, with sadness, the untimely death of David Wilkinson in September 2002. J.D. Garcia agreed to serve on the Advisory Commitee in October 2002.

Table 2.
Participants of the Training and Planning Conference

Maria Bautista	Kapi'olani Community College	Marv Nelson	Green River Community College
Tim Dave	Chabot College	Thomas Olsen	Lewis and Clark College
John Enger	Northwest College	Marie Plumb	Jamestown Community College
John Griffith	Linn-Benton Community College	Chuck Robertson	University of Washington
Sandra Harpole	Mississippi State University	Conley Stutz	Bradley University
Shannon Hart	Applied Materials, TX and CA	Rick Swanson	Sandhills Community College
Bill Hogan	Joliet Junior College	Fred Thomas	Sinclair Community College
Ruth Howes	Marquette University	Bill Waggoner	Creighton University
Len Jossem	Ohio State University	Andy Wallace	Angelo State University
Bill Kelly	Iowa State University	David Weaver	Chandler-Gilbert Community College
Todd Leif	Cloud County Community College	Denise Wetli	Wake Technical Community College
Martin Mason	Mt. San Antonio College	Ali Yazdi	Jefferson State Community College

In preparation for the site visits, the project directors developed five Core Research Questions addressing the defined goals of the project and identified 10 Indicators of Success for an exemplary physics program. These Core Research Questions and Indicators served as guidelines for each visiting team as it prepared and conducted the visit as well as writing the report of its findings.

After consulting with its Advisory Committee, the project leadership elected not to produce one template for all site visits and team reports. It was their collective judgment that such a template would not adequately accommodate the diversity of the colleges to be visited or the difference in personalities of the visiting teams. It was also felt that a standard template might inadvertently stifle the identification of factors contributing to the success of the TYC physics program.

The Training and Planning Conference

The project directors organized the Training and Planning Conference (TPC) for all potential site-visit team members July 25-27, 2002, at Trinity University in San Antonio, TX. (See Appendix B for the agenda of this meeting.)

Conference goals (see Table 3) addressed two needs perceived by the project leadership. Many of the university faculty recruited as site-visit team members had little or no experience with two-year institutions or their physics programs. Also, many community college faculty were not aware of the diversity among two-year colleges. Consequently, it was important that some time be spent in identifying and examining the institutions and programs most likely to be encountered during the site visits. Secondly, community colleges' experiences with site visits are typically limited to those conducted by regional accrediting agencies. The conference participants were therefore engaged in activities that would help them convey to the visited administration and faculty (1) that the site visits were being conducted to learn about the success of the physics programs while at the same time (2) emphasizing that the 10 selected sites should regard themselves as 10 exemplary programs, but not necessarily the "top 10."

Table 3.
Goals of the Training and Planning Conference

1. To discuss how the SPIN-UP/TYC project was a natural next step for TYC21 and NTFUP/SPIN-UP activities;
2. To help participants define the role of site visits in identifying and describing "best practices" in two-year college (TYC) physics programs; and
3. To train participants to collect and report in-depth information that can be used to verify and explain information collected through formal and informal surveys of TYC physics programs.

The participants analyzed the meaning of the SPIN-UP/TYC Core Research Questions prepared by the project directors. Working in teams of three (one university faculty and two community college faculty), the participants studied the Core Research Questions (see Table 4) and proposed site visit strategies that could be used to address these questions.

Table 4.
SPIN-UP/TYC Core Research Questions

1. What type of classroom environments and course structures are effective in preparing two-year college students for success
   - at the transfer institution? (academic/technology students)
   - in the workplace? (technical/technology/vocational students)
   - for self improvement? (non-credit students)

   What activities and practices of the physics program and faculty effectively address the educational and career needs of the diverse student population characterizing two-year colleges?

2. What institutional and faculty activities and practices are effective in promoting change
   - in the classroom?
   - in the physics program?

3. What institutional and faculty initiatives are effective in recruiting and retaining STEM majors?
   - women and underrepresented populations?
   - future K-12 teachers, especially STEM teachers?

4. What formal (articulation agreements, bridging program courses) and informal (professional interactions) mechanisms are most effective in insuring a seamless transition for students from the two-year college to
   - the four-year institution?
   - the workplace?
   - both of these?

5. What institutional and faculty initiatives are effective in establishing cooperative activities with local schools (pre-college), private and public?
   - civic clubs and/or youth organizations (e.g., Boy Scouts of America)?
   - the general public?

The participants critiqued and refined SPIN-UP/TYC Indicators describing a successful TYC physics program. Prior to the Training Conference, the project directors defined characteristics that would identify "successful" physics programs at two-year colleges. During the second session of the Training Conference, Jack Hehn led the participants in a discussion of the indicators for a successful two-year college physics program and how the indicators might manifest themselves during a site visit. An abbreviation of the 10 indicators is given in Table 5. (Complete statements of the indicators are provided in Appendix A.)

Table 5.
Indicators of a Successful TYC Physics Program

SPIN-UP/TYC considers a two-year college physics program successful if:

1. The enrollment in physics courses offered at the TYC is stable at a level that the physics program and administration consider satisfactory or shows significant and sustained growth toward that number.

2. Most of the students completing their physics studies in an academic program at the TYC transfer to a four-year institution with many of the transfers pursuing a bachelor's degree in physics and physics education. Most of the students completing physics studies in a technical program successfully receive an associate in applied science degree or a certificate in a technical program, with many students successfully finding employment in a field relating to their technical studies.

3. Morale is high among physics faculty (full-time and part-time) and physics students.

4. Other science, technology, engineering and math (STEM) faculty and the divisional chairs, deans, and president respect the physics program and all college students find the program attractive.

5. The physics faculty work cooperatively with STEM faculty and college administration in the development and promotion of science-related events or projects, on-campus and off, targeting the general college student population and the college's service community.

6. The physics faculty, in cooperation with other STEM faculty, attract and retain women and underrepresented populations as STEM majors, particularly physics.

7. The physics faculty regularly participate in on-campus and off-campus professional development activities addressing introductory and/or technical physics content and pedagogy.

8. The physics program routinely assesses the needs and learning styles of its students and their misconceptions concerning physics, and evaluates the success of the physics program in addressing these needs and misconceptions.

9. The physics faculty work cooperatively and collaboratively with the faculty of science departments, engineering departments, and health-related programs of four-year transfer institutions and representatives from business and industry concerning course content and offerings in introductory and technical physics.

10. The physics faculty, in collaboration with other STEM faculty, provide courses that recruit and target the science preparation of future teachers.

The participants proposed a set of site visit protocol questions addressing the SPIN-UP/TYC Core Research Questions and Indicators of a successful TYC physics program. Specifically for this Training Conference, Jack Hehn developed four scenarios depicting four fictitious, but representative, community colleges. Using collective dialogue and guided by the Core Research Questions and Indicators, the faculty teams prepared questions that could be used in the collection of data as well as identifying TYC personnel to whom the questions should be directed. (See Appendix B for the four scenarios.)

An important point emerging from the discussion was the need to confirm the data collected. That is, some of the same questions should target personnel at different positions within the visited community college. It was also stressed that the team should work with the site hosts, both before and during the visit, in identifying documentation that might be available confirming the responses and thus strengthening the research aspects of the SPIN-UP/TYC project.

The conference teams conducted trial site visits and prepared reports of their findings. Two groups of four teams conducted half-day visits to two nearby community colleges, Coastal Bend College in Beeville, TX, and San Antonio College, San Antonio, TX. Prior to the trial site visit, each team reviewed the responses to a Physics Program Questionnaire and other documentation submitted by the host institution.

- Coastal Bend College (CBC) is a small, rural community college with a large minority student population. At the time of the trial site visit, the college did not have a full-time physics faculty member. Physics courses were taught by other STEM faculty. Ken Stevenson was the local site host for the visit. The physics program at Coastal Bend College is part of a math and science division and has no support personnel directly responsible to the physics program.
- San Antonio College (SAC), in contrast to CBC, is a large, urban two-year college with a sizable population of minority students. Jerry O'Connor was the local site host for the visit. This college has three full-time physics faculty and several adjunct faculty. The physics program at SAC is part of a physics and engineering department chaired by a physics faculty member, and has support personnel directly responsible to the physics program.

Due to the time constraints of the Training Conference, the trial visits were abbreviated in duration and activities, and different members of each team investigated different aspects of the college.

Working together, the conference teams prepared and critiqued site visit reports. After returning from the trial site visits, each team prepared a site visit report. During the site visits, members from each team attended different aspects of the visit. Therefore in writing their report, team members combined individual observations and sometimes compared notes with other teams on the same site visit.

Each team also prepared an oral report on one of the four areas of study: the general physics program at the visited site, physics and STEM faculty, college administration and support staff, and students. Two teams (one for each site visited) then presented their oral reports on the four areas. The oral reports, critiqued by all the participants and a "panel of experts" (Jack Hehn, Karen Johnston, and Bernard Khoury), produced a list of "17 lessons learned." These lessons addressed better ways to collect, verify, and report the information as well as interpret its value with respect to the success of the physics program, (see Appendix B for the list).

The participants reviewed the current documentation profiling TYC physics/physics programs (e.g. 1998 AIP report on "Physics in the Two-Year Colleges"). Participants at the Training and Planning Conference were given both pre- and post-conference assignments. The purpose of the pre-conference assignment was twofold. The faculty selected to conduct site visits had quite varied experience with two-year colleges. Therefore some of the pre-conference questions asked the participants to review and report characteristics of students attending two-year colleges and contrast these with students that might typically be found in four-year institutions. Additionally, participants were asked to describe a typical two-year college. While the project directors anticipated that some would answer according to their own experience, the directors anticipated that the participants would reference documentation describing TYC physics programs and students. Copies of these documents were made available to all participants.

Post-conference assignments asked participants to reflect on what they had learned or had verified concerning physics programs at community colleges during the San Antonio meeting. The participants were asked to comment on the difficulty they encountered in collecting data, describing aspects of their own physics program in the pre-conference assignment. This question was asked so that the teams would better understand the lead time and assistance the site hosts might require from the visiting teams in providing requested documentation .

The answers to the special assignments were not as important as actually asking the questions and the experiences each participant had in answering. The completion of the assignments improved the awareness among the visiting faculty to the differences among community colleges and differences between two-year institutions and four-year institutions.

Selection Process for the TYC Site Visits

The process to select the visited TYC physics programs involved four distinct steps.

1. The site selection criteria, finalized in September 2002, had two parts—general selection criteria and specific selection criteria. The general selection criteria were concerned with:
    - Diversity as to size of physics program,
    - Diversity as to size of campus student enrollment and/or college district, and
    - Diversity as to geographic location (including location within the country and site status as to urban or rural area).

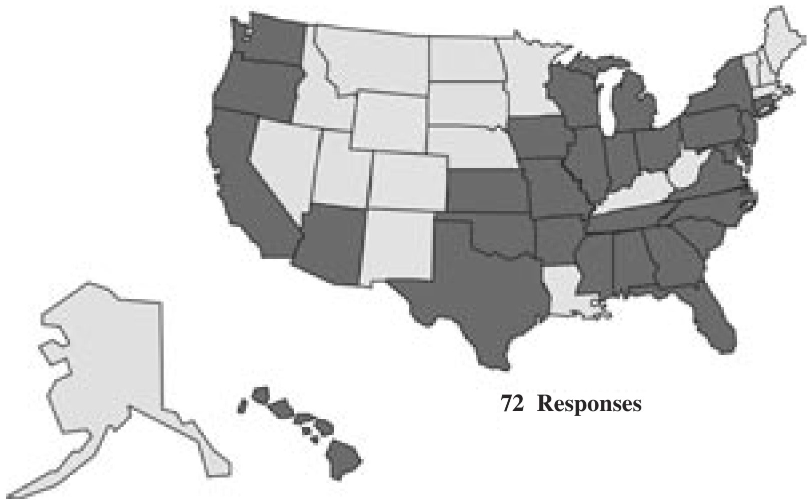
    The specific selection criteria were concerned with

    - Success in recruitment and retention of physics and other STEM students,
    - Success in recruitment and retention of future teachers of science and math,
    - Success in recruiting women and underrepresented populations,
    - Success in implementing innovations, and
    - Success in addressing the needs and learning styles of special student populations.

    Additional information on the site selection criteria can be found in Appendix C.

2. The Site Selection Instrument (the site visit application form to be completed by colleges volunteering for site visits) was finalized by mid-September 2002. (A copy of this form is included in Appendix C.) Emails announcing the site visit program were sent to all TYC physics faculty who were members of AAPT (more than 700) and approximately 1000 announcement letters were mailed to presidents of the community college members of the American Association of Community Colleges, inviting them to complete and submit the selection instrument. Individuals were asked to fill out the survey on-line but could request a paper copy if they preferred. A total of 72 two-year colleges filled out and submitted their completed instrument.

The map below indicates in dark the states in which a two-year college submitted a selection instrument. Responses were received from 30 states and one U.S. territory.



3. The project leadership, in consultation with the SPIN-UP/TYC Advisory Committee, selected the TYC physics programs to be visited. Selection of the initial sites occurred in late October 2002. Additional sites were selected in December and again in January 2003 after meeting with the Advisory Committee at the AAPT Winter Meeting in Austin, TX. The selection of the sites was based on the selection criteria previously described and the responses to the Site Selection Instrument. The project directors developed a point system for the responses to the selection instrument that would identify the stronger physics programs. The project leadership reviewed the responses, both multiple choice and open-ended, for each high-ranking program and cross-matched their reviews with the selection criteria and project goals before completing the selection.

4. Once the sites were selected, the local physics program chair/coordinator was contacted to see if they were still interested in being visited. Each program coordinator was sent a package that contained a letter explaining the purpose of the visit, a contract, and responses to the Physics Program Questionnaire (see Appendix D for copies of these items). The contract had to be signed and completed before a site visit could officially be scheduled. The Questionnaire solicited information about the physics program, its students and faculty, as well as information about the college and the college's service community.

   Subsequently, the project directors selected the site visit team members. In selecting the team members, consideration was given to their geographic proximity to the two-year college and the possible experience of the visiting faculty that would make him/her particularly suited for the visit. Each team had a two-year college faculty member who served as team leader, a university faculty member, and one principal investigator.

   The Questionnaire and all requested documents had to be in the hands of the visiting team at least two weeks before the scheduled visit. Once the project director received the signed contract and the team members were confirmed, the team leader coordinated all communication between the site host and the visiting team.

The Site Visits

Prior to conducting a site visit, each visiting team member was provided with a Site Visit Manual. The manual contained information about the site visit process, the site visit protocol, site visit preparation, the actual site visit, the site visit report, and other relevant information. (The manual's Table of Contents can be found in Appendix A). In preparation for the site visit, each team member was also sent the Program Questionnaire completed by the physics contact person and other appropriate information such as college catalogs and brochures of special program activities provided by the site host.

After a review of the mailed materials, but prior to the visit, the team leader and the site's contact person prepared the visit agenda as to tours and interviews and coordinated all travel and hotel arrangements. Teams were encouraged to have phone conference calls before the actual visit to discuss the characteristic of the physics program, what special interviews and tours should be scheduled, what aspects of the physics program should especially be explored during the visit, and additional documentation the team would like to see during the visit.

During the visit, the team met with students, staff, administration, the physics program contact person, and other physics and STEM faculty. The visit included a tour of the physics program area and other areas that the physics chair and team leader thought appropriate. Before the site visit was completed, the entire team met with the physics contact person to convey their initial findings and any other points that needed to be discussed. Most visits normally took one and a half days.

The 10 TYC physics programs that were visited as part of the SPIN-UP/TYC project were

Estrella Mountain Community College, Avondale, AZ
Contact person: Dwain Desbien *Date Visited*: Dec. 5-6, 2002
Team: Mary Beth Monroe, Leader; Len Jossem; Tom O'Kuma; John Enger* (Editor)

Green River Community College, Auburn, WA
Contact person: Keith Clay *Date Visited*: Feb. 27-28, 2003
Team: Martin Mason, Leader; Andy Wallace; Tom O'Kuma

Howard Community College, Columbia, MD
Contact person: Russ Poch *Date Visited*: March 20-21, 2003
Team: Marvin Nelson, Leader; Chuck Robertson; Warren Hein

Rose State College, Midwest City, OK
Contact person: Jim Gilbert *Date Visited*: March 27-28, 2003
Team: John Griffith, Leader; Conley Stutz; Tom O'Kuma

Mount San Antonio College, Walnut, CA
Contact person: Martin Mason *Date Visited*: March 27-28, 2003
Team: Maria Bautista, Leader; Ruth Howes; Mary Beth Monroe

* John Enger served as a Team Leader in the preparation of site visits. Unfortunately, at the time of the scheduled site visit he was unable to travel to the site due to inclement weather. Therefore he served in an advisory capacity as the site visit reports were prepared.

Amarillo College, Amarillo, TX
Contact person: Art Schneider *Date Visited*: April 3-4, 2003
Team: Denise Wetli, Leader; Sandra Harpole; Mary Beth Monroe; and Karen Johnston, External Evaluator

Delta College, University Center, MI
Contact person: Scott Schultz *Date Visited*: April 3-4, 2003
Team: Bill Waggoner, Leader; Tim Dave* (Advisor); Warren Hein

Gainesville College, Gainesville, GA
Contact person: J.B. Sharma *Date Visited*: April 13-14, 2003
Team: Todd Leif, Leader; Bill Kelly; Tom O'Kuma

Lord Fairfax Community College, Middletown, VA
Contact person: Bill Warren *Date Visited*: April 27-28, 2003
Team: Bill Hogan, Leader; Marie Plumb; Warren Hein

Miami Dade College, Wolfson Campus, Miami, FL
Contact person: Guillermina Damas *Date Visited*: May 29-30, 2003
Team: Rick Swanson, Leader; Shannon Hart; Mary Beth Monroe

The site visit reports were prepared according to the following scheme.

- The site visit team completed the draft of the site visit report within approximately two weeks of the site visit.
- The team leader sent a draft report to the physics program contact person for his/her review as to the factual correctness of the report. The contact person was asked to return the report with any corrections noted within a week.
- After incorporating any corrections and/or revisions and upon approval by the team, the team leader sent the finalized report to the SPIN-UP/TYC project director.
- The project director sent the final report to the program's contact person and the other SPIN-UP/TYC principal investigators.

The last report was completed in June 2003. All project personnel regarded the site visit reports as confidential documents.

In April 2003, the Advisory Committee met with the project leaders at the American Center for Physics in College Park, MD. Following a discussion of the project's status, the members of the committee made recommendations on the writing of the Case Studies and the final project report of the findings of the site visit teams and the AIP Background Survey.

Preparation of Case Studies

Upon the completion of each site visit report, the principal investigators prepared draft Case Studies for the sites they visited. After incorporating any changes suggested by the site visit team leader, the "amended" Case Studies were sent to the physics contact person at each visited site. Upon receiving input from the site hosts, the Case Studies were finalized. Each site visit resulted in the development of a Case Study.

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* Tim Dave served as a Team Leader in the preparation of site visits. Unfortunately, at the time of the scheduled site visit he was unable to travel to the site due to inclement weather. Therefore he served in an advisory capacity as the site visit reports were prepared.

Writing and Planning Conference

A special Writing and Planning Conference (WPC) was held June 26-29, 2003, in Dayton, OH, at the Sinclair Center. The goals of this working conference were to

- Discuss the findings in the Case Studies and the formats/models used for each study,
- Review and comment on the findings of the AIP Background Survey of TYC physics programs,
- Define the target audience for the SPIN-UP/TYC Final Report,
- Prepare a skeleton draft of the Final Report, and
- Make recommendations concerning the appropriate next steps for the TYC physics community.

The project leadership envisioned this meeting to be an intense working conference to deliberate and articulate what the Case Studies and the AIP Background Survey revealed concerning best practices among TYC physics programs. Therefore, they carefully selected a small group of participants from among the faculty who served on site visit teams and attended the Training and Planning Conference. Participants included the three principal investigators, six two-year college and four-year college physics faculty, Jack Hehn as Project Consultant, and Karen Johnston, Project Evaluator (See Table 6). The completed Case Studies and the AIP report of its survey findings were sent to the WPC participants for their review prior to conference time.

Table 6.
Participants of the Writing and Planning Conference

John Griffith	Linn-Benton Community College
Sandra Harpole	Mississippi State University
Warren Hein	American Association of Physics Teachers
Mary Beth Monroe	Southwest Texas Junior College
Marv Nelson	Green River Community College
Tom O'Kuma	Lee College
Bill Waggoner	Creighton University
David Weaver	Chandler-Gilbert Community College
Denise Wetli	Wake Technical Community College

During the first two introductory conference sessions, the principal investigators explained the goals and outcomes of the conference and reviewed the actions of the project to date. At this time, the participants shared their first thoughts concerning the reasons contributing to the success of the 10 programs visited and apparent common characteristics among these exemplary programs.

To facilitate the working nature of this conference, the principal investigators defined specific outcomes for the meeting but did not prepare a rigid agenda for the meeting. Instead, after the initial sessions, project leaders asked conference participants to establish the working plan for the weekend meeting. In response to this assignment, the participants refined the goals of the conference, producing a set of "seed" ideas for study and discussion throughout the conference:

- What are the main topics for the final report?
- What are some of the "key ideas" about two-year colleges the audience needs to know?
- What makes an exemplary TYC physics program?
- What impact do we want the final report to have?

The formulated working plan consisted of three writing teams of three members each (two TYC physics faculty and one four-year college physics faculty), working in two- to three-hour writing sessions on specified topics. One member of each team was a principal investigator who served as the team's scribe. Between writing sessions, the conference participants reconvened for a roundtable discussion to share what each team had written and new points they felt should be included in the project report. These periodic roundtable discussions were extremely valuable in providing insight into the lessons to be learned from the Case Studies as well as providing advice regarding the content and format for the SPIN-UP/TYC final report.

Upon a review of their initial discussions, the participants recognized that the characteristics of the successful physics programs could be divided into three categories: a focus on students, a focus on administration, and a focus on physics faculty. During the first set of writing sessions, each team prepared a report on one of the three focus categories. As the writing and the roundtable discussions progressed, the participants identified additional ideas that should be addressed in the final report. The additional ideas eventually converged to define three new sections to be written by the teams: a description of the two-year college (its similarities and differences in comparison to four-year institutions); what constitutes a TYC physics program (a report of the typical organizational structure of a two-year college); and the TYC involvement with K-12 education (a description of the TYC physics courses and course sequences specifically addressing the science preparation of future pre-college teachers).

By the conclusion of the Writing Conference, the writing teams produced good draft reports (three to five pages in length) on each of the six assigned writing topics that captured the essential points of the conference discussions. The roundtable discussions profiled the target audience for the report to include all TYC physics faculty and TYC presidents, physics departments at four-year colleges and universities, select leaders of professional science and math organizations, and select government and funding agencies.

During the concluding session of the conference, the participants proposed activities that would be appropriate "next steps" for the two-year college physics community. Their suggestions included:

- A follow-up project to SPIN-UP/TYC to conduct at least 10 more site visits to TYC physics programs, especially to those at technical colleges;
- A series of professional development workshops on the "best practices" evidenced in the 10 site visits;
- A conference for TYC physics faculty and their administrations;
- A large array of projects at AAPT addressing different critical issues at two-year colleges;
- A meeting of two-year college physics faculty held in tandem with a national AAPT meeting, akin to the tandem meeting held in recent years by the Physics Education Research community; and
- A strategy to determine the impact of recent TYC projects and workshops on classroom teaching and student learning.

Following the Writing and Planning Conference, the project leadership revised the Case Studies according to the recommendations emanating from the conference. The Case Studies were posted on the AAPT website in November 2003 at http://www.aapt.org/Projects/spinup-tyc-casestudies.cfm.

AIP Background Survey of TYC Physics Programs

Development of the questions for the AIP Background Survey began in early summer 2002. A preliminary form of the survey was presented to the TPC (Training and Planning Conference) participants in July 2002 and the Advisory Committee in August 2002. Using input from the TPC participants and the Advisory Committee members, the project leadership developed a draft of the survey by mid fall 2002. After meeting with Michael Neuschatz of AIP's Statistical Research Center (SRC), the final survey was completed by early spring 2003 and was posted on the AIP website. A copy of the survey can be found in Appendix F.

- AIP selected one in four TYCs nationwide, yielding a sample of 263 TYCs, of which 178 responded to the survey (67%). *This group became the "Sample Schools" in the survey results.*[10]

  In this sample of 263 TYCs were a few of the TYCs that had completed the Selection Survey Instrument (SSI). To get adequate numbers from the TYCs that had completed the SSI, AIP then surveyed all the SSI colleges.

- Of the 70 TYCs who had filled out the SSI, 65 completed the background survey (93%). *This group became the "Pool Schools" in the survey results.*
- Finally, AIP also surveyed the 10 TYCs that had been visited as part of the SPIN-UP/TYC project. By the time the survey closed, nine of the 10 TYCs visited had completed the survey. *This group became the "Visited Campuses" in the survey results.*

Some very preliminary results of the survey were presented to the Advisory Committee meeting in late April 2003. The first complete draft results were available at the WPC in June 2003. The final results were presented to the project leadership in September 2003. The final report was placed on the AIP website in April 2004 at: http://www.aip.org/statistics/trends/undergradtrends.html. The Case Studies and the AIP Findings of the Background Survey of Two-Year College Physics Programs were published by AAPT in booklet form in January 2004.[10] To date, more than 1100 copies have been distributed nationwide. The 10 Case Studies and the AIP Background Survey Findings are published in Chapter 5 of this major report.

Additional Site Visits

In the fall of 2004, the project directors organized three additional site visits to two-year colleges. One of these site visits was to a TYC having a large African American student population and two site visits were to technical TYCs training students for immediate entry into the workforce. The project directors felt that these visits would provide more in-depth information regarding the impact that the two-year college community has on the recruitment and retention of underrepresented groups as well as the training of students to enter the workforce.

The three TYC physics programs that were visited were:

Prince George's Community College, Largo, MD
Contact Person: Scott Sinex *Date Visited*: Oct. 27-28, 2004
Team: John Griffith, Leader; Warren Hein

Florence-Darlington Technical College, Florence, SC
Contact Person: Joshua Phiri *Date Visited*: Nov. 4-5, 2004
Team: Marvin Nelson, Leader; Tom Olsen; Tom O'Kuma

Wake Technical Community College, Raleigh, NC
Contact Person: Rob Kimball *Date Visited*: Nov. 4-5, 2004
Team: David Weaver, Leader; Ruth Howes; Mary Beth Monroe

Each visiting team prepared a report of its visit. Following a review by the physics contact person at the site program, the team completed the report and submitted it to the project directors by December 2004.

References

1. The Task Force on Undergraduate Physics was created in 1999 as a joint venture of the American Association of Physics Teachers, the American Institute of Physics, and the American Physical Society. For more information on NTFUP, see http://www.aapt.org/Projects/ntfup.cfm.
2. The Strategic Program for Innovations in Undergraduate Physics (SPIN-UP) was a project sponsored by AAPT, AIP, and APS with a generous grant through the ExxonMobil Foundation to conduct 20 site visits to successful undergraduate physics programs. The complete report can be downloaded from: http://www.aapt.org/Projects/ntfup.cfm.
3. Michael Neuschatz, Geneva Blake, Julie Friesner, and Mark McFarling, *Physics in the Two-Year College* (AIP R-425, College Park, MD, October 1998).
4. Mark McFarling and Michael Neuschatz, *Physics in the Two-Year College: 2001-02* (AIP R-436, College Park, MD, June 2003).
5. See the *Proceedings of the Topical Conference on Critical Issues in Two-year College Physics and Astronomy*, AAPT, 1991.
6. This project has conducted 60 workshops with more than 1000 participants from more than 300 two-year colleges and 100 high schools that represent 46 states and two U.S. territories. More information about this project can be found at the TYC Workshop Project website: http://www.tycphysics.org.
7. This project conducted seven programs involving more than 150 two-year college physics faculty members representing more than 130 two-year colleges from 35 states and one U.S. territory.
8. See *A Model for Reform—Two-Year Colleges in the Twenty-First Century: Breaking Down Barriers,* AAPT, 2000.
9. Additional information about the Committee on Physics in Two-Year Colleges can be found at their website: http://www.instruction.greenriver.edu/aapt/TYC/.
10. Thomas L. O'Kuma, Mary Beth Monroe, and Warren Hein, *Strategic Programs for Innovations in Undergraduate Physics at Two-year Colleges: Case Studies and Survey Findings* (AAPT, College Park, MD, January 2004).

Chapter 3
Best Practices

During the SPIN-UP/TYC Writing and Planning Conference in the summer 2003, two-year college and university physics faculty reviewed the Case Studies of the site visits conducted from December 2002 to June 2003 and the findings from the 2003 Background Survey of Two-Year College Physics Programs. Their studies (which were similar to conclusions from the 10 site visit teams) produced three sets of "best practices" contributing to the success of these physics programs. They are characterized as "a focus on faculty," "a focus on students," and "a focus on the relationship between faculty and administration." Two site visits conducted during the fall of 2004 provided further insight contributing to the identification of "best practices of two-year colleges serving technical programs in physics."

Focus on Faculty

A key for a successful physics program is its enthusiastic and energetic faculty committed to the successful transition of students to other institutions and the workplace. Each of the 10 two-year college physics programs visited had one or more enthusiastic and energetic faculty member. The exemplary physics programs are defined by committed faculty, with supportive administration, who seek and utilize resources to provide a physics program that integrates proven instructional strategies and includes student program enhancement activities.

Characteristics that contribute to the success include:

- Collegiality,
- Sustained faculty leadership,
- Reform at the local level,
- Attention to pedagogy,
- Recruitment and retention,
- Opportunities for professional development, and
- Scholarship and networking

For a single-person department/program, this wide variety of characteristics is particularly difficult to attain since the physics faculty member has to administer the entire physics program alone. For multi-person departments/programs, the wide variety of activities and interests can be shared with physics faculty colleagues. According to a recent AIP report[1] on *Physics in the Two-Year Colleges: 2001-2002*, most two-year college physics programs have a small number of faculty. The findings of the 2001-2002 report (which were similar to a 1998 AIP report[2]), indicates that 61% of all two-year colleges (TYCs) have one or less full-time physics faculty members, 25% have two full-time faculty, and 14% have three or more full-time faculty members. Five, or 50%, of the TYC physics programs visited as part of the SPIN-UP/TYC project were one-faculty programs, three (30%) were two-faculty programs, and two (20%) had three or more faculty programs.

Collegiality

***All two-year college physics programs visited during the SPIN-UP/TYC project cited the importance of interactions with colleagues, administration, and students as necessary components for developing and sustaining a vibrant physics program*.**

Administration "buy-in" to the physics program can lead to cooperative efforts for desired program changes. The administration of Estrella Mountain Community College (Maricopa Community College District in Arizona) collaborated with existing STEM faculty to develop criteria for hiring the first full-time physics faculty member there. The administration and science faculty wanted a person who advocated inquiry-oriented learning* and would continue to seek professional pedagogical growth after being hired. The administration continues to be receptive to program change that is initiated by the faculty and works cooperatively with them to provide necessary resources.

At Florida's Miami Dade College, Wolfson Campus (MDC), the administration encourages and supports a variety of physics program changes, including requests for new technology to provide cutting-edge technology skills for students and requests for internal resources (financial and physical) to accommodate programmatic changes. To implement microcomputer-based laboratories (MBL) at MDC, the faculty first obtained external funding through a National Science Foundation (NSF) grant in 1994 to buy computers and equipment. Later, through internal allocations, the MBL was upgraded and expanded, accommodating the faculty's experience and training in the usage of microcomputer-based laboratories. In 2002 these labs were equipped with new computers, new interfaces and sensors, additional analysis equipment, a computer projection system, document viewer, and other media. Additionally, the laboratory facility was extensively modified to better accommodate MBL usage and presentation.

At Gainesville College (University System of Georgia two-year institution), the administration has empowered deans, division chairs, and program directors to experiment, develop new ideas and programs, and receive training for the betterment of education and teaching in general. This "shared governance" has substantially enhanced the physics program. When designing their new science building which houses the physics program, faculty were given resources to tour other facilities and to work with external Project Kaleidoscope** faculty in developing a "state-of-the-art" science building.

Supportive STEM faculty can lead to a supportive atmosphere and even interdisciplinary collaborations. At Amarillo College (AC) in Texas, five physics faculty also have program responsibilities in astronomy, geology, computer science, mathematics, and engineering. The AC faculty feel their involvement in these similar program areas has helped develop a stronger physics program. Another example of interdisciplinary collaborations reported by site visit teams

* The inquiry-oriented learning desired was an "active engagement" of students in the scientific process and not just the "traditional" lecture and laboratory approach. The faculty member who was employed uses a "studio approach" that blends together both lecture and laboratory activities in a seamless approach.

** Project Kaleidoscope is an informal national alliance working to build strong learning environments for undergraduate students in mathematics, engineering and the various fields of science.

includes the supportive geology instructor at Howard Community College (Maryland) who was instrumental in developing an inquiry-based physics course for future teachers. At Green River Community College (Washington), several faculty developed a three-quarter course sequence for future pre-college teachers, incorporating inquiry-based curriculum. This sequence, designed by physics, geology, chemistry and biology faculty, has an integrated, activity-based curriculum that prepares students to teach science at the elementary and middle school levels.

During many of the SPIN-UP/TYC site visits, students interviewed cited “caring teachers” and “faculty enthusiasm” as important ingredients contributing to a successful experience in physics. Students at Rose State College (Oklahoma) feel a sense of ownership in the physics program because of the extensive faculty-student interactions. These interactions occur daily as faculty make themselves available at all times while they are on campus for students, both in curricular and extracurricular activities. Physics students participating in honors projects enhance the student “buy-in” of the physics program. For the last three years, a physics student has been awarded the best honors project in a college-wide competition.

Sustained Faculty Leadership

The leadership for many successful physics programs is provided by one faculty member with significant experience.

Experience not only includes years of teaching and service to the college, but more importantly “soft skills” (team building, communication, collaboration, relationships with constituents), and involvement in professional development activities that promote a focus on student learning and contribute to successful K-12 teacher preparation and outreach. For example, the physics faculty member at Howard Community College (HCC) in Maryland has been teaching physics there for 31 years. Using professional development opportunities to learn about technology in the mid 1980s, this faculty member was able to convince administration to convert the physics laboratory to a microcomputer-based laboratory. By participating in a number of campus, regional, and state committees, this faculty member also built support for a strong pre-service elementary education teacher program at HCC. Similar sustained leadership at Lord Fairfax Community College (Virginia) led to changes and growth in their physics program.

Physics programs that report several full-time faculty members may include faculty whose responsibility is not only teaching physics but also teaching other disciplines. As previously described, Amarillo College (Texas) has several faculty who teach physics as well as other STEM disciplines. They have built a successful program in part due to their diversity and the experiences that the multi-discipline faculty bring to the physics program. AC also uses an adjunct faculty member (a retired physics teacher from the Amarillo school district) to serve as a consultant to the teacher preparation program and to coordinate the students’ experiences with in-service teachers.

The role that faculty enthusiasm and commitment plays in successful programs underscores the importance of preparing for sustaining faculty leadership in physics over a long period of time. The Rose State College Case Study (Oklahoma) indicates a program can die without, and be revived with, faculty leadership. Prior to 1999, the physics program at RSC had practically disappeared because it did not have enough classes to make a full load for a physics faculty member. Since his hiring in the fall 1999, James Gilbert has steadily increased the physics enrollment so that a second full-time physics faculty member was hired in the fall 2002 and now adjunct faculty are needed to teach additional classes.

A successful transfer of leadership is necessary if a physics program is to remain strong during a transition in senior faculty. The colleges visited by SPIN-UP/TYC teams experienced such successful transfers with designed plans of action that incorporated commitments from the college administration to support activities to develop new leadership and to implement programmatic change when warranted.

Green River Community College (Washington) crafted a plan for its transfer of leadership when a 30-year veteran faculty member retired. During the five-year process, a new faculty person was "groomed" for the physics program leadership role. The faculty at both Delta College (Michigan) and Mount San Antonio College (California) had many years of experience and for that reason each college chose to hire new faculty to begin the transition of leadership to a younger faculty.

Reform at the Local Level

A strength of the two-year college is the flexibility two-year college faculty have to implement program innovations and changes without multiple layers of an approval process.

Usually TYC faculty have the authority to make programmatic changes that do not require money or the use of additional college facilities. However, any changes must be consistent with the mission of the institution and be compatible with transfer institutions or programs. This flexibility extends to incorporating innovations that fit individual teaching situations and student populations. According to the Survey of Two-Year College Physics Program[3] conducted by the AIP Statistical Research Center:

- 47% of two-year colleges engaged in some programmatic change during the last five years.
- Of the TYCs that completed the SPIN-UP/TYC Project's site selection survey,[4] 75% have engaged in programmatic changes during the last five years.
- Of the 10 TYC sites visited, all (100%) have engaged in programmatic changes during the last five years.

The data (collected from the 2003 AIP Background Survey[5]) reported in Table 7 indicates what type of physics course was most frequently impacted by curricular changes at the surveyed two-year colleges. [*Note*: "Sample TYCs" refer to all the TYCs that responded to the AIP survey (January 2004) including some from the "Pool" TYCs. "Pool" TYCs refer to all TYCs that completed the Site Selection Instrument. "Visited Campuses" represent the TYCs visited as part of the SPIN-UP/TYC Project.] Reform efforts are more common for the "transfer courses," which include the conceptual physics course, the algebra/trigonometry-based physics course, and the calculus-based physics course. A majority of two-year colleges visited during the SPIN-UP/TYC Project made curricular changes in the pre-service education course for K-12 teachers.

Table 7. Type of Physics Course Most Frequently Impacted in Curricular Changes

Responding TYCs	Sample TYCs	Pool TYCs	Visited Campuses
Of TYCs that made a change, type of physics course changed:			
Conceptual	48%	39%	56%
Algebra/Trig. based	75%	92%	89%
Calculus based	69%	86%	100%
Technical	31%	43%	44%
For K-12 teachers	19%	37%	89%
Other	15%	10%	11%

Also from the 2003 AIP survey,[6] Table 8 indicates where the most frequent aspect of change to the curriculum was made. The introductory physics laboratory was the most common area where curricular changes were made. However, the majority of all responding TYCs made pedagogical changes in their courses: 51% at the "Sample" TYCs, 74% of the "Pool" TYCs and 100% of the Visited Campuses.

Table 8. Most Frequently Indicated Aspect of Change to Curriculum

Responding TYCs	Sample TYCs	Pool TYCs	Visited Campuses
Of TYCs that made a change, % that:			
Added course	45%	39%	56%
Removed course	18%	10%	0%
Changed course content	33%	55%	56%
Changed course pedagogy	51%	74%	100%
Upgraded lab equipment	60%	76%	89%
Revised lab content	55%	71%	78%

For example, when the new physics faculty member at Estrella Mountain Community College (Arizona) was hired in 2001, he decided to implement a Modeling Approach[7] in all the physics classes. He also implemented a class management technique known as Modeling Discourse Management which he had developed during his dissertation work. This pedagogical strategy* has become very successful for him resulting in increased enrollment, high retention, and exceptionally high student assessment scores. Using this pedagogical approach, EMCC has had over 90% retention of students during the last two years. In using assessment instruments such as the Force Concept Inventory (FCI), the Mechanics Baseline Test (MBT), and the Conceptual Survey of Electricity and Magnetism (CSEM), EMCC physics students have scored much higher than national averages— .69 and .60 normalized gains on the FCI for calculus-based and algebra/trigonometry-based students respectively; post-test averages of 72% on the MBT; and 71% on the CSEM.[8-10]

Another example of reform can be found at Lord Fairfax Community College (Virginia). The physics instructor attended a professional development workshop, returned to his college, and immediately began to teach all his physics courses in the style of Workshop Physics.[11] Although his student evaluations initially dropped, they improved overtime as the approach worked well for his students. This pedagogical change has led to more student interest and higher student performance on national assessment instruments.[8-10]

At Amarillo College (Texas), programmatic reform is strongly supported by the administration. During interviews between the site visit team and the college's vice president and dean of instruction, the administration described their style as "hiring of good people and giving them support to carry out their job." The administrators characterized the general attitude of the college as one of having "no fear of failure; the fear is not to try."[12]

* Modeling Discourse Management is a student-centered management that focuses on the epistemology of science. Modeling discourse is social constructivist in nature and was designed to encourage students to present classroom material to each other. In modeling discourse management, the instructor's primary role is of questioner rather than provider of knowledge.

Many of the visited programs implemented pedagogical reform with funding from their own institutions. Physics faculty at Gainesville College (Georgia) and Miami Dade College, Wolfson Campus (Florida) attended workshops on microcomputer-based laboratories (MBL) and upon their return were able to convince their administrations of the virtues of MBL. Within a year, each physics program had a fully equipped MBL laboratory. The instructor at Gainesville College also redesigned the physics laboratory room to accommodate his modular adaptation of MBL with all his physics classes.

Two-year physics faculty can respond relatively quickly not only to the changing needs of the students enrolled in physics, but also to the needs of other academic programs serviced by the physics program. For example, at Delta College (Michigan) a new course, Ultrasound Physics, was developed for students in the sonography program. This two-credit hour course is taught in a half-semester with a second half-semester course on the same subject taught by an ultrasound technician. At Green River Community College (Washington) a special course in electricity and magnetism was created for physics and electrical engineering majors to better prepare them for their upper-division undergraduate courses once they transfer to a four-year institution. At Rose State College (Oklahoma), a special two-credit hour advanced laboratory course was created to provide additional laboratory experiences for physics and engineering majors.

Several of the visited two-year colleges have created special courses or programs for the training of future teachers. For a discussion of these see "Two-Year College Involvement with Teacher Preparation" in Chapter 4.

Attention to Pedagogy

One of the characteristics that contributes to the success of a two-year college physics program is the ability of the faculty to devote attention to pedagogy.

From the AIP "2003 SPIN-UP/TYC Background Survey of Two-Year College Physics Programs" report,[3] preparing students for transfer was rated as the principal priority of the majority of the TYC physics programs surveyed. The responses ranged from 72% of the Sample Schools to 100% of the Visited Campuses. In tune with this emphasis, many TYCs have implemented a number of curricular changes.

The 2003 AIP Background Survey reports that an average of 9.3 curricular changes were made during the last five years at the Visited Campuses, 5.2 changes at the Pool Schools and 2.3 changes at the Sample Schools. Furthermore, this AIP report "reveals the greatest differences between the three categories of schools were in areas like changes in the pedagogical approach used in conceptual physics courses, which were found in roughly two-thirds of the Visited Campuses, one third of the Pool Schools, and less than a fifth of the Sample Schools."[13] In the revision of laboratory curriculum for the calculus-based introductory course, "revisions were undertaken by two-thirds of the Visited Campuses, over one-half of the Pool Schools, and less than a third of the Sample Schools."[13]

Additionally, the 2003 AIP Background Survey shows "that the most widely taught courses, calculus-based and algebra/trig-based introductory physics, are most likely to be the subject of reform efforts."[14] However, it is worth noting that the largest contrast is in the proportion of site-selected schools that had added and/or revised the content of courses aimed specifically at introducing physics to K-12 teachers. This report also states "that laboratories are most often the focus of reform efforts, specifically involving major revisions in lab curriculum and/or upgrades in equipment." [14]

At Green River Community College (Washington), this emphasis on pedagogy has evolved over the years to the point where all physics courses are taught using the inquiry method. All faculty, including both full-time and adjunct faculty, use the active engagement method as well. The physics faculty are so convinced that this pedagogical method leads to superior results that they will only hire new faculty who are committed to teaching by inquiry. GRCC successfully transfers a large number of engineering, physics, and other STEM majors who have been taught using the inquiry approach. In a recent survey of its transferring engineering and physics majors, GRCC reports that 94% intend to get a baccalaureate degree in a STEM field and 54% plan to pursue an advanced degree. The physics program at GRCC also credits the inquiry approach for improving its retention rates: more than 80% in the calculus-based sequence and more than 80% in the interdisciplinary science sequence for future teachers.[15]

At Mount San Antonio College (MSAC) in California, the physics program also places a high emphasis on the pedagogy in its physics courses. The physics faculty have successfully implemented inquiry-based activities within all physics levels. The conceptual physics course uses materials adapted from *Physics by Inquiry* and *CASTLE* in an integrated lecture/lab format.[16,17] The laboratory section of algebra-based physics uses interactive materials from *RealTime Physics*[18] and *Workshop Physics*.[11] The third semester of calculus-based physics has introduced *Just in Time Teaching*[19] with desktop experiments, McDermott's *Tutorials*[20] and white boarding.* Initial assessment tools show positive gains in student learning. The physics-engineering faculty have biweekly department meetings where they share information about what works and what will not work in the laboratory exercises or share ideas on methodology. Lecture notes, belonging to all faculty teaching the same course, are available to all enrolled students.

Recruitment and Retention

In addition to institutional recruitment activities, most of the visited two-year colleges have a recruiting program that seeks to attract students to STEM fields and emphasizes the recruitment of underrepresented groups.

Preliminary findings from the 2003 AIP Background Survey of Two-Year College Physics Programs[3] indicate that Visited Campuses have a higher average of recruitment and retention activities than Sample Schools (3.3 activities as compared to 1.2). Specific strategies targeting K-12 teachers and students for visited campuses are substantially larger than Sample Schools. Forty-four percent of the Visited Campuses offer summer workshops for K-12 students as compared with 8% of the Sample Schools. Student or faculty visits to local schools were reported by 44% of the Visited Campuses while only 23% of the Sample Schools promoted such visits. Workshops for local K-12 teachers are important recruitment activities for 56% of the Visited Campuses. Only 10% of the Sample Schools conduct K-12 teacher workshops.

An effective method of recruitment reported by Visited Campuses is "word of mouth", evidence of the success of physics programs and high regard for the education provided by the institutions to their students. Mount San Antonio College (California) actively recruits students from the local high schools. Its Society of Physics Students conducts a High School Outreach Day. At Gainesville College (Georgia), the Society of Physics Students (SPS) works with the faculty to conduct science education activities for the community and K-12 schools, including science shows and professional development opportunities for K-12 teachers. At Green

* White boarding in this context is the use of a white board by a group to discuss and write down a solution to a posed question. The solution is then shared with the rest of the class by the students of the group.

River Community College (Washington), the SPS chapter was recently revived and presented demonstrations at local high schools to recruit future students. Rose State College (Oklahoma) physics faculty visit local schools with a traveling science show that is used as a recruitment tool.

Estrella Mountain Community College (Arizona) hosted an NSF-funded symposium[21] for two-year college STEM faculty from Hispanic-Serving Institutions (HSI). The proceedings of this symposium highlight the educational needs of a growing Hispanic student population and describes the best practices of HSIs.

Several two-year colleges have received NSF Computer Science, Engineering and Mathematics Scholarships (CSEMS) grants. The CSEMS program at Amarillo College (Texas) attracted 51 CSEM majors from the fall 2000 to spring 2003. Forty-eight percent of these students are minority students. Florida's Miami Dade College, Wolfson Campus, has had two CSEMS scholarship programs, increasing the visibility of the Wolfson Campus within its local community. Forty CSEMS scholarships were awarded during the first NSF funding term in 2000. The physics enrollment for the Wolfson Campus for the fall of 2001 displayed a marked increase, indicating that the NSF award was serving as a positive recruitment tool for the physics program. Twelve of the CSEMS student graduates received scholarships to universities in the fall 2003. Seventy students received CSEMS scholarships in 2002. Due to improved screening of the candidates for 2002, the physics faculty anticipated that the student performance and retention among these scholarship students would be higher.

The findings of the SPIN-UP/TYC site visit teams substantiate that a supportive and open environment for student learning successfully impacts the retention of students in physics courses. These reports also reveal how the faculty play an important role in creating a sense of community or family for physics students. They are accessible to students and foster learning environments in which the students are actively engaged. In several cases, faculty offices are located in close proximity to student lounges, work areas, or laboratories. The administration at Miami Dade College, Wolfson Campus, attribute the high retention rate of their students in physics courses (a range of 78.8% in basic physics to 95% in noncalculus physics) to improved student attitudes about the physics programs brought about by innovations in teaching, improved laboratory facilities, and increased use of technology.

The Mount San Antonio College (California) faculty have designated a room centrally located among the faculty offices as a study room for students. The study area is well used and is equipped with computers, Internet access, whiteboards, and reference materials. Students (typically four) actively tutor and mentor other students either as student instructors in the college's Supplemental Instruction Program or as departmental tutors/lab assistants. At Rose State College in Oklahoma, the faculty open the physics laboratory during non-instructional time periods, making it the central place for students to meet. Students have access to not only the faculty, but also computers with Internet access and instructional software for use in their classes.

Based on their interviews with students, the site visit teams confirmed that faculty advising and mentoring contribute to the students' successful retention. At Green River Community College (Washington) students are assigned to a faculty advisor in their discipline. Students at Amarillo College (Texas) must see the division chair before they are allowed to register for classes. These required visits help to guarantee that students are placed in the correct courses and at the appropriate level to meet their entry-level skills and expressed majors or fields of study. In addition these visits foster interactions between the faculty and students that continue beyond registration.

Opportunities for Professional Development

Faculty in exemplary programs take advantage of institutional support for professional development activities both on and off campus.

Participation in national meetings and workshops introduces faculty to teaching innovations and develops networking capacity. All of the Visited Campuses provide a variety of professional development (PD) support opportunities for their faculty. In turn, the faculty at all sites are interested in and participate in a number of PD opportunities. On-campus professional development is planned with input from faculty. Many of the Visited Campuses provide on-campus PD opportunities for both full-time and part-time faculty. Sabbatical opportunities are generally available at every TYC, but the availability and design of the sabbatical policies vary greatly among institutions.

At Amarillo College (Texas), professional development is required for promotion and tenure, and faculty are granted semester or year-long sabbaticals. All new faculty are required to take a sequence of four courses taught by West Texas, Texas A&M, and Texas Tech Universities that provide an orientation to the culture, mission, and objectives of community colleges. On-campus professional development is planned jointly by faculty, administration, and staff and includes significant training in the use of media technology. Three of the AC faculty have participated in multi-year professional development programs to enhance their innovative teaching methods and uses of instructional technology in their physics program.

Green River Community College (Washington) provides professional development funds for full-time faculty and part-time faculty. These funds can be used for workshops, travel to professional activities, and other professional development opportunities. Recently, two of the GRCC part-time faculty received PD funds to develop optics materials for their conceptual physics classes. Mount San Antonio College (California) encourages participation in regular professional development activities and provides support for attending national meetings.

Delta College (Michigan) provides $825 per year to every full-time faculty member to use for faculty development. Additionally, Delta College provides support for curricular improvement in the form of grants and release time. Faculty at Gainesville College in Georgia regularly participate in on- and off-campus professional development, hosting and attending AAPT section meetings and attending Project Kaleidoscope conferences. All faculty (including adjunct) at Lord Fairfax Community College (Virginia) are eligible for up to $550 of PD funds, and additional travel monies are available through other resources.

There are a variety of professional development opportunities available for two-year college faculty—some permanently established and some temporary. Professional organizations, such as the American Association of Physics Teachers, provide on a permanent basis a number of PD opportunities at its national and sectional meetings. There are a number of funded grants, primarily through the National Science Foundation, that provide PD opportunities for TYC faculty for a limited time period. Some grants have provided PD opportunities to TYC faculty over a fairly long period of time. Projects that have received funding over a long period include the Chautauqua series, the Two Year College Physics Workshop Project,[22] and the Physics Enhancement Project for Two Year College Physics Faculty.[23]

Scholarship and Networking

Scholarship in the context of a two-year college is a process of instituting, evaluating, and reporting curricular or pedagogical change made in a physics program.

Scholarship is a very important feature of the exemplary programs visited by SPIN-UP/TYC teams. Reporting instructional changes implies that some level of networking is occurring. Multiple-person departments have a convenient “built-in” network. The biweekly meetings of the physics-engineering faculty at Mount San Antonio College (MSAC) is a good example of an in-house network. Members of small departments often must look outside their own department for networking opportunities, such as their STEM colleagues and regional and national professional groups. The TYC21[24] program of AAPT established several regional and national networks across the country. These networks were an effective communication system for many people in the TYC physics community for years. (The creation of a national network of smaller, regional networks by the TYC21 Project is detailed in its monogram, *A Model for Reform.*[25])

AAPT provides a more permanent venue for TYC scholarship and networking through a variety of services. AAPT offers national and sectional meetings where many two-year college physics faculty report on their curricular or pedagogical changes. Networking opportunities exist through the Committee on Physics at the Two-Year College (CPTYC) which has a listserv and occasional publications.[26] AAPT has scholarly journals[27] in which TYC faculty can, in a more permanent manner, report curricular or pedagogical changes. A product of the TYC21 program was the continued special emphasis on TYC scholarship through activities sponsored by the CPTYC. These activities include sponsoring workshops, sessions, cracker barrels, and a TYC resource room at national AAPT summer meetings.

Findings from the 2003 AIP Background Survey indicate that nearly 50% of sampled TYCs and all of the TYCs visited reported involvement in curricular or pedagogical changes. While many faculty at TYCs are involved in change, few of their results appear in print or are communicated to their colleagues.

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Focus on Students

Two-year colleges (TYCs) are well placed in the higher education community to help students make the transition from high school to college. The supportive environment provided by an institution close to the students' home and family are especially important to the success of non-traditional students, women, and minority students who are underrepresented in STEM (science, technology, engineering, and mathematics) majors. In fact, students who are typically considered a minority (Hispanics, Native Americans and African Americans) might actually form a majority population on some two-year campuses such as the tribal colleges and Hispanic-serving institutions. The support provided by family and friends in these community environments frequently makes the difference between a student being able to complete a baccalaureate degree and one who drops out of the higher education system.

An outstanding physics program that supports and encourages students to pursue a STEM major will focus on all students and have the following characteristics:

- A nurturing classroom environment,
- A welcoming social environment,
- Co-curricular activities that support the academic program,
- A support system including faculty and peer mentors/tutors,
- A plan to assess student learning and program improvements, and
- A plan for student advisement that includes career and transfer advising.

Each of these points is discussed in the following paragraphs. In discussing these points, reference is made to the AIP Background Survey conducted for this project by the American Institute of Physics in 2003 (see Appendix F). This survey was sent to a random sample of TYC institutions, the pool of TYC institutions that filled out the Site Selection Survey from which the institutions visited were selected, and the 10 visited institutions. These are referred to as the "Sample Schools," "Pool Schools," and "Visited Campuses," respectively in the following discussion, and the survey will be referred to as the 2003 AIP Background Survey.

A Nurturing Classroom Environment

***The classroom environments typified by exemplary physics programs that foster effective student learning tend to be small in size, have lectures integrated with lab activities, and use active engagement strategies tailored to student needs*.**

The visited institutions reported curricular changes such as:

- Addition of courses in response to increased demand from students, transfer universities, and the workplace,
- Changes in the content and/or pedagogy based on the results of frequent assessments of student learning, and
- Upgrades to lab equipment and lab instruction.

Estrella Mountain Community College (Arizona) takes advantage of its small size and nurtures interactions among faculty and students through the integration of physics within the science and math division. The site visit team reported that the science-math faculty and support services staff provide a community support for both the physics faculty and the physics students.

The 2003 AIP Background Survey reports that visited institutions dramatically increased physics courses and physics activities targeting K-12 teachers over the past five years (56% of the Visited Campuses vs. 8% for Sample Schools). As an example, Mount San Antonio College (California) offers a specific section of physical science designed for pre-service teachers. Eighty percent of the 60 students enrolled are pursuing an elementary education major. In fulfillment of the course requirements, students prepare presentations for nearby elementary schools. Gainesville College (Georgia) involves science education students in community programs such as K-12 science shows. Howard Community College (Maryland) has a two-semester physical science sequence that is required of all pre-service elementary education majors.

Changes within other programs of study also influence the makeup of physics courses at two-year colleges. Delta College (Michigan) reports that a “total transformation” occurred in its introductory physics course due to the addition of a Diagnostic Medical Sonography program. As a result, the course now consists of a majority of female students, and a second course was added that includes an in-depth treatment of the acoustics underlying sonograms.

The SPIN-UP/TYC Case Studies report that visited physics programs place a strong emphasis on pedagogy, especially in the conceptual physics courses. Sixty-seven percent of the visited programs made pedagogical changes in their conceptual physics courses and 56% of these programs made changes in their courses for K-12 pre-service teachers. Howard Community College makes special efforts to identify student misconceptions using pre-tests. Then, the faculty design in-class activities utilizing interactive lecture demonstrations and web-based interactive activities to correct the misconceptions. Gainesville College uses wireless keypads to poll students during instruction to provide immediate feedback.*

Many of the visited institutions have reformatted their scheduled times for physics courses to create flexible integrated lecture-lab studio environments. Gainesville College (Georgia) reports 90% of its physics students agree that this combined arrangement “made for a more effective learning environment.”[1] These settings also allow for flexibility in the delivery approach. The 2003 AIP Background Survey shows that although many physics programs upgrade their labs with new equipment, the Visited Campuses upgraded the accompanying curriculum more often than other institutions from the Sample Schools. Lord Fairfax Community College (Virginia) utilizes the Workshop Physics curriculum.[2] This teaching strategy allowed low-enrollment courses to be offered and students to work at different levels and paces. The inquiry-based philosophy of Workshop Physics in the integrated lecture-lab format, such as that used at Lord Fairfax, thrives because students see no distinction between “lecture” and “lab,” thus allowing the students’ attention to be focused on the process of science and not just the content.

A Welcoming Social Environment

An environment such as a student club or study lounge that encourages student interactions with their peers and faculty members shows a commitment by two-year institutions to students and their needs.

An inviting, nonthreatening atmosphere within a physics program appears to make physics attractive and accessible to increasing numbers and a greater diversity of TYC students. During interviews with SPIN-UP/TYC visiting teams, physics and other science faculty suggested that their student-friendly environments also help to retain students in STEM studies and careers.

* Typically, the physics instructor will cover a specific topic and then ask students what they think on a conceptual exercise such as a ranking task. Students are given a set time period to respond on their wireless keypads. Their responses are tabulated automatically on a computer and the results displayed. The instructor can then use the results to decide to further discuss the topic or move on to another topic.

At Mount San Antonio College in California, the Physics-Engineering Department has designated a room centrally located among the faculty offices as a student study. This room is equipped with computers, Internet access, whiteboards, and reference materials. Students (typically four) actively tutor and mentor other students either as student instructors in the college's Supplemental Instruction Program or as departmental tutors/lab assistants.

The college facilities at Amarillo College (Texas) include informal student lounge areas located near the science-engineering classrooms and laboratories, which serve as sites for student study groups.

Student-led activities at the visited two-year colleges contribute to the students' sense of community as well as play an important role in recruiting students. Students taking astronomy at Delta College (Michigan) assist in planetarium shows that are conducted for the public and visiting school children. The findings from the 2003 AIP Background Survey revealed that exemplary TYC physics programs have clubs for physics or STEM majors more often than TYCs in general (78% of Visited Campuses compared to 10% of the Sample Schools). These clubs, such as the Society of Physics Students, conduct outreach activities serving the physics program and institution, provide students with materials from professional societies, and introduce students to representatives from transfer universities, research industries, and industry. Often the SPS students conduct outreach activities, serving both the physics program and institution.

Co-Curricular Activities That Support the Academic Program

Physics programs that have emerged as exemplary programs offer their students a wide range of learning opportunities and experiences, including internships, cooperative programs, research experiences, and special projects.

The 2003 AIP Background Survey reported that 100% of the Visited Campuses had co-curricular program enhancement activities as compared to 94% for the Pool Schools and 75% for the Sample Schools. The average number of activities offered annually at the Visited Campuses was 7.1 compared to 4.2 at the Pool Schools and 2.0 at the Sample Schools.[3] The percentage of campuses that had a summer research program was 56% for Visited Campuses compared to 32% for Pool Schools and only 9% for Sample Schools. Similar percentages were found for cooperative education programs with 57% of Visited Campuses having these programs compared to 23% for the Pool Schools and only 8% for the Sample Schools.

Mount San Antonio College (MSAC) in California provides research opportunities for its students and places several students per year in summer internships at the Jet Propulsion Lab, California Institute of Technology, as well as in REU (Research Experiences for Undergraduates) programs at other institutions. A special projects course at Mount San Antonio College allows students to conduct special research projects, typically two per year. For example, four students worked with Martin Mason, assistant professor of physics at MSAC, to develop a sound analysis program that utilized both LabVIEW[4] and LabPro[5] interfaces to take and analyze data. Rose State College (Oklahoma) encourages individual student honors projects that generate a great deal of student interest.

A Support System Including Faculty and Peer Mentors/Tutors

Many students enter college with a knowledge transmittal model of learning, where teachers are mostly active and students are mostly passive learners.

Exemplary TYC physics programs recognize that student success depends on students adopting a community of learners model where faculty, tutors, and students all work together.

The use of faculty and peer mentors/tutors encourages students to become active partners in the learning process and breaks down the student-faculty "barrier." Mount San Antonio College (California) typically uses four students to actively tutor and mentor other students. Amarillo College (Texas) furthers its commitment to student success by providing basic skills development and peer tutoring. Delta College (Michigan) has a peer-mentoring program that uses former students to work with current students, both in class (as lab assistants) and out (as tutors). Student-to-student interactions like these help students realize their place as a colleague in the learning community. However, there is another important level of mentoring that seems to take place with some regularity in exemplary programs.

Faculty can serve as powerful mentors for students, further breaking down the perceived barriers between student and teacher. Several of the exemplary TYC physics programs indicated a conscious effort to encourage one-on-one interaction between the faculty and students. In addition to the office-hour level of tutoring, dialog about transfer and careers often takes place. The physics faculty members at Rose State College are available to their students at all times and spend many hours outside of class interacting with students. Furthermore, students who serve as peer mentors often are, themselves, mentored by a supervising faculty. At Lord Fairfax Community College (Virginia), a student mentor decided to become a STEM major and then went on to become a high school teacher as a result of a positive mentoring experience.

A Plan To Assess Student Learning and Program Improvements

Exemplary physics programs use various assessment techniques to continuously monitor student outcomes and improve courses and programs of study with the overall goal of improving student learning and their future academic and career success.

The 2003 AIP Background Survey reported that 78% of the Visited Campuses did outcome tracking versus 60% for the Pool Schools and only 36% for the Sample Schools. This tracking included surveys of employment/transfer outcomes and periodic surveys of former students. In terms of changing the physics curriculum, the survey reported that 100% of the Visited Campuses and 75% of the Pool Schools changed at least one course compared to 47% for the Sample Schools. In terms of the type of change that occurred, the Visited Campuses reported a change in course content 56% of the time and a change in pedagogy 100% of the time compared to 55% and 74% for the Pool Schools and 33% and 51% for the Sample Schools.[6]

The physics program at Howard Community College (Maryland) gives misconception pre-tests before most units in the trig-based physics sequence. The test results identify concepts that need extra attention in the classroom presentation. Estrella Mountain Community College (Arizona) uses the Force Concept Inventory (FCI), the Mechanics Baseline Test, and other standardized assessment instruments[7-9] as both pre- and post-tests to measure student understanding and learning gains. Green River Community College (Washington) tracks the success of its transfer students. Out of approximately 400 students who have graduated with a pre-engineering degree, only one has failed to complete a bachelor's degree in engineering. Florida's Miami Dade College, Wolfson Campus, improved performance in its calculus-based physics sequence by developing a one-semester bridging course as a prerequisite for students who had not completed high school physics.

A Plan for Student Advisement that Includes Career and Transfer Advising

Many successful TYC physics programs recognize the importance of regular student advising for STEM students.

The 2003 AIP Background Survey identified 78% of Visited Campuses as providing for regular advisement of STEM students.[10] Program faculty and institutional advisors can assess student preparation, provide information on course selection, and provide career and transfer information. This advisement, formal and informal, helps the student to better understand how the physics courses are relevant to their degree plan and career goals. This understanding will often enhance the student's performance within the course.

The physics program at Green River Community College (Washington) has "a well-defined and functional advising process, which supports its strong minority and female student enrollments"[11] as well as the large numbers of physics and STEM majors who enroll in their courses. Amarillo College (Texas), in accord with its institution-wide policy, requires that all science and math majors receive advisement from the chair of the Science Division prior to registration.

A number of the visited physics programs indicate that they encourage one-on-one conversations between students and faculty and these conversations often include transfer and career topics. Furthermore, some of these programs use visitations (visitors coming to the classroom as well as students visiting other sites) to expand their informal advisement. These interactions with external "experts" enhances the credibility of the advice that TYC physics faculty give their students. The physics program at Estrella Mountain Community College (a Hispanic Serving Institution in Arizona with a Hispanic physics student population of nearly 40%) focuses on providing relevant transfer and career information through student visitations to transfer universities and classroom visits by representatives from both industry and transfer universities. These visits provide a motivational incentive that aids retention.

In an effort to ensure a seamless transfer for their STEM students, the exemplary physics programs visited by SPIN-UP/TYC have developed articulation agreements with their transfer institutions. For example, Miami Dade College, Wolfson Campus (Florida), has articulation agreements with 60 engineering schools, including Georgia Tech and Kettering University. The state of Virginia has instituted a Master Course File system for the Virginia Community College System. Every course in the community college system with the same number has the same course objectives, which simplifies the transfer of courses to any public institution in Virginia. This has greatly enhanced the transfer of students from Lord Fairfax Community College to four-year institutions in the state.

The general perception of all students interviewed during this project is that their two-year college provides a welcoming and nurturing environment. They have been successful in pursuing STEM studies because of the smaller class sizes and personal attention they receive from the faculty and other resource persons at the two-year institution.

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Focus on Faculty and Administration

Fostering a Positive Working Relationship Between Faculty and Administration

Findings from the SPIN-UP/TYC sites visits and the related 2003 AIP Background Survey[1] indicate that two-year college administrators have a key role in implementing and sustaining change at the physics program level, perhaps even more so than at other higher education institutions.

In the case of the SPIN-UP/TYC site visits, visiting teams reported that the successful physics programs were the result of cooperation and collaboration between committed physics faculty and college administrators who are receptive to and encourage academic change.

Physics faculty at every visited institution said they could not have implemented changes within the classroom and across the program if not for the support of their administrators. While there is no single blueprint for building this type of relationship between faculty and administration, one element common to all of the visited institutions was open and regular communication between the two groups.

It can be difficult for TYC physics faculty, especially in the case of a typical one-faculty program, to justify voluntarily spending time talking to administrators about their program on a regular basis given their other responsibilities and time commitments. Likewise, it can be just as difficult for an administrator who has many areas of responsibility to justify spending the time to talk about a program that has no apparent problems. The findings from the 2003 AIP Background Survey conclude that "the nationwide survey of two-year college physics programs found substantial differences in the effort being mounted at the fraction of programs that chose to respond to the site selection survey on 'best practices' compared with what was being done at more 'typical' physics programs around the country."[2] The survey finding also state "faculty and administration policy, energy, and organization play key roles in the broadening and strengthening of the physics programs at the Visited Campuses."[2] It is likely that the reported high morale at the Visited Campuses, which leads to faculty going "above and beyond" what is expected, is a direct result of administrative support and encouragement.

The 10 SPIN-UP/TYC Case Studies and the findings from the 2003 AIP Background Survey provide insight into the cultivation of faculty-administration relationships and the mutual benefits to be gleaned from such cooperation at both the programmatic and institutional levels. The next two sections summarize what the project learned regarding the roles of the physics faculty and college administration in building and maintaining a working relationship.

The Role of Faculty in Building and Maintaining the Working Relationship

The implementation of change in physics curriculum and programs is most often due to the dedication and energy of a single faculty member. This is especially true for small, rural community colleges. However, the maintenance and institutional breadth of reform rely significantly on a college's commitment to provide academic offerings and services addressing the needs of students. The findings from the 2003 AIP Background Survey report that "the most active departments (TYC physics programs) are those who are especially adept at 'prospecting' for funds within their larger institutions, likely building influence and alliances with those controlling the spigot, rather than going outside to foundations, industry, and so forth."[3] Reports from the 10 site visit teams mirror this finding.

Physics faculty at Green River Community College (Washington) attribute the success of their reform efforts in part to "the long-term cooperation and communication" between the physics program and the GRCC administration.[4] Other site visits showed that the alliance between physics faculty and the college administration is not spontaneous, but is built over time with deliberate efforts from both groups to establish and maintain lines of communication.

The SPIN-UP/TYC Case Studies reveal areas of understanding that the faculty can help to foster at the administrative level, thus eliciting their support.

1. Physics activities are in alignment with the institutional mission/strategic plan.

The physics program, only one of many programs of study at a two-year college, is sometimes viewed at the institutional level as a small program in terms of number of employed faculty and student enrollment. For many community colleges, the physics program is very expensive in terms of necessary institutional expenditures versus head count. Two case studies help convey how cooperation between faculty and administration at community colleges can enhance the institutional role of the physics program to the mutual benefit of the college and the program.

In 2001 Estrella Mountain Community College in Arizona hosted an NSF symposium on *Best Practices for Student Achievement in Science, Mathematics, Engineering and Technology in 2-Year Hispanic Serving Institutions*.[5] The recommendations coming from the conference served as the philosophical foundation for much of EMCC's five-year strategic plan formulated that year. One strategic goal was the establishment of an engineering program. In anticipation of this action, the administration hired a full-time physics faculty member to develop a suite of physics courses that would service the needs of the engineering program as well as other programs of study. Subsequently, upon recommendations from the new faculty member, the administration committed funding and physical space to set up and maintain a microcomputer-based laboratory for these courses.

In similar action, Rose State College (Oklahoma) hired an energetic and dedicated faculty member to revitalize a dying physics program housed within the Division of Engineering and Science. The college administration provided physical resources to purchase additional laboratory and demonstration equipment to complement existing equipment. The physics and astronomy laboratories were renovated, and a computer room was added for student and laboratory use, increasing flexibility in the scheduling of classes. In addition, the administration hired a second physics faculty person to help in developing the physics program and accommodate the realized increase in physics enrollment.

The majority of two-year colleges in the United States are viewed as comprehensive community colleges that primarily provide core curriculum at the freshman and sophomore level for students planning to complete their baccalaureate studies at a nearby four-year college or university. The 2003 AIP Background Survey reveals that 100% of the visited physics programs saw their primary goal as the preparation of students for transfer. In line with this perceived goal, the visited physics programs most often target reform for the algebra-based and calculus-based introductory physics courses and laboratories.

In 1992, physics faculty at Lord Fairfax Community College (Virginia) implemented the Workshop Physics* curriculum into the calculus-based physics sequence. Initially, student

* Workshop Physics is an interactive curriculum primarily for calculus-based introductory physics developed by Priscilla Laws of Dickinson College and colleagues. The entire curriculum is available from John Wiley & Sons, NY.

evaluations were less than positive. However, the faculty were able to demonstrate to the administration that the inquiry-based instruction produced significant learning gains by students on national assessment tests, such as the Force Concept Inventory.[6] Consequently the administration supported the continued use of the new curriculum and, in time, student reactions to the curriculum changed. The Workshop Physics approach was extended to the algebra-based physics sequence during the 2002-2003 academic year.

2. The physics courses realize a stable or growing student enrollment.

Enrollments in any academic program are influenced by factors originating within the program and the college, as well as external factors such as a decline in the area's economy or job market. The need to understand and remedy the reasons for a declining enrollment should be a topic for conversation between faculty and administration. In addition, reasons explaining a steady enrollment or increasing enrollment also warrant discussion.

Amarillo College (Texas) has maintained a stable enrollment in physics over the past five years but has realized a 4% increase in the number of STEM (science, technology, engineering and math) majors enrolled in physics. Efforts to attract and retain students enrolled in physics address many fronts. The physics program, in cooperation with the other disciplines in the Science and Engineering Division and with financial support from the college, conducts outreach activities to pre-college students and teachers. For more than 13 years, the division hosted the Pre Freshmen Engineering Program for area middle and high school students. Follow-up studies revealed that 63% of these students attended college and 47% entered science and engineering disciplines. The division also hosts the annual Panhandle Science Fair, which has become a permanent line item in the division's budget. Amarillo College was awarded a CSEMS scholarship from the National Science Foundation, which attracted 51 computer science, engineering, and math majors from the fall 2000 to the spring 2003. In addition, the physics faculty are active participants and contributors to the K-12 teacher training program on the AC campus.

3. Physics faculty regularly visit with the college administration, describing the activities occurring within the program and how these activities impact student learning and the changing needs of the institutional student body.

SPIN-UP/TYC visits to TYC physics programs confirmed that regular and frequent visits between physics faculty and administration are major contributors to the health and open communications aspects of the faculty-administration alliance. Opportunities for communication range from casual meetings on campus at the coffee area to more structured, scheduled appointments. The faculty and administration use this time to foster mutual respect and understanding of each other's roles and responsibilities that contribute to a successful physics program.

The fruits of such visits and conversations are exemplified by the changes implemented by the physics program at Gainesville College (Georgia). In the fall 2000, the GC program expanded its facilities when it moved into a new building. The program utilizes innovative technology, including microcomputer-based laboratories in all physics courses, the Internet (WebAssign and WebCT) to supplement in-class instruction, and homework and out-of-class activities. Additionally all physics courses are taught in a combined lecture/lab format.

Mount San Antonio College (California) has offerings in physics for all students, including the conceptual physics course for nonscience majors, the algebra-based sequence which enrolls STEM majors and students, and the calculus-based physics sequence which services the engineering majors and students majoring in physics, chemistry, and physics. The faculty report that a special audience for the algebra-based course is the engineering major who has not completed high school physics. In a special effort to address the different learning styles of its students, particularly among its growing Asian population, the faculty have implemented inquiry-based activities within all physics levels. Through both the college's Supplemental Instruction Program and departmental funds, student tutors and mentors are readily available to all students enrolled in physics

Two institutions, Gainesville College and Mount San Antonio College, are typical of the 10 colleges visited. Efforts to address the multiple learning styles of students stemming from a diversity of ethnic backgrounds and experiences at the 10 sites included the implementation of new technology and/or the implementation of new pedagogy, departmental and institutional student tutors, and opportunities for student research via design projects or research opportunities at nearby universities. The implementation and maintenance of these activities within the physics program involves some level of institutional support, such as funding, commitment of physical resources, assignment of support staff time and faculty release time. The SPIN-UP/TYC teams learned that administrations not only supported and encouraged these activities but were well informed about them and their impact on the physics program.

4. The sphere of influence of the TYC physics program extends to other disciplines and instructional programs on the TYC campus or at the transfer university.

Physics faculty at the SPIN-UP/TYC sites avail themselves of opportunities to expand the boundaries of the physics learning community to include student support services, other STEM faculty and students, physics faculty at transfer universities, and local K-12 teachers of science and physics. Activities such as these strengthen the resolve of the college administration to work with, support and encourage the activities of the physics program.

At Howard Community College (Maryland), a two-course sequence, Earth and Space Science and Physical Science, has been developed for pre-service elementary teachers addressing the essential topics identified in the Maryland core physics and chemistry standards for K-8 students. Additionally the college has hired a new full-time faculty member to teach the Earth and Space Science course.

Site visit teams reported that the colleges visited implemented programmatic changes to accommodate the needs of students enrolled in physics as well as to address the needs of students in other academic programs. For example, the physics faculty at Delta College (Michigan) made changes in the course offerings to broaden service to the college's new Diagnostic Medical Sonography program. Delta College also implemented several 3 + 1 programs (students take their first three years at Delta and then transfer to Michigan Technological University or Ferris University for the fourth year).

The 2003 AIP Background Survey indicated that Visited Campuses excelled in providing instruction to nonscience majors through both course offerings of conceptual physics courses and special design courses for students who plan to become K-12 teachers. Sixty-seven percent of the Visited Campuses reported that faculty view the preparation of students to be K-12 teachers as the second most important priority of their program. The Visited Campuses also led all surveyed campuses with 22% saying that they viewed the science preparation of students as future citizens as their second most important priority. The implementation of reform efforts in any of these identified priority areas requires money. The success of the Visited Campuses to launch reform efforts addressing these areas is a credit to the cooperative efforts of both the physics faculty and the college administration.

The Role of Administration in Building and Maintaining the Working Relationship

The SPIN-UP/TYC Case Studies reveal practices of community college administrations that significantly contribute to the success of their physics programs. SPIN-UP/TYC interviews conducted with administrators and college support staff revealed that at least one administrator had an intimate knowledge of program activities; typically this was a division chair or instructional dean. Often the support extends to the college president who leverages an atmosphere fostering academic reform and instructional excellence. A working and visible partnership between physics faculty and administration inspires a commitment from college support staff and other STEM faculty to explore and implement cooperative activities that enhance physics learning, physics appreciation and interdisciplinary collaborations.

1. ***The college encourages and supports professional development.***

The SPIN-UP/TYC visiting teams reported various methods of professional development on the Visited Campuses. Most sites provide some type of in-service training for faculty. Amarillo College (Texas) provides faculty training in the implementation of new technology. The college also requires all newly hired faculty to complete a special four-course sequence that provides an understanding of the educational role of community colleges in our society today and an understanding of the particular mission and goals of Amarillo College. Delta College (Michigan) provides mentors for its entire adjunct faculty, thus helping to ensure program-wide continuity and quality instruction.

The Visited Campuses provide travel and expenses for faculty to attend local and national professional conferences and workshops, and many of the colleges provide sabbaticals for their faculty. With college funding, the physics faculty member at Lord Fairfax Community College (Virginia) has participated in the TYC Workshops[7] addressing recent innovations in introductory physics teaching and served as a regional leader in the five-year project TYC21 (The Two-Year College in the Twenty-First Century)[8] funded by the NSF/ATE program. In addition, the faculty member regularly attends regional and national meetings addressing issues associated with science and physics education. Mount San Antonio College (California) provides faculty with paid sabbaticals every seven years. The MSAC faculty have used this release time to improve classroom instruction, complete additional studies in physics and related STEM topics, and conduct technical research at nearby universities.

One particular SPIN-UP/TYC visit clearly substantiated the impact of professional development on curricular reform. Physics faculty at Florida's Miami Dade College, Wolfson Campus credited the TYC Workshops with (1) helping them to realize that new pedagogy could improve student learning in physics on their campus, (2) providing them with training in recent physics teaching innovations, and (3) training in preparing proposals to seek external funding for instructional change. Clearly the availability of appropriate professional development is instrumental in helping faculty to recognize the need for reform. However, as Miami Dade College illustrates, faculty was only able to implement new ideas and teaching strategies with the encouragement and support from their administration.

Professional development also includes seminars, workshops, and conferences hosted by home institutions. The Case Study of Estrella Mountain Community College (Arizona) described earlier demonstrates how professional activities conducted on one's own campus can foster change not only at other institutions but also within the host institution itself. The administration told the visiting SPIN-UP/TYC team that the college's strategic plan was a result of the findings of the *Best Practices for Student Achievement in Science, Mathematics, Engineering and Technology in Two-year Hispanic Serving Institutions*.[5] The realization of its goals necessitated hiring the college's first full-time physics teacher and identifying qualifications that the new faculty member would need to best serve the needs of EMCC and its students.

2. College administration is receptive to and supports academic change.

Descriptions of faculty and administration interactions varied among the 10 sites visited, but all had an atmosphere where both administration and faculty are receptive to change. SPIN-UP/TYC visiting teams characterized administrations as respecting faculty members' decisions to change curriculum, content, and pedagogy. In fact, faculty were encouraged to make changes. The faculty often said their physics programs were aligned with the administration and the mission of their colleges. In several of the Case Studies, administrators several levels away from the programs supported the faculty efforts.

One such example can be found in the Green River Community College Case Study. The visiting SPIN-UP/TYC team reported that "the GRCC faculty union gives the faculty freedom to innovate with the support of the administration. The commitment to inquiry-based teaching is stressed even in the hiring of new faculty."[9] The Case Study also reported that "the GRCC administration from division level through the Office of the President are aware of what the physics program is trying accomplish and supports the program both financially and by encouraging their endeavors."

In an earlier section, Focus on Faculty, it was stated that often the implementation of curricular and programmatic change had been successful due to efforts of one physics faculty. In some cases, the incentive to initiate change began at the administration level. The stories of hiring "just the right physics faculty," described earlier, testify how such administrative initiatives can positively impact academic programs and instruction.

3. The college commits its physical resources to its programs, thereby encouraging quality instruction.

Many community colleges, while providing some financial support for professional development, hesitate in allocating its own physical resources to provide for academic change. The 2003 AIP Background Survey suggests, however, that physics programs at the Visited Campuses receive most of their funding to implement change from college monies, not departmental monies. Eighty-nine percent of Visited Campuses report that they received college funds outside the physics program for equipment and supplies and 22% report that the college funds were used for personnel. In comparison, of the 178 Sample Schools surveyed, 49% said that college funds from outside the physics program provided for equipment and supplies, but of these, 34% reported that funding for curricular change came from internal reallocation of departmental resources.

The Case Study of Lord Fairfax Community College (Virginia) reports that "new STEM programs are being developed in conjunction with the building of a new $11 million science building scheduled for completion in March 2005."[10] Similarly, Rose State College (Oklahoma) has made a sizable commitment of its budget for facilitating change: "The physics laboratory and demonstration equipment was consolidated from various locations into a single dedicated physics lecture/laboratory room. Adequate support was provided to purchase additional laboratory and demonstration equipment to complement the existing equipment. New and greatly expanded spaces for physics and astronomy laboratories will be in place for the fall 2003. There have been additions, expansions, and upgrading of computer facilities, student access to these facilities, and necessary software in the physics area. A portion of one of the stockrooms in the physics laboratory has been turned into a computer room with four Internet-access, networked computers for student and laboratory use."[11]

Physical resources also refer to personnel. The physics program at Howard Community College (Maryland) includes not only two full-time physics faculty, but also a shared full-time faculty member who teaches many of the physics and chemistry laboratories and a laboratory manager who is responsible for setting up and stocking most of the laboratories for physics and chemistry courses. The services of the lab instructor and the lab manager, not typically found in many community colleges, provide physics faculty with more time to focus on instruction, thereby enhancing opportunities to implement change, both in the classroom and across the program.

4. College administration provides services enhancing the student pipeline from K-12 schools to the community college and from the community college to the university and the workplace.

These services, which originate outside the physics program, include financial support to outreach programs, designation of personnel/staff to initiate and foster outreach and to assess entry-level skills of students, services of students to universities and to the workplace, tutoring and mentoring personnel and facilities, and coordinated career counseling.

The Science and Engineering Division at Amarillo College (Texas) hosts the annual Panhandle Science Fair, which has become a permanent line item on the college's budget. At Delta College (Michigan), the dean of students and educational services conducts surveys of transfer students to assess the preparation the students receive from the community college. Lord Fairfax Community College (Virginia) reports that a large number of pre-college students from the region enroll in dual enrollment courses, easing the transition from high school to college.

5. College administration supports interactions among STEM faculty and the establishment of science learning communities among students and faculty.

One should not construe that the small size of most community colleges automatically implies strong cooperative activities across disciplinary programs and institutional levels. During the five-year term of the AAPT project, TYC21: Breaking Down Barriers, the project leaders learned that many community college physics faculty work in isolation from their colleagues in the other STEM disciplines and institutional programs, and regrettably some faculty prefer this environment.[12] However, SPIN-UP/TYC visiting teams found that physics faculty at the successful programs had strong interactions with STEM and other colleagues and college personnel servicing students enrolled in physics.

The administrations at the Visited Campuses recognize the benefits of this type of interaction for the college and students and provide support for it. Gainesville College has a "Learning Communities" project that encourages interdisciplinary professional interaction and curricular design. Administrators at Mount San Antonio College (California) were instrumental in getting two bond issues passed to fund the construction and renovation of new science buildings by 2005. According to these administrators, the new construction would produce a quadrangle of four buildings housing the STEM programs at MSAC. The administrators said their actions were in response to an increased student demand for more STEM classes and were an effort to enhance the cooperation across the STEM disciplines.

The Wolfson Campus of Miami Dade College (Florida) houses all STEM disciplines within the same department. In addition, the natural sciences have a shared tutoring service that helps to foster communication and interactions among the STEM faculty. Resulting from a college presidential directive, the six campuses of Miami Dade College impressively operate as one college with all like-discipline faculty sharing a responsibility for the definition of their institution-wide course objectives. The chair of the Natural Science Department at Wolfson serves as the college's convener for the natural sciences.

In summary, all the Case Studies reveal administrative support, cooperation, and even collaboration as key to establishing and maintaining successful physics programs. The 10 SPIN-UP/TYC visiting teams report the following manifestations of administrative and institutional support common to all Visited Campuses. The colleges:

- Provide institutional funding, external to budgeted monies for the physics program, for implementing changes;
- Provide funds for travel and attendance at professional meetings;
- Allocate funds for professional development activities, including sabbaticals;
- Provide release time for attending professional development activities or curriculum development;
- Are receptive to curricular change/actively promote curricular change;
- Actively promote team work, collaboration, and cooperation among faculty;
- Promote and initiate planning;
- Maintain stable funding of program;
- Focus on sustaining innovations;
- Provide institutional technical support;
- Recognize faculty efforts;
- Provide student tutoring and/or formal mentoring programs; and
- Have academic activities and student services aligned with strategic mission and goals.

The presence of this support to faculty and programs of study clearly indicates an institution-wide commitment to provide for the needs of its students, a commitment shared by faculty, administration, and support staff. These services enable college faculty to quickly respond to the changing needs of their students, who are preparing to enter a dynamic society and workforce, nationally and locally. A strong working relationship between physics faculty and college administration mutually bolsters each to make that response.

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Role of Two-Year Colleges in Serving Technical Programs in Physics

One of the unique aspects of two-year colleges is the sizeable number of students who are being educated for immediate entry into the workforce. These students are enrolled in a variety of programs that are called by names such as vocational, technical, occupational, applied science, and technology.

In 1964, the American Association of Junior Colleges (AAJC) formed a National Advisory Committee on the Junior College, which concluded that "the two-year college offers unparalleled promise for expanding educational opportunity through the provision of comprehensive programs embracing job training as well as traditional liberal arts and general education."[1] In 1963 the federal Vocational Education Act was passed by Congress, which broadened the criteria for federal aid to schools. Congress has appropriated funds several times since 1963 to finance the purpose of this Act. Other federal programs provided additional funds that community colleges shared, including the Carl D. Perkins Vocational Educational Act in 1984.

The 1998 report by the American Institute of Physics, *Physics in the Two-Year Colleges*, provided a comparison concerning the enrollment of students taking physics courses that are technical/applied physics or technology involving 50% or more of physics content. A little less than 10% of the student population at two-year colleges (TYCs) enrolled in physics are in these courses.[2] On the other hand, these types of courses are not usually taught at four-year colleges and universities since they serve students who are seeking one-year certificates or terminal associate degrees in applied science. Unfortunately, it is hard to obtain exact numbers for technical students since many of the technical students at TYCs will take academic-transfer physics courses. Nationally, the percentage of students at TYCs enrolled in technical fields with the intent on direct employment is around 40%.[3]

The 10 site visits conducted during the academic year 2002-2003 included TYC campuses with enrollments of technical students. However, most of these visited sites did not have separated courses in physics for technical students. Therefore, teams of physics faculty in October 2004 conducted additional site visits, one to Florence-Darlington Technical College in South Carolina and another to Wake Technical Community College in North Carolina, both having large numbers of technical students who take physics in their certificate or degree programs. The information from these site visits, combined with the findings from the 10 original visits, generated the following conclusions.

Initial Site Visits

Findings from the 10 site visits conducted in 2002-2003 reveal that these exemplary physics programs address physics education of technology/technical students in three different ways:

- First, several of the colleges (Estrella Mountain Community College in Arizona, Green River Community College in Washington, Mount San Antonio College in California, Gainesville College in Georgia, and Amarillo College in Texas) either had no technology programs requiring physics or not enough interest to require separate courses in technical physics. Technical students at these colleges usually enroll in one or more courses from the algebra/trigonometry-based physics sequence. Lord Fairfax Community College (Virginia) does not have significant enrollment in physics from technical programs, but, at the time of the site visit, was developing a new physics course to support the college's program of study in sonography.

- Second, two visited colleges had special courses in “technical physics” for technology students, but with limited enrollment. Rose State College (Oklahoma) has a one-semester applied physics course that is taught by the engineering technology faculty. Miami Dade College, Wolfson Campus (Florida) has a two-semester sequence called Physics with Applications that is intended for students specializing in health and technical fields. There is also a major emphasis change originating with the technology department at Miami Dade to prepare more students for transfer to engineering programs at four-year colleges. At this time, the number of students from this new emphasis entering physics is unknown.
- Third, Howard Community College (Maryland) and Delta College (Michigan) offer special “technical physics” courses, and at the time of the site visits, were expanding their offerings in physics to accommodate the needs of other fields of study available. At Howard Community College, technology/technical students opt for one of two different physics sequences—the two-semester algebra/trigonometry-based sequence or the one-semester technical physical science course. Responding to the needs of technology/technical majors (particularly cardiovascular technology majors), Howard Community College used internal funds to redesign an existing course as a technical physical science course. The redesign also incorporated an inquiry approach with cooperative groups and microcomputer-based activities. This course now has one of the highest success rates in student completion of all science courses.

  Technology/technical students at Delta College either enroll in the two-semester algebra/trigonometry-based physics sequence (although most only need to take one semester of physics) or a special one-semester applied physics course. According to Scott Schultz,[4] chair of the Physics Department in 2003 during the site visit, the applied physics course is taught four times a year and the number of sections offered has increased by one section per year. A recent increase in student enrollment in applied physics was attributed to a new field of study in Diagnostic Medical Sonography introduced at Delta College. Historically, the majority of students enrolled in applied physics to satisfy the employment requirement of local companies. In response to the career needs of these new students, the physics faculty at Delta made appropriate modifications to the applied physics course and also created a new two-credit course in ultrasound physics.

Additional Site Visits

The site visits conducted by SPIN-UP/TYC faculty teams in the fall of 2004 confirmed that the educational programs at Florence Darlington Technical College in Florence, SC, and Wake Technical Community College in Raleigh, NC, have a strong emphasis on workforce training. Although many students enrolled in physics courses at both colleges transfer to four-year colleges, the physics programs are designed with the technology/technical student in mind. The site visits to these colleges revealed two very strong, but different, models for technical physics education programs.

The Florence Darlington Technical College Model

With strong administrative support from the college and support from the South Carolina Advanced Technological Education Center (SCATE),[5] the physics program at Florence Darlington Technical College (FDTC) transformed its physics courses to better address the needs of their technology/technical students while also enhancing the transferability of the courses to four-year colleges. The site visit team identified three elements used at FDTC to create a model program for students entering its technology/technical fields of study.

- The *integrated curriculum* for first-year engineering technology students is clearly the centerpiece of FDTC's program. The physics department distinguishes itself as the "lynch pin" for the integrated curriculum and as an agent of change for enhancing student learning. Each person interviewed by the site visit team credited Joshua Phiri (the senior physics instructor) as the person responsible for the program's success.

- A second element contributing to the success of this program is the *administrative support to faculty* in their development and maintenance of top-notch course offerings. For example, FDTC sent Phiri to two different professional development workshops introducing and providing training in the Introductory College Physics for the 21st Century (ICP/21)[6] curriculum. Subsequently, he chose this curriculum to serve as the basis for the physics content for both the integrated physics courses and the transfer courses.

- The third element of success is the *strong support from industry*. For example, ESAB Welding and Cutting Products in the fall of 2004 employed three FDTC students as electronic tech interns. In the near future, ESAB and FDTC plan to develop a re-training program involving physics that will enable their assemblers to become electronic techs. These three elements have led to vibrant programs for students in technical education and in physics. Consequently, Florence Darlington Technical College, along with Piedmont Technical College, have been recognized as leaders in providing technical education both in South Carolina and the entire country, and consequently, have been selected by the National Science Foundation as a National Resource Center of Excellence.

Engineering technology students take four courses each semester in the first year: physics, mathematics, engineering, and communications. The timing of the various topics in any one course is arranged to complement that in the other courses. In addition, the topics are organized so as to prepare students to work on various problem scenarios, which encourage students to synthesize what they are learning. The team-learning strategy at the heart of the integrated curriculum has proven to be an essential piece of their growing success with underrepresented groups.

Florence Darlington seeks to prepare students for the workplace by incorporating many features from the work environment into the classroom. Students in the FDTC curriculum report to a cluster of dedicated classrooms. Thanks in part to the SCATE grant funds, the classrooms employ well-integrated, contemporary technology (e.g., smart boards, computer workstations, and microcomputer-based laboratory experiments). Faculty members come and go during the day, but the students remain in the same locale. Consequently students develop a strong identity among themselves and to the program. The Integrated Engineering Technology classes are limited to 18, which fosters student to student and student to teacher interactions.

Course materials for the FDTC program were developed from curricula suggested by SCATE with physics as the core component. The materials consist of a series of context-rich modules that feature industry-based problem scenarios as the basis for developing an understanding of physics concepts while honing the student's problem-solving skills. These active learning modules encourage students to synthesize what they are learning. *Introductory College Physics for the 21st Century* (ICP21) curriculum serves as the basis for the physics content for both the integrated curriculum and the transfer courses. Mathematical skills are taught as required for analysis of the assigned problems.

Each semester, student teams are assigned several projects that involve open-ended problem scenarios designed to replicate those found in the workplace. As in real life, these scenarios require knowledge and skills from a variety of disciplines. Each team is required to submit a written report of its solution as well as give a PowerPoint presentation.

The efforts of the physics program are strongly supported by the variety of student services available at Florence Darlington. These student services not only help current students, but they are also strong recruitment tools for future students in the program. One service is financial support through special scholarships,* internships, and financial aid. When a student enters the Engineering Technology program at FDTC, they are carefully screened and placed according to their preparation and skills, especially their mathematical achievement. If students are insufficiently prepared to succeed in the Engineering Technology program (sometimes called the ATE Integrated Curriculum), they take appropriate preparatory courses. A key service provided to enhance student success is the Success Center, a tutoring/help center with discipline-appropriate materials to aid students. Additionally, an open computer lab is available with a wide variety of discipline-specific software[7] on every computer to assist students. Recruitment activities reach a wide variety of potential students, including underrepresented groups.** These activities include summer engineering camps for middle school children, competitions for high school students, and special programs for women and underrepresentative groups. There is a full-time administrative staff to help guide both the recruitment and retention of the students in the Engineering Technology program as well as serve as the industry liaison.

A significant strength of the physics program at Florence Darlington is the involvement from industry. Local industries contribute to the curriculum (through realistic problems used in the integrated curriculum), to the program (through an advisory capacity to the integrated approach for the engineering technology core), to student workforce enhancement (through scholarships and internships), and job placement for students completing the program of study. The needs of the local industrial workforce helped define aspects of the ATE Integrated Curriculum program which in turn gives these local industries a vested interest in the program and students who complete it. An SCATE Industry Consortium has been organized to enhance industry involvement in both curriculum and student employment during and after completion of their studies. This consortium of local industries started with four or five companies two years ago. Now there are over a dozen members.

Another industry-supported program is the ATE Scholars Program, an intern program that awards roughly 10 internships a year. Participating industries commit to pay for student salaries, books, and tuition.

The Wake Technical Community College Model

Wake Technical Community College (WTCC) in Raleigh, NC, has an expanding academic transfer program, but its major purpose is “and shall continue to be the offering of quality vocational and technical education and training.”[8] Historically the physics program at WTCC has provided support courses for two-year technical programs. Engineering technology students pursuing associate of applied science degrees have enrolled in the technical physics sequence, Physics 131—Mechanics and Physics 133—Sound and Light. With the addition of transfer courses at Wake Tech in 1991, technical students (nursing, veterinary medicine, manufacturing, and computer programming) pursuing baccalaureate studies enroll in the algebra-based physics

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* Tech Stars Scholarships are funded by an NSF grant and includes tuition, fees, books, and supplies. The Career Ambassadors program selects students to represent FDTC at recruiting functions and conferences and provides to the student clothes and a stipend.

** The involvement of underrepresentative groups through recruitment and then retention activities led to the publication “Monograph on Retention”[7] by SCATE.

sequence and pre-engineering majors will take the calculus-based physics sequence.

In the fall of 2003, the dean of Vocational Technology, with input from the instructors of vocational technology, suggested that the physics faculty develop an applied physics course satisfying the mathematical requirements for the one-year certificate program. Prior to this time vocational technology students were required to take an application-oriented and integrated course covering arithmetic, geometry, and algebra.

The development and implementation of the applied physics course for vocational programs is a testament to the “focus-on-students” attitude shared by the administration, technology faculty, and academic faculty, as well as the college’s support of curricular change. The faculty took the initiative to develop a solution and the result was a nontraditional approach—the development of an integrated physics and applied math course. Equally significant, the faculty and administration showed little concern that the solution was not another math course. During the site visit, the vocational technology faculty expressed confidence in the physics faculty, saying they frequently talk with them and feel very comfortable talking about curricular content and pedagogy as it relates to the needs of vocational students.

Since 1994, Rob Kimball (chair of the Math and Physics Department) and physics faculty have served as principal investigators for five NSF-funded projects targeting math and physics, particularly their applications in the workplace. A curriculum-development project, “Integrated Mathematics and Physics,” funded in 1997 and again in 1999, (Kimball, Maynard, McCarter, Sexton and Wetli) produced a resource package of classroom activities[9] integrating the sequence of WTCC’s MAT 121 and 122 and PHY 131. According to the faculty, these activities provided a more student-centered classroom, strengthened workplace-relevant skills among their students, and enhanced students’ abilities to apply mathematical skills. Several sections of the integrated course were offered and were team taught by a math and physics instructor. Although course-scheduling problems no longer allow this course offering, Denise Wetli (senior physics faculty instructor) stated that the “experiment” produced permanent changes in the physics curriculum. All physics courses are now taught in an integrated lecture-lab format. In addition, all physics classes are now offered in the two physics labs. The lab setting, facilitated by the adjoining stockroom, provides the necessary flexibility to incorporate hands-on inquiry activities, demonstrations, and more intense experiments. This allows students to test their understanding of physics concepts more readily and more often.

The math-physics program at Wake Tech exemplifies TYC physics programs servicing two very different student populations, each with sizable enrollments in common courses. This dual-purpose program places responsibility on the faculty to remain abreast of findings in physics and math education research as well as the changes in the entry-level workforce knowledge and skills. Kimble and Wetli are recognized leaders in the math and physics education professional organizations at both the local and national levels. In addition to the frequent interactions with the vocational technology faculty, the physics faculty are members of industrial advisory committees to the Engineering Technology programs. This puts them in touch with local industry and makes physics a direct contributor to the college’s positive impact on the local economy. It is notable that the faculty from the Math and Physics Department meet once a year with engineering technology faculty to sustain the close mesh of the programs in the two areas.

The site visit team found the math-physics program to have many of the same features (strong administrative support with equally strong support from student services, very student- friendly environment, and commendable team collaboration among the multidiscipline STEM faculty) of the exemplary programs visited by SPIN-UP/TYC teams in 2002-2003. The Wake Tech program is exemplary as well in its instruction and services to technical students, even assuming leadership in the "development of new curriculum bridging the need for an instructional foundation in physics and math with the need for experience in applying these principles to workplace scenarios." The success of this math-physics program is the result of a common focus on student learning shared by the faculty, the support staff, the college administration, the community, and industrial employers.

Chapter 3

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Chapter 4
Critical Issues

Two important issues currently receiving a lot of attention within the science-education communities, especially within the American Association of Physics Teachers, the American Institute of Physics (AIP) and the American Physical Society, are the science preparation of K-12 teachers and the recruitment and retention of ethnic minorities and females into science studies and related careers. In an effort to determine how physics programs at two-year colleges are responding to these concerns, the project leadership asked the visited physics programs to describe their activities addressing these two critical issues and the impact of these activities on their students and the surrounding geographic community. The SPIN-UP/TYC teams also investigated these two concerns during their site visits. The 2003 AIP Background Survey[1] provided additional information regarding the activities within the larger two-year college community.

Two-Year College Involvement with Pre-College Education

The Role of Two-Year Colleges in Teacher Preparation

The publication of the *Shaping the Future* report[2] in 1996 helped to awaken the STEM (science, technology, engineering, and mathematics) education communities to the potential leadership role that two-year colleges can have in teacher preparation.

> *"A large percentage of prospective teachers begin their education in two-year colleges. These institutions, with their clear commitment to teaching and with so many prospective teachers as students, must be more significant partners in the system of teacher preparation."* [3]

Luther Williams, former NSF assistant director for Education and Human Resources stated:

> *"The resources of the nation's community colleges must be utilized fully if the need for a teaching force well prepared in science, mathematics, engineering, and technology is to be met."* [4]

These resources were exemplified by 11 two-year college programs highlighted during a 1998 NSF conference, "Investing in Tomorrow's Teachers: The Integral Role of the Two-Year College in the Science and Mathematics Preparation of Prospective Teachers." The report of this conference addressed this issue with these statements:

> "*Because excellent instruction is the primary focus at two-year colleges, their faculty members are well positioned to provide leadership*

in the quality of instruction in mathematics and science. Furthermore, two-year colleges are often located in regions directly serving rural and urban communities where new teachers will be needed most." [5]

The 2003 AIP Background Survey conducted in parallel with the SPIN-UP/TYC site visits revealed that approximately 19% of the 178 sampled two-year colleges have made course additions or curricular changes in the area of teacher preparation in the past five years.[6] The AIP findings[7] also state that most surveyed TYCs ranked "preparing students to be K-12 teachers" as their third highest program priority behind preparing students for transfer and preparing students for work.

The SPIN-UP/TYC site visit teams found that nearly 90% of the colleges visited have teacher preparation activities that range from individual courses to integrated course sequences leading to seamless transfer into teacher education programs at the four-year institutions. In addition, the Case Studies reveal that these colleges rate "preparing students to be K-12 teachers" as second program priority behind preparing students for transfer.

The NSF conference "Investing in Tomorrow's Teachers" and the findings from this SPIN-UP/TYC project provide strong and persuasive evidence of the existing involvement of two-year colleges in teacher preparation, developed through partnerships with universities, state certifying agencies, and local school districts. More importantly, the reports of these two initiatives strongly recommend that more TYCs should play an active role in recruiting and preparing the next generation of teachers, strengthening the science content of in-service teachers, enlarging a more diverse teacher workforce, and creating an awareness of and interest in physics through outreach activities.

Science Preparation

Since many future teachers satisfy their science requirements at a TYC, it is incumbent upon STEM faculty to provide a meaningful experience for these future teachers.

According to the report of the 1998 TYC conference,[4]

> *"While precise data do not exist, it is estimated that more than 40% of all teachers completed some of their science and mathematics course work at two-year colleges. Indeed, many future elementary and middle school teachers are taking most, if not all, of their college-level science and mathematics courses at two-year colleges*." [8]

Existing TYC models of comprehensive teacher preparation programs include three visited by SPIN-UP/TYC teams: Green River Community College (Washington), Howard Community College (Maryland), and Amarillo College (Texas).

Green River Community College (GRCC) has a comprehensive program designed for seamless transfer into teacher education programs at state universities. They require a year-long interdisciplinary science sequence that is team taught by science and mathematics faculty. Physics faculty (who created this sequence) are part of the team teaching these courses in two of the three quarters. Enrollment in this sequence, which is more than 80% future elementary education majors, has steadily grown and is now over 60 per year with more than 80% retention. GRCC's efforts are now known as Project Teach. Project Teach is a nationally recognized, exemplary program[9] and is a model being copied by other institutions around the country. There are currently more than 150 students in the Project Teach program. Project Teach has agreements with six local school districts and is now offering an on-campus, four-year degree and certification for teaching in grades K-8 with Central Washington University. To find out more about GRCCs effort, visit their website at: http://www.projecteach.org.

Howard Community College and colleagues around the state were partners in the development of an Associates of Arts in Teaching degree for the state of Maryland. The program they developed for elementary teachers includes two specially designed physics courses: Physics-106, Earth and Space Science and Physics-107, Physical Science. The courses have been designed to cover the essential topics identified in the Maryland core physics, earth/space and chemistry standards for K-8 students. Both courses extensively use inquiry-based lab activities taught in a constructivist learning style. In support of this effort, the college hired a new full-time faculty member to teach the Earth and Space Science course.

Amarillo College (AC) offers four science and two math courses designed explicitly for and required of future teachers. The physics program is an active participant in and contributor to teacher training. The program has implemented an Integrated Physics course, one of four integrated science courses fulfilling education requirements set by AC's major transfer institution. Ninety percent of the students in this course go on to become teachers. In addition, three to five students enrolled in the algebra-based and calculus-based physics courses (about 1% of the enrollment in these courses) will pursue a major in physics as a secondary teaching area. A part-time staff member, a retired physics teacher from the Amarillo School district, serves as consultant for the AC Teaching Education Center and coordinates the students' experiences with in-service teachers.

Other SPIN-UP/TYC visited colleges have added some course offerings in physics/physical science specifically designed for future pre K-12 teachers.

Delta College (Michigan) developed a two-semester sequence, Physical Science 101-102, which especially targets pre-service elementary teachers. Each of the four-credit courses is taught in the same integrated laboratory-lecture studio format as the other physics courses and promotes learning by inquiry. The courses make use of the curriculum materials from *Powerful Ideas in Physical Science*[10] and *Tools for Scientific Thinking.*[11]

In the fall 2003 Miami Dade College (Florida) introduced a bachelor's degree in physics education, with the main physics component being offered at the Wolfson Campus. This action is the college's response to recent legislation enacted by the State of Florida allowing community colleges to offer bachelor's degrees in secondary education.

A third effort by visited two-year colleges to address teacher preparation is the creation of excellent transfer arrangements with nearby universities.

Students planning to become K-12 teachers comprise 20% of the physics enrollment at Estrella Mountain Community College (EMCC) in Arizona. The identification of education majors in introductory physics is a pioneering effort among the physics programs at two-year colleges. Articulation agreements and collaboration between EMCC and the education departments at Arizona State University and Arizona State University West facilitate the seamless transfer of education majors from the community college as well as ensure the provision of quality science and physics preparatory courses for these majors.

At Lord Fairfax Community College (LFCC), the Physics 101-102 conceptual physics sequence provides a very strong inquiry-based sequence for pre-service elementary teachers.

These pre-service teachers can complete their entire four-year program at LFCC through Old Dominion University's TeleTechNet distance learning system.

Outreach

From the 2003 Survey of Two-Year College Physics Programs,[12] a number of TYCs are involved in outreach to their communities. Outreach is a set of activities that establish or confirm a continuing relationship with the pre K-12 community. Activities include professional development workshops, summer camps for students, faculty and student presentations, physics demonstration shows, campus and departmental tours for students, loaning equipment, and science competitions. Table 9 indicates the percentage of TYCs involved in such activities.*

Table 9. TYC Outreach Activities

Responding Schools	Sample Schools	Pool Schools	Visited Campuses
Summer workshop for K-12 students	8%	15%	44%
Student or faculty visits to local schools	23%	34%	44%
Workshops for local K-12 teachers	10%	29%	56%

The SPIN-UP/TYC Case Studies report that physics programs at many of the Visited Campuses have outreach activities, involving both the TYC faculty and students. The experience of these TYC physics faculty in implementing new teaching strategies (especially inquiry-based instruction) and national assessment tools to measure student learning facilitates the delivery of physics and science content to the pre-college teachers but also introduces future teachers to new models of science/physics instruction. Outreach activities to pre-service and in-service teachers ranged from very short presentations to multiple-day professional development workshops.

Dwain Desbien from Estrella Mountain Community College leads a number of Modeling Workshops[13] each summer for high school physics teachers. These workshops provide training in how to incorporate modeling strategies into their classrooms.

Mount San Antonio College (MSAC) in California provides a variety of outreach activities to area schools and their teachers. Students enrolled in the Teacher Preparation Physical Science Course prepare activities that they present to fourth graders in nearby elementary schools. Physics and engineering faculty regularly participate in visitations to local high schools during the schools' college-recruitment days. The Society of Physics Students (SPS) chapter also annually hosts a High School Outreach Day. One physics faculty member is active in the Speakers Bureau on the MSAC campus and presents talks to local community groups.

* Sample Schools represent a sample of all TYCs across the country; Pool Schools represent the 70 plus TYCs that responded to the SPIN-UP/TYC Site Selection Instrument; and Visited Campuses represent the TYCs visited as part of the SPIN-UP/TYC project.

The science faculty and students at Gainesville College (Georgia) and Rose State College (Oklahoma) present science educational programs for the community and K-12 schools. These include science shows and professional development opportunities for K-12 teachers.

The SPIN-UP/TYC teams reported that many of the physics faculty at the visited colleges present workshops for pre K-12 teachers at section and national meetings of the American Association of Physics Teachers. Still other faculty are participating with high school teachers in the Physics Workshops for the 21st Century.[14] At these three-day national workshops held around the country, TYC and high school faculty are actively engaged in new instructional strategies that are designed to allow them to implement them immediately in their classes.

Summary

The findings from SPIN-UP/TYC site visits and the 2003 AIP Background Survey verify that the two-year college community is responding to the *Shaping the Future* call for TYC involvement in teacher preparation. As described above, the science preparation and training of pre-college teachers is a high priority among the physics programs at visited and surveyed two-year colleges. The very characteristics identified by visiting SPIN-UP/TYC teams as contributing to the success of the 10 physics programs (a focus on students, the strong faculty attention to pedagogy and faculty assessment of student learning, the close ties to the local community and transfer universities, the strength of cooperation among STEM faculty, and the strong institutional support of the physics program) also contribute to the development of course offerings and outreach activities targeting the needs of pre-service teachers as well as in-service teachers.

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Role of Two-Year Colleges Serving Underrepresented Groups in Physics

The 1998 report from the American Institute of Physics, *Physics in the Two-Year Colleges*, provided a comparison concerning the enrollment by minorities (African Americans, Hispanic Americans, Native Americans) and women in two-year colleges and four-year colleges.[1] Thirty-one percent of the TYC student population enrolled in physics are female; this in comparison to the 58% of all two-year college students being female. In 1993, four-year colleges estimated their female enrollment in physics to be about 25%.[2] The 1998 AIP report revealed that 23% of the students enrolled at two-year colleges are minorities and minorities comprise about 15% of the students enrolled in physics at these institutions.[3] Both of these figures are larger than the enrollments at four-year colleges and universities whose enrollment is 16% minorities and 9% minorities in physics.[3]

Subsequently, the 2003 report from SPIN-UP (Strategic Programs for Innovations in Undergraduate Physics, a forerunner to this two-year college study) stated that the findings of the site visits to exemplary physics departments at four-year colleges and universities revealed that these institutions were not particularly successful in recruiting and retaining physics majors from among minorities and females.[4] Spurred by these two reports, the project directors of the TYC study felt that it was important to review the findings of the site visits to two-year colleges more closely to determine the reasons for the large percentage enrollment from underrepresented groups at these local institutions.

The 10 site visits conducted during the academic year 2002-2003 included TYC campuses with large enrollments of Hispanics, Asian Americans, and international (non-U.S. citizen) populations and females. However these sites did not have large enrollments by African Americans, either in physics or institution-wide. Therefore a team of physics faculty, in October 2004, conducted a site visit to Prince George's Community College in Maryland, which has more than 75% African American students in its population. The information from this site visit, combined with the findings from the 10 original visits generated the following conclusions.

SPIN-UP/TYC Conclusions

Except for historically Black and Hispanic colleges and universities, the student populations at most four-year colleges and universities tend to be heterogeneous, and minority populations (African Americans, Hispanics, and Native Americans) in the general population are also in the minority at the four-year colleges and universities. Because two-year colleges enroll students who come mainly from their geographic region, the demographics of the student population at two-year colleges will usually mirror the demographics of the region. A two-year college located in a community where the population is predominantly African American, Hispanic, or Native American will also have a student population that reflects that particular demographic.[5]

Two-year colleges that serve predominantly African American, Hispanic, or Native American populations have a significant opportunity and even a responsibility to encourage students to consider careers in STEM disciplines and to make them aware of transfer opportunities to four-year colleges and universities where they can successfully major in a STEM discipline.

As discussed in Chapter 1, the role of the two-year college in providing an intermediate higher education opportunity for students who find it difficult to leave their local communities cannot be overstated. Students may need the emotional support of their family and community or it might be financial issues that make attending a four-year college or university a hardship on the students and their families. The small class sizes of two-year colleges make it easier for these students to make the transition to the more demanding college course work than the larger class sizes usually found at four-year colleges and universities.

Several of the site visits made during this project were to institutions that had predominantly Hispanic populations, those being Estrella Mountain Community College (Arizona) and Miami Dade College, Wolfson Campus (Florida). Although both institutions are Hispanic serving, they are quite different in their settings and the students that they serve. The Hispanic population at Estrella Mountain primarily consists of students with a Mexican-American heritage. Miami Dade enrolls a more diverse Hispanic population including Mexicans, Cubans, and Puerto Ricans. These institutions are described in more detail in the Case Studies (see Chapter 5). The percentage of Hispanics enrolled in physics courses at these institutions is equal to or higher than the percentage of Hispanics enrolled in the institution.

Prince George's Community College (PGCC) serves a predominantly African American population in the Washington, D.C., metropolitan area. More than 75% of the 12,500 credit students were African American in the fall semester of 2003. Approximately 40% of the students are enrolled in transfer program options. Over the last three years at PGCC, more than 25% of the student credit hours generated have been in one of the STEM disciplines. Due to the close proximity of four-year colleges and universities to PGCC (University of Maryland, George Washington University, Howard University, Georgetown University, Towson University, and Bowie State University), many students transfer to four-year STEM programs after only one or two semesters at PGCC. For example, the calculus-based physics sequence at PGCC exactly mirrors the same course at the University of Maryland (no first-semester laboratory) to make it easier for students to transfer after completing only the first course in the sequence.

The percentage of enrollment of underrepresented students in the introductory physics courses at the two-year institutions visited during this project was typically equal to or greater than the institutional enrollment of underrepresented students. This contrasts markedly with what is found at most four-year institutions and is observed nationally. Table 10 below summarizes these differences.[6]

Table 10. Underrepresented Student Populations for Undergraduates (1997)

	Two Year Colleges		Four-Year Colleges/Universities	
	Number of Students	% of All Students	Number of Students	% of All Students
African Americans	599,586	11.1%	710,531	10.4%
Native Americans	69,879	1.3%	57,054	0.8%
Asian/Pacific Islanders	316,172	5.8%	376,525	5.5%
Hispanics	637,813	11.8%	523,883	7.7%
Total Minority Students	1,623,450	30.0%	1,667,994	24.4%
Nonresident Alien	203,702	3.8%	233,820	3.4%

Percentages are based on totals students enrolled.

For the most part, the large percentage enrollments among underrepresented students mirror the ethnic populations in the geographic communities of the two-year colleges. But another glance at the table above reminds us that the percentage enrollments of these minorities at TYCs are students in their first two years of collegiate studies. Female students comprise only about 30% of the enrollment in introductory physics courses nationally[1] but their enrollment in physics courses at the visited institutions is close to 40% in every case. The small class size and welcoming environment that characterizes two-year college physics courses are certainly main contributors to these higher enrollments, even though the evidence is only anecdotal. The cited data suggests that two-year colleges are well positioned to recruit students into physics from among underrepresented groups (ethnic minorities and females) early in their studies. The 13 campuses visited over the two-year term of SPIN-UP/TYC are meeting this challenge.

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Chapter 5
Project Findings

This chapter contains 10 Case Studies of exemplary physics programs at two-year colleges and the "Findings from the 2003 SPIN-UP/TYC Background Survey of Two-Year College Physics Programs." These reports emanate from the activities of Strategic Programs for Innovations in Undergraduate Physics in Two-Year Colleges (SPIN-UP/TYC). SPIN-UP/TYC, a program of the American Association of Physics Teachers and funded by the National Science Foundation, Lee College, and Southwest Texas Junior College, is a cooperative effort with the SPIN-UP project of the National Task Force for Undergraduate Physics funded by ExxonMobil and a follow-up to the Two-Year Colleges in the Twenty-First Century Project of the AAPT.

Within the last two decades physicists and educators have turned more attention to two-year institutions (community colleges, junior colleges, and technical colleges) to enlist their cooperation in implementing educational innovations and reform. American two-year colleges, now a century old, epitomize diversity—diversity in institutional vision and mission, diversity in programmatic vision and mission, and diversity among their students. Sandwiched between high school and four-year colleges/universities, two-year colleges (TYCs) occupy a pivotal position in the students' preparation for continuing baccalaureate studies and their preparation/retraining for the technical workforce. The AAPT SPIN-UP/TYC initiative is the third project in a series since 1989 to tap the rich resources at two-year colleges to produce an increase in the number of science, technology, engineering, and mathematics (STEM) majors, particularly physics majors, and a better understanding of the contributions of TYC programs to physics education.

SPIN-UP/TYC conducted 10 site visits to two-year colleges during the academic year 2002-2003. The physics programs selected for visitation had demonstrated excellence in one or more of the following areas:

- Success in recruitment and retention of physics and other STEM students;
- Success in recruitment and retention of future teachers of science and math;
- Success in recruiting women and underrepresented populations (these include traditionally recognized minorities and nontraditional students);
- Success in implementing innovations;
- Success in addressing the needs and learning styles of special student populations (special populations include underrepresented students, technical-vocational students, students who work full-time and students who are middle-aged or older).

Selection criteria for the TYC sites also considered the diversity of the programs as to number of full-time physics faculty, the size of the TYC campus student enrollment and/or college district, and the geographic location.

The Background Survey, conducted by the Statistics Research Center of the American Institute of Physics (AIP), was administered to a representative sample of all two-year college physics programs nationwide. The report of the AIP Findings describes the characteristics of all responding schools and identifies ways in which the visited programs were exemplary.

Amarillo College

Institutional Setting

Amarillo College (AC) located in Amarillo, TX, serves a diverse population of approximately 8,300 credit students and 30,000 continuing education students through its four campuses located in Amarillo and a fifth campus located in Dumas, 50 miles away. Governance for the college system is provided by a local board of trustees operating under community college guidelines set by the Texas Coordinating Board.

AC is an integral part of the community, due in part to Amarillo being the largest city in Texas without a university. Fifty percent of all high school students in the Amarillo city limits attend AC within two years of graduation, and one in six Amarillo residents attends AC each year. The breakdown of gender and ethnicity of AC students is similar to that of the area high school populations, with the exception of a slightly higher female population (59% at AC vs. 49% at high schools) and higher Asian and American Indian populations (4% vs. 3%, 1% vs. 0.2%, respectively). The African American populations are comparative at 4% at AC vs. 6% at high schools.

Approximately 50% of the students enrolled at AC are enrolled in a transfer curriculum and 50% in a career tract program. AC students who transfer to universities will typically receive GPAs higher than other transfers or native students. Technical program graduates report a placement rate of 94%. Health occupations rate consistently high (90%) for licensure and certification.

The Physical Science Department, comprising physics and chemistry, is housed within the Science and Engineering Division, the largest division on campus with a staff of 145. Atypical of most TYC physics programs that have one or two faculty, AC has five full-time physics faculty, one of whom serves as the chair of the Science and Engineering Division. Two of these faculty teach geology and astronomy as part of their regular teaching responsibilities and one faculty teaches calculus during the summer. A retired high school physics teacher serves as a consultant for a NSF/ATE funded project addressing in-service and pre-service teacher training. The support staff includes a full-time administrative assistant and a staff assistant.

The AC physics program provides a wide range of courses including the traditional suite of algebra-based and calculus-based physics courses, a preparatory physics course for students with limited backgrounds in science and math, an integrated physics course for elementary and middle school teachers, and a physical science course for non-science majors. An allied health physics course services the occupational therapy, pharmacy, and physical therapy programs.

What Has Been Done

1. The enrollment in physics has been stable over the past five years, and the number of STEM majors enrolled in physics has increased by about 4%.
2. The physics program aggressively recruits minority and female students.
3. Microcomputer-based activities, spreadsheet, and computational activities are used extensively in physics laboratories.
4. The physics faculty, in partnership with other STEM faculty, conduct successful and highly popular outreach activities to area schools.
5. Engineering and physics majors successfully transfer to universities and applied health programs are well served by required physics courses.

6. The physics program is an active participant in and contributor to teacher training. The program has implemented an Integrated Physics course, one of four integrated science courses fulfilling education requirements set by AC's major transfer institution. A part-time staff member—a retired physics teacher from the Amarillo School district—serves as consultant for the AC Teaching Education Center and coordinates the students' experiences with in-service teachers.

Indicators of Success

1. The physics courses at AC have achieved a comparative balance between males (52%) and females (48%), and minorities comprise about 21% of the physics student population.
2. From 2000 to 2002, the physics program enrolled about 12 students who indicated that they were pursuing a major in physics. For the same period, the total number of students majoring in a STEM discipline increased from 209 in 2000 to 235 in 2002. The majority of these students will transfer to universities. Most of these will go directly into the workforce as engineers after completing their baccalaureate studies, and some transfer students will enter the workforce with degrees in technology.
3. Faculty are implementing physics education research based curriculum (*Just in Time Teaching* and *Physics of Inquiry*) into physics courses targeting STEM majors (among these are students who plan to teach physics/science at the secondary level).
4. The Division of Sciences & Engineering conducted a successful Pre Freshman Engineering Program (Amarillo PREP) over 13 years for area middle and high school students. Eighty-eight percent of the students recruited during the lifetime of the program were minority students. Follow-up studies of its student participants reveal that all graduated from high school, 63% went on to college, and 47% entered engineering or science disciplines.
5. The Science and Engineering division hosts the annual Panhandle Science Fair. (This commitment has led to a permanent line item in the division's budget.)
6. The AC's CSEMS scholarship program funded by the NSF successfully attracted 51 computer science, engineering, and math majors from fall 2000 to spring 2003. Forty-eight percent of these students are minority students.
7. The Integrated Physics Course satisfies the education requirements for future teachers at Amarillo College's transfer institutions. Ninety-eight percent of the students enrolled in this AC course go on to become teachers. In addition, three to five students enrolled in the algebra-based and calculus-based physics courses (representing about 1% of the combined enrollment for these two courses) will pursue a major in physics as a secondary teaching area.

Keys to Making the Changes

1. ***Strong Departmental and Divisional Leadership.*** Decision making responsibility for implementing academic change, instructional and programmatic, is the domain of the leadership of the Physical Science Department and the Science and Engineering Division, who are themselves science teaching faculty.
2. ***Collaborating STEM Faculty.*** The leadership of the Science and Engineering Division and the Physical Sciences Department has forged a strong and viable collaboration

among the STEM faculty, enhanced by the multi-science teaching responsibilities of many of the divisional faculty. The activities of the division reflect the faculty's shared commitment to providing quality education and helping their students succeed.

3. ***Supportive Administration.*** The administration encourages its faculty to try new ideas and, upon recommendation from the divisional chair, cooperates with them to find the resources to implement change. The administration supports the efforts of the Science Division in seeking external funding from such sources as the NSF, NASA, and Hewlett-Packard. However, many of the physics efforts are internally funded and some appear as college budget line items. Professional development is required for faculty promotion and tenure and appropriately then, faculty are granted semester or year sabbaticals. AC also requires that all newly hired faculty complete four courses providing a philosophical understanding of community colleges and the mission and goals of the AC system. (This provision is rarely encountered among two-year colleges in our country.)
4. ***Team of Diverse Physics Faculty.*** The physics faculty, with many years of combined physics teaching experience, have diverse backgrounds ranging from astronomy, geographic information systems, geology, research physics, teacher education, and computer technology. The faculty are very receptive to new ideas and technology. They are active members of physics professional societies, including the national and Texas Section of the American Association of Physics Teachers, and regularly participate in professional development activities addressing both physics content and new teaching innovations.
5. ***Student-Centered Environment.*** There is a college-wide commitment to student success manifested by college policies and support programs. STEM majors are required to obtain faculty advisement from the Science Division chair prior to registration. Institutional tutoring and mentoring programs, such as Supplemental Instruction and the Access Learning Center, provide basic skills development and peer tutoring. The college facilities include informal student lounge areas located near the science-engineering classrooms and laboratories that serve as sites for student study groups. Special college services help faculty prepare presentations using technology, and a Testing Center provides assessment services facilitating instructional planning.
6. ***Financially Resourceful.*** With funding from the Texas A&M University System through the Houston Endowment Grant, the college was able to establish the Community College Teaching Education Center, which oversees the award of scholarships and advisement of pre-service teachers. With funding awards from the Texas A&M University System through the Houston Endowment grant to AC and West Texas A&M University (WTAMU), AC provides 40 scholarships from $300 to $800 to specified education majors who start their college career at the community college and finish at WTAMU. An NSF/ATE grant received last year provides funding to extend the alignment, articulation, and oversight of AC's science education courses. AC combined these two grants into the Teacher Education Center, housed and operated on the AC Washington campus. Currently 575 majors in education are being assisted.

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Delta College

Institutional Setting

Delta College is a two-year public college offering degrees in academic, professional, and technical programs located in Bay County, MI, and predominantly serving the counties of Bay, Midland, and Saginaw. The 640-acre main campus lies midway between the three counties' major cities of Saginaw, Bay City, and Midland. This triangle forms the heart of the Saginaw Valley area. Delta College has major centers in each of the three counties: Delta Planetarium and Learning Center in Bay City; Delta College Midland Center; the Ricker Center and Saginaw Center in Saginaw. The main industrial employers in the area include Dow Chemical, Dow Corning, General Motors, Chrysler, and Ford.

Almost 200 full-time and 400 part-time faculty teach daytime and nighttime classes to a student population of 3,650 full-time equivalent students with an unduplicated headcount of more than 10,000 students (fall and winter). The spring semester (equivalent to a summer session) has roughly half that number. The majority of the population is urban, with roughly 40% of the students in career education, 30% in a transfer program, and 20% undecided. Approximately 60% of the students are female. The percentage of underrepresented students is about 8%.

Programs at Delta College are organized into eight divisions, and the physics program is in the Science Division, which also offers the disciplines of astronomy, biology, chemistry, geography, and geology. Pre-engineering courses (for both two-year and four-year programs) are in a separate Technical Pre-Engineering division. Faculty must have a master's degree and 18 hours in their field to teach in a discipline. Full-time faculty teach 68% of the total credit hours at the college, but in physics 80–90% of the total credit hours are taught by full-time faculty.

What Has Been Done

1. The most innovative aspect of the physics program at Delta College is block scheduling of classes, which allows the integration of laboratory and lecture in a studio physics format during a 110-minute class period. The four-credit courses (Physics 101, Physical Science 101-102, and Physics 111-112) meet for four 110 minute periods each week. The five-credit Physics 211-212 sequence meets for five 110 minute periods each week.
2. All three classrooms used by the physics program have the latest in technology for providing audiovisual and computer-aided instruction. Students sit and work in groups of three or four, and the furniture can be moved to include MBL activities as needed. Cooperative learning is encouraged and the physics program faculty are committed to active engagement methods.
3. An optional astronomy laboratory has been added that can be taken with the descriptive astronomy course. The laboratory course makes extensive use of a planetarium on campus and a more modern planetarium facility located at a satellite campus. The planetarium on campus is being renovated to make it more useful for laboratory activities and hands-on laboratory work.
4. The physics program has developed a two-semester sequence, Physical Science 101-102, that especially targets pre-service elementary teachers. Each of the four-credit courses is taught in the same integrated laboratory-lecture studio format as the other physics courses and promotes learning by inquiry. The courses make use of the curriculum materials from *Powerful Ideas in Physical Science* and *Tools for Scientific Thinking*.

5. Physics 101 has undergone a total transformation in student body. The students in the course, mostly female, intend to enter the Diagnostic Medical Sonography Program. Some adjustments have been made to the class to meet the needs of the current student body.
6. Ultrasound Physics, DMS 105, is a brand new class that has been developed for the Sonography program. Ultrasound Physics is a two-credit course taught in a half-semester. Students take a second half-semester course on the same subject but taught by an ultrasound technician.
7. Delta College has established several 3 + 1 programs where students take their first three years at Delta and then transfer to Michigan Technological University or Ferris University. In a relatively new program, the fourth year is also at Delta College with the instruction being provided by Michigan Tech.

Indicators of Success

1. The physics program is experiencing increasing enrollment, and class offerings are limited by available faculty and facilities.
2. About 27% of the students graduating from high schools in the tri-county area start their post high school education at Delta College. About 40% of all area high school students attend Delta College at some time during their first five years after graduation from high school.
3. The percentage of females in the Physics 111-112 varies between 30% and 50%, much higher than the national average. The percent of females taking the Physics 211-212 sequence tends to 20% to 25% in the fall semester of Physics 211 but drops significantly during the winter semester of that same course. The number of females in Physics 212 remains fairly constant at 25%.
4. The percent of minorities in the Physics 111-112 and Physics 211-212 sequences varies between 10% and 15%, again significantly higher than the national average, but representative of the demography of the tri-county area where most of Delta's students originate.
5. Surveys of transfer students done by the dean of students and educational services indicate a high degree of satisfaction with the preparation received at Delta College.

Keys to Making the Changes

1. ***Collegial Spirit Among the Faculty.*** Faculty members respect each other and support the program at Delta College. Although all physics program faculty have not adopted extensive use of MBL or innovations such as WebAssign, they support their use. Faculty from other departments in the Science and Technical Pre-Engineering divisions interact with the physics faculty and support the program.
2. ***Commitment to Student Learning.*** All physics program faculty are dedicated to student learning. Full-time faculty, based on their concern for quality teaching, teach more than three-fourths of the courses. Adjunct faculty must adhere to the same objectives and outcomes as the full-time faculty.
3. ***Mentors for Adjunct Faculty.*** The college has a mentors program for adjunct faculty to help ensure the quality of courses taught by the adjuncts. Most of the physics adjuncts are high school teachers who have extensive teaching experience.

4. ***Implementation of Technology.*** The use of technology is stressed in the hiring of new faculty. One of the requirements for the two new faculty hires is that they be interested in using technology such as computer-assisted instruction, MBL, and WebAssign in their teaching. This requirement is supported by the college administration.
5. ***Financial Support for Faculty Development.*** There is support for curricular improvement in the form of grants and release time. Every full-time faculty member receives $825 per year that they can use for faculty development. Other faculty development funds are available through the dean of faculty. Several faculty members regularly participate in national and statewide meetings and workshops.
6. ***Administrative Commitment to the Physics Program.*** Both the Science Division chair and dean of faculty expressed a strong commitment to the physics program. The physics program receives an adequate share of the funds available for new equipment and recently received special funds to renovate the planetarium into a more useful teaching facility. The administration is willing to provide funds for full-time faculty to teach more than 75% of the physics offerings.

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Estrella Mountain Community College

Institutional Setting

Opened in fall 1992, Estrella Mountain Community College (EMCC) in Avondale, AZ, is the newest of 11 campuses in the Maricopa County Community College District. It provides educational opportunities and workforce training for western metropolitan Phoenix. EMCC is a public institution serving a student population of 7,000, 85% of whom are part-time students. EMCC offers numerous associate degrees, university transfer partnerships, and 17 specialized certificate programs. The college is an Hispanic-serving institution with 37% of the enrollment comprising minorities and 57% female. Estrella Mountain CC is funded through the Maricopa County Community College District which draws 60% of its support from property taxes. The two-year colleges in Arizona are no longer governed by a state coordinating board; thereby the MCCD functions independently from the other state community colleges.

Estrella Mountain Community College is located in an area once characterized as rural and sparsely populated. The college's service community is experiencing a rapid growth in population with an increasing need for college-prepared young people. Consequently the college is expanding its physical facilities and number of full-time faculty to accommodate the increasing enrollment.

The first full-time physics faculty at EMCC was hired in 2001. Prior to that time, physics courses were taught by part-time faculty. The physics program, housed within the Science and Math Division at EMCC, has one full-time physics faculty. Providing support to the program is a full-time lab technician serving all sciences and an administrative secretary for the science-math division. The program provides seven physics courses (a one-semester bridging course for those wanting to be engineers but who need some preparation, a one-semester physics course for liberal arts majors, a two-semester algebra-based course sequence and a three-semester calculus-based course sequence) on the EMCC campus and one dual-enrollment class at a local high school. Enrollment on the campus is approximately 55-60 students.

What Has Been Done

1. The EMCC administration successfully conducted a faculty search for an experienced and innovative physics teacher to establish a program providing an array of physics course offerings from conceptual physics through the calculus-based physics course sequence.
2. The physics faculty has successfully implemented teaching innovations into its physics courses. The Modeling Method is the basic methodology for every physics class, and the Modeling Discourse Management Method is employed for the management of each class. The physics courses use MBL activities (Vernier Software) either created locally or from *Tools for Scientific Thinking* and *RealTime Physics.*
3. The program successfully recruits and prepares STEM majors for successful transfer to a college/university. Approximately 30 of the students currently enrolled in physics at EMCC (50%) plan to pursue a major in a STEM discipline.
4. The number of nontraditional students enrolled in physics averages about 10 to 15%, which is fairly representative of the nontraditional physics student populations among community colleges.

5. The physics program identifies students who plan to become K-12 teachers and provides, with institutional and divisional support, introductory and preparatory science-math courses for education majors transferring to Arizona State University and Arizona State University West.

Indicators of Success

1. Since hiring the full-time physics faculty in 2001, class enrollment and offerings have increased each semester. The college now offers the entire range of physics courses provided by the Maricopa County Community College District. In addition, many students completing the one-semester survey course in physics decide to major in one of the STEM disciplines. A bridging one-semester physics course has been implemented to enhance the preparatory skills of EMCC entering students who plan to pursue studies in STEM disciplines.
2. Student understanding has been measured using standardized assessment instruments such as the Force Concept Inventory (FCI), the Mechanics Baseline Test, the Conceptual Survey of Electricity and Magnetism, and the Test of Scientific Reasoning (Lawson). The Force Concept Inventory post-test scores for first semester calculus-based physics have averaged 80% with a normalized gain of 0.69. The post-test average for the first semester algebra-based physics course is 73% with a gain of 0.60. Both of these FCI results are better than the national average. Calculus-based students scored 70.8% on the Mechanics Baseline Test (MBT) and 72% on the Conceptual Survey of Electricity and Magnetism, these scores being high, particularly among TYC students. Students in the conceptual physics course were given the Test of Scientific Reasoning and scored an average of 93% with a mode score of 100%.
3. Seventy-seven percent of the students enrolled in the algebra-based and calculus-based physics courses are STEM majors and successfully complete the physics studies at EMCC. Retention rate for all physics courses has been greater than 90% over the last three semesters. Anecdotal information indicates that most of these students successfully transfer to a four-year institution. The physics program at EMCC is too new to provide tracking data of its students. The high retention rates, the high gain on standardized assessment instruments, and the "buy-in for the innovations" from interviewed students testify to the appropriateness of the selected curriculum and pedagogy.
4. The combination of all the minority physics students at EMCC is approximately 50%, which is double the national average and higher than EMCC's minority student population. The Hispanic physics student population is nearly 40%, which is five times the national average and larger than the Hispanic student population college wide.
5. Students planning to become K-12 teachers comprise 20% of the physics enrollment at EMCC. The identification of education majors in introductory physics is a pioneering effort among the physics programs at two-year colleges. Articulation agreements and collaboration between EMCC and the education departments at Arizona State University and Arizona State University West facilitate the seamless transfer of education majors from the community college as well has to ensure the provision of quality science and physics preparatory courses for these majors.

Keys to Making the Changes

1. ***Strong Administrative Support.*** The administration at EMCC is receptive to academic

change, initiated at the faculty level, and works cooperatively with its faculty to provide the resources, with internal and external funds, necessary to implement and maintain change. The administration also encourages and supports the development and maintenance of a student pipeline from the local elementary schools through the transfer university. The administration has identified and adheres to its institutional strategic directions and goals for the next five years. Much of the philosophical foundation for the college's strategic planning is based on the findings from the NSF symposium held at EMCC on "Best Practices for Student Achievement in Science, Mathematics, Engineering and Technology in 2-Year Hispanic Serving Institutions."

The physics program, as one component of the Science and Math Division at EMCC, has evolved slowly and deliberately since the opening of the campus. The establishment of a physics program, with the hiring of a full-time physics faculty member, was precipitated by the specified institutional goal to implement an engineering program within the next few years. The search for the full-time physics faculty member was also well defined and deliberate. The administration wanted a teacher with demonstrated experience in best teaching practices appropriate to the needs and career goals of the EMCC student body.

The dean of instruction allocated the resources for the newly hired full-time physics faculty in 2001 to create a microcomputer-based laboratory for all physics classes and will allocate resources to remodel a lab area during the summer of 2003 to better accommodate the Modeling Method innovation used in all physics classes. The dean has also stated that the college will continue to update the physics program's computer and technology needs on a regular basis.

2. ***Innovative Curriculum Appropriate to Student Needs.*** The physics program offers an innovative approach to teaching introductory physics at all levels. The Modeling Method is an adaptation of the innovations used successfully in many high schools across the country. Students work together cooperatively in small groups and then discuss their conclusions as a whole in one large group, thus "actively engaging" students in the learning process. In addition, the physics faculty uses a class management technique, Modeling Discourse Management Method, that forces students to take ownership of their learning. Each semester the physics faculty incorporates design projects relevant to everyday life that serve as capstone experiences. A physics bridging course has been a significant contributor to the program's success in preparing students for academic success in the college-level physics courses at EMCC. Minority students comprise about 80% of the enrollment in this course.

3. ***Commitment of Physics Faculty to Quality Education.*** The physics faculty is committed to providing quality physics education to all students. The faculty member is accessible to students and is an effective facilitator in their learning process. In addition he is an active and visible participant within the broader physics and physics education communities.

   The physics faculty member implemented the Modeling Method because the faculty felt, based on his training and experience in physics education research at Arizona State University, that this technique best addressed the learning needs and career goals of the diverse student body at EMCC. He is actively involved in professional societies such as the American Association of Physics Teachers, the Arizona Section of AAPT and the Maricopa Area Physics Teachers, connecting him to the broader physics communities. In addition, the faculty member works collaboratively with the Physics Education Research group at Arizona State University and the nationwide Modeling Program.

The physics faculty member is also actively engaged in outreach activities at EMCC to increase the number of STEM majors, to increase the enrollment of students from underrepresented groups, and to increase the number of students planning to become K-12 science and math teachers. The physics faculty member maintains close ties and partnering activities with the physics faculty at the transfer institution, Arizona State University, and local industries. He arranges for his students to visit physics classes and faculty at the transfer university and for representatives from both industry and the transfer universities to visit his students during class time at EMCC.

4. ***A Supportive Environment.*** Interactions and collaborations among faculty, students, and administration are nurtured by the small size of the campus, the small class enrollments, the integration of physics within the Science and Math Division, and the institutional focus to prepare the EMCC students for success in both their academic studies and career pursuits. The science-math faculty and support services staff effect a community of support for both the physics faculty and the physics students.

   Estrella Mountain Community College provides institutional initiatives that strengthen the links between its STEM academic programs and the local schools, the general public, local industries, and universities. The NASA Center for Success in Math and Science provides outreach activities to pre-college and college students in its efforts to ensure that underrepresented groups are fully prepared to pursue careers that require mastery in mathematics and science. Several programs, such as the Young Scholars Program, the NASA Summer Academy, and the AMAS Summer Bridge Program, target the recruitment and preparation of entering freshmen from among the underrepresented populations, thereby helping to enhance the retention of students in academic programs at EMCC. The college has also received an NSF-funded CSEMS (Computer Science, Engineering and Mathematics Scholarship) award providing scholarships for students pursuing studies in computer science, engineering, and math. Through the Inspire. Teach Program the college in partnership with two transfer institutions, Arizona State University, and Arizona State University West, has developed a new science-math template in an effort to better prepare future teachers of science and math.

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Gainesville College

Institutional Setting

Gainesville College is a unit of the University System of Georgia. It is located in Gainesville, 50 miles from downtown Atlanta, on the shores of Lake Lanier and is the gateway to the Northeast Georgia Mountains. Gainesville College was established in 1966 and has grown to an enrollment of 3,500+ students. Gainesville College (GC) has recently opened a campus in Athens, GA, which has shown significant growth in a period of a few years. Gainesville College has primarily an academic mission with an adjoining institution, Lanier Technical College, which has occupational and vocational programs. Gainesville College has developed a reputation for teaching excellence and innovation in the University System, which is validated by several measures. GC students do very well upon transfer to baccalaureate programs and increase their GPA on the average. The college received the most exceptional commendations in its recent self-study and re-accreditation process.

The Physics Department is in the Division of Natural Sciences, Engineering and Technology which is administered by a division chair. There are two options available to students within the physics program—associate science degree in physics or associate science degree in physics education.

Gainesville College provides the typical range of physics courses including the two-semester algebra-based physics sequence and the two-semester calculus-based physics sequence designed for science and engineering majors. A two-semester integrated science sequence serves the general education needs of non-technical and non-STEM majors and education majors.

What Has Been Done

Over the last few years, the physics program at Gainesville College has developed a successful program. To accomplish this program change, GC's physics program has done the following:

1. The GC physics program utilizes various forms of technology. It has not only implemented microcomputer-based laboratory (MBL) activities in all its physics courses, but it has also implemented use of the Internet to supplement in-class instruction, homework, and out-of-class activities. GC's MBL uses modular self-contained stations (12) that allow minimum setup and tear-down time for different physics classes. GC's MBL utilizes traditional MBL activities, digital video analysis, and 3-D activities using global position system units. Instructors use a SoftBoard (allowing them to quickly upload their lecture notes to their webpage) as part of their instruction with wireless keypads to poll their students during instruction. By using WebAssign and WebCT as an instruction tool, physics instructors give students access to quizzes, homework, and other resources designed for their individual use.
2. All physics classes are taught as a combined lecture/laboratory class allowing students to perform activities and labs at any time during instruction.
3. GC's physics program expanded its facilities when the division moved into its new building in the fall 2000. The new building allowed a technology update for the program and more integrated use of technology within the physics courses and program.
4. Gainesville College is a Regents' Engineering Transform Program (RETP) institution, which guarantees that qualified students who complete their pre-engineering curriculum

at GC will transfer to the Georgia Institute of Technology. GC sends 15 to 20 students a year (all physics students) to Georgia Institute of Technology as part of the RETP.

5. A Society of Physics Student chapter has become very active and provides many activities that are also attractive to engineering and mathematics students.

Indicators of Success

The physics program at Gainesville College has a number of strong indicators to demonstrate their success over the last few years.

1. GC has a large number of physics majors. It has had two to four students each year who are physics majors and who later transfer to four-year institutions to obtain their baccalaureate degree in physics. Additionally, GC has about five students each year who later become K-12 physical science teachers.
2. GC has a large number of STEM majors who take physics. In addition to a growing number of pre-professional and allied health majors, the physics program has a healthy number of technology majors and majors in geographic information science. Physics students from GC have an almost 100% rate of completion of a baccalaureate in a STEM discipline.
3. The GC physics program has seen a steady enrollment growth the past three years, due primarily to the growth of engineering majors, growth in other STEM areas, and expansion and updating of facilities when the division moved into the new Science Building. This growth has been particularly large in the calculus-based sequence.
4. Students from GC who transfer to four-year institutions (nearly 400 during the academic year 1999–2000) actually improved their grade-point averages at the four-year institutions. This same trend is true for physics students who transfer to the University of Georgia, North Georgia College and State University, and Southern Polytechnic State University. Virtually all physics students transfer to four-year institutions.
5. The number of female physics students has increased and is comparable to the national average. The number of minority physics students has increased and is now significantly higher than the national average and the Gainesville College average. GC is the largest transfer feeder school to Southern Polytechnic State University. GC physics enrollment has about 60% of its students who graduated from rural high schools and approximately 50% of its students are first-generation college students.
6. Physics students polled during the last two years have consistently indicated satisfaction with the technology used in the physics program. Of the nearly 59 students polled, well over 90% thought the lecture/lab combined class made for a more effective learning experience, thought that the WebAssign homework aided their physics learning experience, that collaborative problem solving in class was helpful to learning, that “cycling” through lecture-activity-lab was helpful in learning physics, and that the technology used in the class added to their physics learning experience.
7. The GC physics program has received strong administrative support from the division chair to the president in the form of funding for equipment and facilities and recognition of the efforts of the physics faculty. The division chair in particular is intimately aware of the goals of the physics program and actively supports them.
8. Strong collegial support from other faculty members in mathematics, engineering, life sciences, and other physical sciences have led to a common goal in the SMET programs.

Faculty members work together to promote each others programs and they conduct with their students science educational programs for the community and K-12 schools, including giving science shows and providing professional development opportunities for K-12 teachers.

Keys to Making the Changes

There are several "keys" that have allowed the GC physics program to make the programmatic changes that have led to their success.

1. ***Supportive Administration.*** The administration is well aware of the excellent work that the physics program does both on and off the GC campus. Empowerment has been given to the deans, division heads, and the program director to experiment, develop new ideas and programs, and receive training for the betterment of education and teaching in general.
2. ***Supportive Technical Structure.*** The Information Technology (IT) Department provides outstanding support for the physics program as well as others. Many of the IT employees are ex-physics students and understand what the program is striving to achieve. Both the director and the Science Division IT specialist were "in tune" with and supportive of the mission of the physics program.
3. ***Supportive Collegial and Professional Leadership.*** Gainesville College has a very collegial environment with a lot of interaction between faculty across all disciplines. The "Learning Communities" project further encourages interdisciplinary professional interaction and curricular design. The Natural Sciences, Engineering and Technology Division is also a very collegial group and they all have a rich personal and professional interaction. This professional interaction helps fuel a noncompetitive, yet richly active, professional environment.
4. ***Faculty Leadership.*** The professional leadership provided by the faculty is the cornerstone to GC's superior program. The faculty is extremely enthusiastic about teaching physics, brings a positive attitude to work everyday and demonstrates mastery of the subject matter. The results of faculty leadership can be seen in the well planned out curriculum package. It can be seen in the well thought out and planned science building, and also the culture and communication abilities that are brought into the program.

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Green River Community College

Institutional Setting

Named after the river that winds through most of its service area, Green River Community College, in Auburn, WA, is a two-year public college that offers degrees and certificates in academic and professional and technical programs, as well as courses in continuing education and developmental education. Located on 186 acres, Green River Community College (GRCC) has been committed to maintaining the ecological integrity of the campus's forested growth. Students enjoy this beautiful campus in its safe and peaceful environment.

A core of about 120 full-time faculty and 210 part-time faculty teach daytime and evening classes. The student population is approximately 9,000—both full-time and part-time students—and features a growing diversity of ages and ethnic backgrounds. The roots of GRCC stretch back to 1945, when the Auburn School District started a program of adult evening education, which soon became the largest in the state. The popularity of the program convinced citizens from the surrounding communities that the Green River Valley needed its own community college. Local committees began working to secure state approval to start a community college in 1959. In 1963, the determination of local citizens paid off when the State Board of Education approved the community college.

GRCC's professional and technical program began in September 1964 at a location near the Auburn Boeing plant. A year later, Green River Community College opened its doors at its present location on Lea Hill, east of Auburn. This favorable location is easy to reach from local communities and is a 40-minute drive from either Seattle or Tacoma. With increasing demand for higher education, GRCC has opened satellite campuses in Kent and Enumclaw. The 1967 Washington State Legislature defines Green River Community College's service area as District 10. A five-member board of trustees governs the college. Financial support comes from state appropriations and student tuition.

The physics program provides a broad range of courses including a one-quarter physics course for liberal arts majors, a one-quarter astronomy course, a three-quarter algebra-based physics sequence, and a three-quarter calculus-based physics sequence. The physics program also offers a two-credit hour course in electromagnetism for physics and certain engineering majors and a three-credit hour course in Modern Physics. In addition, the physics program actively participates in a three-quarter interdisciplinary science sequence for future elementary school teachers. GRCC has three full-time faculty members, several part-time faculty members, and a laboratory technician to support the physics program.

What Has Been Done

Over a number of years, the physics program at Green River Community College has developed into an innovative, successful program. To accomplish this program change, GRCC's physics program has done the following:

1. The inquiry approach to teaching introductory physics has been adopted in all physics courses. The inquiry approach is used by all full-time and part-time physics instructors.
2. Longer class periods have been instituted in physics classes to allow more time for activities during every class period. In many physics classes, there is no distinction between "lecture" and "lab."
3. Microcomputer-based activities, video-based activities, spreadsheet and computational

activities have been instituted and are used extensively in all physics classes.

4. A three-quarter interdisciplinary science sequence has been created for pre-elementary education majors.
5. A special course in electricity and magnetism was created for physics and electrical engineering majors to better prepare them for their upper-division undergraduate courses once they transfer to a four-year institution. A modern physics course is also annually offered to aid these students.
6. A third full-time physics faculty member has been added to accommodate increased demand for physics classes. Additional sections are also being added for both the calculus-based sequence and the pre-elementary education interdisciplinary science sequence.
7. Faculty have consistently tracked students after they have transferred from GRCC. This tracking of students has given faculty valuable feedback on how well their GRCC programs have prepared students for their transfer programs and has led to significant program changes.
8. Consistent and long-term collegial interaction with other science, technology, engineering, and mathematics (STEM) faculty members has led to a number of team taught courses as well as changes to both the physics program and physics courses.
9. Long-term cooperation and communication with the GRCC administration has benefited the physics program.

Indicators of Success

The GRCC physics program has a number of strong indicators to demonstrate their success over the last few years.

1. GRCC has a large number of physics majors. It transfers three to seven physics majors each year to four-year colleges and universities. This is an unusually large number of physics majors for a two-year college.
2. The physics majors who transfer from GRCC have consistently obtained their baccalaureate degrees. Many of these physics graduates have received employment immediately, while several have chosen to pursue graduate degrees in physics.
3. The number of STEM majors for an institution the size of GRCC is large. GRCC transfers more than 50 engineering majors, three to seven physics majors, and a number of other science, mathematics, and technology majors each year. Of the transferring physics and engineering majors, 94% intend to get a baccalaureate degree in a STEM field and 54% plan to pursue an advanced degree.
4. During the past several years, only one student that has graduated from GRCC with a pre-engineering degree has failed to complete a bachelor's degree in engineering. (This is out of about 400 students!)
5. GRCC has strong minority and female student enrollments in all of its physics courses.
6. The use of inquiry methods in all physics classes has led to greater student retention and understanding.
7. GRCC has very high retention rates in all its physics courses. The retention rate for the calculus-based sequence has been around 80% and for the interdisciplinary science sequence over 80%.
8. GRCC physics students have performed extremely well on national assessment

instruments. Post-test scores and gains on the Force Concept Inventory have been much higher than the national average.

9. GRCC has an unusually strong emphasis on students who plan to become K-12 math and science teachers. The pre-elementary education program, as represented by Project Teach, originated in the physics area and now involves all the sciences and mathematics. Project Teach is a nationally recognized, exemplary program and is a model being copied by various other institutions around the country.
10. Students are actively involved in the instruction and excited about what they are learning in physics. This student involvement has led to active student organizations.
11. The GRCC administration from division level through the Office of the President are aware of what the physics program is trying to accomplish and supports both financially and philosophically their endeavors.

Keys to Making the Changes

There are several "keys" that have allowed the GRCC physics program to make the programmatic changes that have led to their success.

1. ***A Strong Collegial Spirit among STEM Faculty.*** Some of this collegial spirit is enhanced due to the close office proximity of the math and engineering faculty to the physics faculty. Collaboration among the faculty is recognized as an essential ingredient in both the hiring and evaluation process of new full-time and part-time faculty. There is a process in place for removing faculty who do not align with the mission of the physics program. There exists a strong mentoring program for new full-time and part-time faculty.
2. ***Long-Term (more than 30 years) Quality Leadership in Physics Program.*** One or more strong faculty members have a clear vision of the future direction of the physics program. GRCC has benefited from having multiple full-time physics faculty members. There was a well-defined transitional period from old to new leadership within the physics program. In part due to this long-term leadership, transfer institutions have respect for the GRCC physics program and the physics faculty as individuals. GRCC offers an attractive environment where there are rewards to staying a long time.
3. ***Attitude Stressing Innovation and a Commitment to Inquiry-Based Teaching.*** The GRCC faculty union gives the faculty freedom to innovate with the support of the administration. The commitment to inquiry-based teaching is stressed even in the hiring of new faculty. There is institutional support for curricular improvement in the form of grants and released time.
4. ***Strong Student Commitment to the Program.*** The physics faculty is dedicated to student learning. Active student organizations enhance student participation and student learning. There is a well defined and functional advising process and students receive sound advising from the faculty. The physics program is recommended by other STEM faculty and the administration.

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Howard Community College

Institutional Setting

Howard Community College is located in Howard County, MD, just north of Washington, D.C., and southwest of Baltimore. The college was established in 1970 and now has about 6,000 students following an academic transfer or career path making up a population of approximately 4,000 FTE. Another 12,000 people take courses for personal or professional development. Unduplicated students number 8,000. There is about a 60/40 ratio of students in transfer to career path programs. Howard Community College is currently the college of choice for 46% of all undergraduates from Howard County, an increase from 20% of the same student population in the early years of the college's existence. Students cited three reasons for choosing Howard Community College: "We can stay at home;" "the cost is affordable;" and "the college has a good reputation." Fees for in-county students are less than half of those for in-state but out-of-county residents.

Community colleges in Maryland are organized and funded, in part, at the county level. Howard Community College's current budget is funded approximately 40% by county appropriation, 40% by tuition, and 20% by the state appropriation. A governor-appointed Board of Trustees composed of Howard County citizens oversees the operation of the college, approves tuition, hires the president, etc. The Maryland Higher Education Commission approves all new programs, and the Maryland Association of Community Colleges provides some coordination between course offerings and programs. However, there is no statewide system of course descriptions, objectives, or numbering.

The physics program is located in the Science and Technology Division with the Chemistry, Earth and Space Science, Biology, Engineering, and Technology programs. There are currently two full-time faculty members teaching in the physics program, with the second person mainly responsible for the new two-semester sequence for pre-service elementary teachers. A shared full-time faculty member is responsible for teaching many of the physics and chemistry laboratories. A laboratory manager is responsible for setting up and stocking most of the laboratories for physics and chemistry courses.

The HCC physics program offers a wide range of physics courses including a one-semester technical physics course, a two-semester physical science and earth and space science sequence, a two-semester algebra-based physics sequence and a three-semester calculus-based physics sequence.

What Has Been Done

1. Microcomputer-based laboratories (MBL) have been introduced in all the physics courses, especially the calculus- and trig-based sequences. More than 65% of the first-semester laboratories and 50% of the second-semester laboratories use MBL equipment. Data analysis is carried out using Excel spreadsheets and the Vernier Graphical Analysis software. Some of the funding for adding MBL to the physics program was provided by a Howard Community College challenge grant.
2. Although the "lecture" and laboratory portion of the course are not integrated, special attempts are made to address student misconceptions in the lecture portion of the course using interactive lecture demonstrations (ILD), web-based activities, *Interactive Physics,* and similar resources. A Science Problem Solving CD-ROM was developed by Howard Community College faculty to use in several science courses, including physics.

3. Misconception pre-tests are given before most units in the trig-based sequence to identify those concepts that need extra attention in the classroom presentations. The in-class activities and assignments are designed to address those concepts.
4. The Force Concept Inventory, Conceptual Survey in Electricity, and Conceptual Survey in Magnetism have been used occasionally as pre- and post-tests, especially for the outcomes assessment projects that are done periodically throughout the Division of Science and Technology and the college.
5. A two-course sequence has been developed for pre-service elementary teachers—PHYS-106, Earth and Space Science, and PHYS-107, Physical Science. The courses have been designed to cover the essential topics identified in the Maryland core physics, earth/ space and chemistry standards for K-8 students. Both courses make heavy use of inquiry-based lab activities taught in a constructivist learning style. A new full-time faculty member, Sharon Lyon, has been hired to teach the Earth and Space Science course.
6. Howard Community College Faculty Summer Grant Program and Teaching Improvement Project funds were obtained to purchase new equipment, fund travel to meetings and workshops, update course objectives, and develop problem and concept worksheets.

Indicators of Success

1. Positive student comments on questionnaires and numerical ratings for Teacher Improvement Projects.
2. High passing grades on the science/mathematics portion of the Cardiovascular Technology Certification Science Test by the students in the Technical Physical Science class.
3. Increasing enrollments in the last three years for most of the physics courses, especially the courses for pre-service elementary teachers.
4. Anecdotal evidence that students transferring to colleges and universities in the Maryland system are very successful. Former Howard Community College students interviewed during the site visit were very complimentary of the preparation they received in the physics program.
5. A very positive relationship exists between Howard County's K-12 school system and Howard Community College, especially the two full-time faculty members involved in the physics program.
6. Enrollment in physics courses by minority students has a similar profile as the number of minority students enrolled in the college. Minority students make up about 40% of the enrollment in physics.
7. Enrollment in all physics courses by female students is greater than 40% as compared to a college enrollment by females of approximately 60%. Enrollment by females in the calculus-based sequence is typically close to 30%.
8. The high percentage of Howard County students that enroll at Howard Community College sometime during their higher education experience.

Keys to Making the Changes

1. ***Faculty Focus on Student Learning.*** Professor Russ Poch has been teaching physics at Howard Community College for 31 years. He has been responsible for obtaining funds and other support to upgrade the laboratories with MBL equipment and other technology. He regularly participates in faculty development opportunities that result in new learning and assessment methods being introduced to the classroom.
2. ***Strong Administrative Support.*** There is strong support for the physics program and the changes being made in the program by all levels of the administration from Science and Technology Division Chairman Dan Friedman, to College President Mary Ellen Duncan. Funds have been provided to the physics program to support the introduction of MBL equipment in the laboratory, as well as faculty participation in various workshops and other professional development activities.
3. ***Strong Community Support.*** There is strong support for Howard Community College from the citizens of Howard County. The county provides significant support to the college through its tax dollars which allows the college to provide the infrastructure and quality instruction that encourages students from the county to enroll in the programs offered by the college. The recently completed classroom building that includes computer laboratories and high-tech classrooms to bring the total number of computer workstations available on campus to more than 3000 is an example of this significant support.
4. ***Cooperation among Faculty and Administration.*** There is a very strong collegial relationship between faculty and between the faculty and administration. Both entities seem to have the welfare of the students as their greatest area of concern.
5. ***Active Outreach to Pre-College Teachers.*** Professor Poch has played an active role in K-12 science education at the county level. He currently serves as chairperson of the Howard County Science Advisory Committee that advises the public school system on science curriculum issues.
6. ***Faculty Involvement in the Development of State Teacher Standards.*** Professor Poch served as the Howard Community College representative to the statewide Maryland Articulation Partnership for Teachers (MAPT) committee which developed the science curriculum for the associate of arts in teaching degree for pre-service elementary teachers. He is also serving on the MAPT committee that is designing the curriculum for the Physics Secondary Education Transfer program.

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Lord Fairfax Community College

Institutional Setting

Lord Fairfax Community College, Middletown, VA, is a comprehensive, nonresidential, two-year public community college located in northwest Virginia. The college was founded in 1970 to serve the citizens of Clarke, Fauquier, Frederick, Page, Rappahannock, Shenandoah, and Warren counties and the city of Winchester. The service area encompasses 2,559 square miles and has a population of approximately 237,500. Between 1980 and 2000, the college's service area population increased by more than 23%. Lord Fairfax Community College's annualized full-time equivalent (FTE) enrollment has doubled over the past decade, reaching an enrollment of 2,470 in 2001–2002 (1,981 at the Middletown Campus and 489 at the Fauquier Campus). The unduplicated headcount has increased from 4,482 in 1991–1992 to 6,630 in 2001–2002.

The college operates as part of the Virginia Community College System, which is administered by the State Board for Community Colleges. The chancellor is the chief executive officer of the system and is responsible for statewide planning and coordination of the 23-campus system. The chief administrative officer of the college is the president, who is responsible for the organization and operation of the college in accordance with the policies, procedures, and regulations of the State Board, the Virginia Community College System, and the local College Board. Lord Fairfax Community College is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award the associate degree.

The 2001–2002 budget for the college was $13.8 million, 97% of which comes from state funds with the remaining coming from grants and the college foundation. All colleges in the Virginia Community College System charge the same tuition, which is currently $57.71 per credit hour. The typical teaching load for faculty is 12 to 15 credits per semester (15 to 20 contact hours). There are approximately 50 full-time faculty and 189 part-time or adjunct faculty. The interim president estimated that 50% of the FTE are taught by full-time faculty and 50% by adjunct faculty.

The physics program at Lord Fairfax Community College is located in the Division of Mathematics, Science, and Technology. The program has one full-time faculty member at the main campus in Middletown and a part-time faculty member at the Fauquier campus. An adjunct faculty member is employed occasionally to teach astronomy. There are no other support staff available to the program except shared secretarial support through the Division Dean's office.

What Has Been Done

Lord Fairfax Community College offers three physics course sequences that serve the transfer and career needs of the current students: a calculus-based three-semester sequence (PHY241, 242, 243) taken primarily by engineering students and a few physical science transfer students; an algebra-trig-based two-semester sequence (PHY201, 202) taken mainly by engineering technology, life science, and liberal arts students; and an algebra-based conceptual-level sequence (PHY101, 102) intended primarily for pre-service K-12 teachers.

1. Professor William Warren, who has been at Lord Fairfax since 1984, made a significant change in the way these courses were taught beginning in 1992 when he began to use Workshop Physics in all the physics courses. The Workshop Physics approach was extended to the PHY101-102 sequence this past academic year.
2. All the courses are taught in three 2-hour blocks or two 3-hour blocks each week for a

total of six contact hours for the four credit courses. Students work through a 20-page handout each week in a collaborative arrangement of three or four students at each station.

3. All the physics classes use a significant amount of MBL equipment that was purchased with an NSF ILI grant and matching college funds in 1992. Plans are in place to replace the aging microcomputers used in the laboratory with either new Macintosh or high-end PC machines before the start of the 2003-2004 academic year.
4. The Force Concept Inventory is used as a pre- and post-test in the first semester of all courses and the gains in student scores average about 20 to 30%. This is about double the gain obtained before Workshop Physics was implemented at Lord Fairfax.
5. By moving to the Workshop Physics approach, the physics program has been able to continue offering low-enrollment sections of PHY242 by “stacking” the section with a section of PHY202. Students from both classes meet at the same time and work independently through similar materials but at a slightly different level and pace.
6. Virginia has instituted a Master Course File system for the Virginia Community College System. Every course in the community college system with the same number has the same course objectives. This simplifies the transfer of courses to any public institution in Virginia. In addition, transfer guides to all institutions in the state are available online.
7. The PHY101-102 conceptual physics sequence provides a very strong inquiry-based sequence for pre-service elementary teachers. Because these pre-service teachers can complete their entire four-year program at LFCC through Old Dominion University’s TeleTechNet distance learning system, there is a good potential for growth in enrollment of this course.

Indicators of Success

1. Lord Fairfax Community College’s Office of Planning and Research does a follow-up survey of transfer students after one year and three years with about a 30% return rate. A transfer summary for recent LFCC physics students from the State Council for Higher Education for Virginia (SCHEV) showed 50% of the students transferring to STEM programs with 80% of those students being in good academic standing.
2. The limited data provided to the site visit team and interviews with some former students indicated those students are adequately prepared to make the transition from Lord Fairfax to the four-year programs. There is anecdotal evidence that the Lord Fairfax transfer students do better than native students. SCHEV collects data that may make these kinds of comparisons possible.
3. New STEM programs are being developed in conjunction with the building of a new $11 million science building (scheduled for completion in March 2005). Healthcare programs and associated support courses are very strong with more than 500 students enrolled in healthcare programs. There is good potential for increased enrollment in physics courses that are required for these programs.
4. A large number of pre-college students from the region enroll in dual-enrollment courses that ease the transition from high school to college. LFCC serves a very important bridging role between secondary and higher education for residents of its service region.
5. Although it varies by county, approximately 50% of college-bound residents from the service region enroll at Lord Fairfax Community College.

6. The number of females enrolled in the college is much higher than males, approximately 60%, mainly due to enrollment in health-care programs. The percentage of females in the physics courses is about 30%, still significantly higher than the national average for introductory college-level physics courses.

Keys to Making the Changes

1. ***Innovative Curriculum.*** Professor Warren's initiative to change all the physics offerings to the inquiry-based Workshop Physics approach has resulted in significant learning gains by students taking physics. All current and former students were very complimentary of Professor Warren.
2. ***College-wide Commitment to Student Learning.*** College faculty are dedicated to student learning. More than half of the FTE are taught by full-time faculty because of the concern that the faculty have for quality teaching. Adjunct faculty must adhere to the same objectives and outcomes as the full-time faculty.
3. ***Support for Professional Development.*** All faculty members (including adjunct) are eligible for up to $550 of professional development funds, and additional travel funds are available through Maintenance and Operation funds. Professor Warren has participated in workshops at the national and local level.
4. ***Supportive Administration.*** There is evidence of substantial cooperation between the faculty and administration. There is strong support for the changes Professor Warren has made in the physics program at all levels of the administration. Even though Professor Warren's student evaluations were less positive when he first instituted Workshop Physics, the administration supported his use of inquiry-based methods because of the increase in student learning that he was able to demonstrate.

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Miami Dade College, Wolfson Campus

Institutional Setting

The Wolfson Campus, one of six campuses comprising the Miami Dade College (MDC), annually enrolls approximately 16,000 students, reflecting an increase of 17% in each of the last two years. Located in the heart of the Miami business and government districts a few blocks away from Biscayne Bay, the campus offers 60% of its classes during the day, and 40% are offered as evening classes. The campus is easily accessible to students via the city's inexpensive public transportation systems, and two parking garages accommodate the commuting students and faculty.

The Wolfson Campus provides a wide range of academic and occupational programs utilizing modern facilities and state-of-the-art technology that is available to all faculty and students. The Emerging Technologies Center of the Americas is available to all faculty for special classes, presentations and conferences. In addition students have access to two 200-computer classrooms within the Computer Courtyard that are available during the day and early evening.

Wolfson is distinctly an international campus (53% are U.S. citizens) with many students only recently immigrating to the United States. The student profile for the Miami Dade campus reveals that 62% of the students are Hispanic, 59% are female, and the mean student age is 26.5. Sixty-six percent of the students are from low-income families and only 37% of the enrolled students attend college full time. Seventy-eight percent of the students report that they work while attending college; 27% indicate that they work full time.

The physics program is part of the Natural Sciences, Health and Wellness Department, which includes chemistry (three full-time professors), biology (five full-time professors) and general education science programs (four full-time professors). The physics program consists of one full-time physics faculty member, Henry Diaz, who has taught at the college since 1976 and holds a physics Ph.D. from the University of Miami; one part-time physics laboratory assistant, three to five part-time physics instructors and one full-time laboratory technician serving the laboratory needs of all sciences. Guillermina Damas, the department chair, was a full-time physics faculty at the North Campus of Miami Dade before transferring to Wolfson Campus five years ago. She is active in physics curriculum development and student recruitment and teaches one or two physics courses each year. Like the students at Wolfson, many of the physics faculty and staff are from typically underrepresented groups and some of the part-time physics faculty are recent immigrants. Physics students have access to daily tutoring services provided by the Natural Sciences Tutoring Lab (the CHESS lab) open from 8:00 a.m. to 7:00 p.m. on weekdays and 10:00 a.m. to 2:00 p.m. on Saturday. The Math Lab is open from 7:30 a.m. to 9:00 p.m. Monday through Thursday and 8:00 a.m. to 4:00 p.m. on Fridays and Saturdays.

The physics program provides a typical range of physics courses including a one-semester introductory astronomy course, two semesters of physics with applications targeting students pursuing health and technical careers, a one-semester basic physics bridging course for students not completing physics in high school, the two-semester algebra-based physics sequence, and the two-semester calculus-based physics sequence designed for science and engineering majors. Each physics course, with the exception of the bridging course, has a separate co-requisite one-credit laboratory component. Two physical science courses serve the general education needs of non-technical and non STEM majors.

What Has Been Done

1. The physics program at the Wolfson Campus has successfully incorporated the use of technology and MBL-based pedagogy to facilitate student learning in the classes.
2. The campus administration has dedicated a new room for a physics laboratory and classroom. The room has been remodeled according to the specifications of Diaz, Damas, and the laboratory technician, Arnold Fleisch, producing a state-of-the-art learning environment with full technological capabilities. The room is equipped with 2002-vintage Macintosh computers with the full range of MBL sensors. A computer projection system has been installed accommodating interactive media presentations with interconnected Document camera, DVD, and VCR for projection as well as the availability of SmartBoard and Mimeo with both an instructor PC and instructor Macintosh. Recently installed software, the Classroom Performance System, allows faculty to record and instantly analyze student responses.
3. The implemented changes have enhanced the physics instruction at Wolfson with the addition of hands-on experiences and the incorporation of computer simulations of physical problems, motion video analysis, and computerized data acquisition and analysis. The curricular change was implemented to minimize the use of traditional lecture/laboratories, not eliminate this pedagogical venue.
4. In an effort to promote enrollment and retention in the calculus-based physics sequence, the physics program took overt action in 1999 to enforce the prerequisites for these courses. In 2000, the physics faculty developed and offered a one-semester bridging course as a prerequisite for students who had not completed high school physics.
5. The Natural Science Department obtained NSF funding for two CSEMS (Computer Science, Engineering, and Mathematics Scholarships) grants in 2000 and 2002. Ten carefully selected faculty from the Natural Science, Math and Computer Science departments serve as mentors for the CSEMS students. The screening of student candidates was revised prior to the second funding to increase the retention rate of students in the CSEMS program.

Indicators of Success

1. Since 1997, physics enrollment at Wolfson has realized a growth overall, even during periods when the college campus was not experiencing growth. In fall 1997 the combined enrollment in all courses was 84 and the combined enrollment during the spring 2002 was 281. During the past two years, the physics enrollment increased about 8%.
2. The physics program at Wolfson has a very strong retention rate among its physics students. For the last three years, each physics course has reported a retention rate greater that 72%. The first semester of the calculus-based sequence, for the last three years, had a 72% retention rate in the lecture portion and a 84.7% retention rate in the lab portion. During this same period of time, the second and third semesters in the sequence had 82.3% and 87.5 % retention rates, respectively. Both lab portions reported better than 92% retention rates. The courses taught by the Natural Science Department had an average retention rate of 68.2%.
3. The physics enrollment at Wolfson is 38.8% female, which is higher than the typical community college enrollment of 31% as reported by AIP in 1998 (Physics in the Two-Year College). Anecdotal data at Wolfson also indicates a higher than normal enrollment

in physics from minorities attributed to the campus population comprising 62% Hispanic and 24% African American.

4. Forty CSEMS scholarships were awarded during the first NSF funding term in 2000. The physics enrollment for fall 2001 displayed a marked increase, indicating that the award was serving as a positive recruitment tool for the physics program. Twelve of the CSEMS student graduates will receive scholarships to universities in the fall of 2003. Seventy students received CSEMS scholarships in 2002. Due to improved screening of the candidates for 2002, the physics faculty anticipate that the student performance and retention among these scholarship students will be much higher. The Natural Science Department will submit a third request for NSF funding in 2004.

5. Anecdotal evidence provided by the departmental chair indicates that most students enrolled at Wolfson Campus pursuing STEM studies successfully transfer to four-year colleges and universities. The calculus-based physics sequence serves as prerequisites for sophomore-level engineering statics and electrical circuits courses. According to the engineering faculty, the campus has a strong reputation for being able to provide university engineering programs with traditionally underrepresented students who are well prepared for the bachelor's engineering programs. The college pre-engineering program has articulation agreements with 60 engineering schools across the country, including Georgia Tech and Kettering University.

Keys to Making the Change

1. ***Opportunities for Professional Development.*** Damas and Diaz attribute the successful implementation of physics innovations in the classroom and laboratory to the training and support of the leaders of the NSF-funded TYC Workshops. These workshops provided the faculty with training in the recent innovations in introductory physics education as well as training in writing NSF grants to procure funding to support the change. More importantly, faculty credit the workshops with helping them to realize that the new pedagogy could improve student learning of physics at Wolfson.

2. ***Supportive Administration.*** The cultural climate institution-wide and within the Natural Science Department fosters academic change. The administration encourages and supports (1) requests for new technology, thus helping the college to provide cutting-edge technology skills to its students; (2) requests from faculty to attend professional development activities; (3) faculty efforts to procure external funding for programmatic change; and (4) requests for internal resources (financial and physical) to accommodate programmatic changes. As further evidence of the administration's willingness to embrace change, the college, beginning in fall 2003, will offer a bachelor's degree in physics education, with the main physics component being offered at the Wolfson Campus. This action is the college's response to recent legislation enacted by the state of Florida allowing community colleges to offer bachelor's degrees in secondary education.

3. ***Strong Cooperation among STEM Faculty.*** The housing of the STEM disciplines within the same department, the enforcement of prerequisites for STEM courses, and the shared Natural Science tutoring services foster the strong cooperation among the science and math faculty on the Wolfson Campus. In addition, there is strong cooperation among the STEM faculty college-wide. In line with the directive from the college president, the six campuses of MDC operate as one college and faculty share a responsibility in defining the objectives for the college's academic courses.

Professor Damas has served as the college's convener of natural science faculty. Cross campus communications occur multiple times during the year via face-to-face meetings, teleconferences, and email.

4. ***Student-Friendly Environment.*** The Natural Science Department provides a friendly and supportive environment for students. Physics faculty, the lab assistant, and tutors spend many hours in the physics classroom/laboratory, making themselves available to the students. A part-time lab assistant, in addition to the lab instructor, also works with students as they conduct and complete their lab activities. The network of tutoring centers (the CHESS and Math Labs) located near the physics classroom provide tutoring and peer support as well as providing employment for STEM majors as tutors. Approximately 40–50 students attend the seven or eight annual activities of the science-math club. These club activities include field trips, special speaker presentations and workshops.

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Mount San Antonio College

The Institutional Setting

Mount San Antonio College (Mt. SAC) in Walnut, CA, enrolls about 42,000 students, making it one of the largest single-campus two-year colleges in the United States. When the college was opened in 1946, it enrolled 625 students. The growth experienced by Mt. SAC mirrors the growth occurring within the community it serves. The college shares a boundary with California Polytechnic State University–Pomona, which receives the largest number of Mt. SAC transfers. The community surrounding Mt. SAC is highly educated but the economic bracket is middle to low income. Currently the college, a Hispanic serving institution, has an enrollment that is 38.2% Hispanic, 22.1% Caucasian, 24.5% Asian and 5.8% African American. During the last 10 years, the community has experienced a substantial growth in the Asian population.

Mt. SAC has 37 academic departments grouped within six instructional divisions, each of which is headed by a dean. The Department of Physics and Engineering is in the Division of Natural Sciences along with the departments of Agricultural Science, Biological Sciences, Chemistry, Mathematics and Computer Science, Registered Veterinary Technology, Earth Sciences, Astronomy, and Photographics.

The Physics and Engineering Department has five full-time physics faculty and one full-time engineering faculty. Two of the physics faculty with engineering backgrounds share responsibility for teaching some of the engineering courses. Two of the five physics faculty are tenured and have taught at Mt. SAC for 10 years. The department chair was hired as a physics faculty member three years ago and was only recently promoted to the chair position. The remaining two faculty have completed their first year at Mt. SAC. Approximately five part-time faculty teach physics, one of whom is the former department chair. The department has a full-time physics lab technician and shares a secretary with the other sciences in the division.

What Has Been Done

1. The enrollment in physics courses targeting STEM majors at Mt. SAC has grown significantly during the last four years.
2. The physics program successfully transfers STEM majors to four-year institutions.
3. The physics faculty have implemented research-based teaching innovations in their physics courses.
4. The physics program successfully recruits and retains students from underrepresented populations.
5. The physics program provides courses targeting all students enrolled at Mt. SAC, including those students who plan to become K-12 teachers.
6. The physics program provides a nurturing environment for its students beyond the classroom.
7. Physics faculty work cooperatively with each other and with other STEM faculty.
8. Physics faculty regularly participate in professional development activities.
9. The program provides research opportunities for its students.
10. The physics program has a strong outreach program with local schools.

Indicators of Success

1. The enrollment in the algebra-based physics course displays a steady growth over the last four years with a 43% increase. The three-semester calculus-based course has realized a 69% percent increase since 1999.
2. Students who complete all three sections of the calculus-based physics successfully transfer to the local universities. Seventy-five percent will transfer as engineer majors. Typically three to five students per year transfer as physics majors, a reputable number from a two-year college.
3. The program has successfully implemented inquiry-based activities within all physics levels. The conceptual physics course is using materials adapted from *Physics by Inquiry* and CASTLE in an integrated lecture/lab format. The laboratory section of the algebra-based physics uses interactive materials from *RealTime Physics* and *Workshop Physics*. The third semester of calculus-based physics has introduced *Just in Time Teaching* with desktop experiments, McDermott's *Tutorials in Introductory Physics* and white boarding. Initial assessment tools show positive gain in student learning.
4. The students enrolled in physics mirror the college's student population by minority representation. Owing to the large influx of Asian families in the area, 70% of the students in engineering physics are Asian. The physics program enrolls approximately 40% females.
5. Mt. SAC course offerings target students of all majors. The conceptual physics course and the physical science course target nonscience majors. The algebra-based sequence enrolls STEM majors and students pursuing studies in architecture and allied health. A special audience for this sequence is the engineering major who has not had high school physics. The calculus-based, engineering physics course enrolls primarily engineering majors and students majoring in physics, chemistry and mathematics.

   One section of physical science is a linked lecture-laboratory course specifically designed for pre-service teachers. Approximately 80% of the 60 students enrolled in the Teacher Prep physical science class are pursuing an elementary education major.

   Forty percent of the algebra-based physics students and the engineering physics students indicate that they will consider teaching as part of their career path. Physics student tutors employed and trained by the college's Supplemental Instruction Program are inspired to pursue degrees in physics and ultimately to teach at the college level.
6. The Physics-Engineering Department has designated a room centrally located among the faculty offices as a well-used student study room with computers, Internet access, whiteboards and reference materials. Students (typically four) actively tutor and mentor other students either as student instructors in the college's Supplemental Instruction Program or as departmental tutors/lab assistants. The department also hires two to four students per semester as paper graders.

   Mt. SAC has a large and vibrant SPS chapter. Approximately 20 two-year colleges currently have SPS chapters and of these only about five to six can be described as active chapters.
7. The physics-engineering faculty have biweekly department meetings where they share information about what works and what does not work in the laboratory exercises or share ideas on methodology. Lecture notes belonging to all faculty teaching the same course are available to all enrolled students. Two of the physics faculty will teach some

engineering courses in the fall and therefore work cooperatively with the engineering faculty to successfully prepare the engineering students for transfer to Cal State Fullerton, Cal State Los Angeles and Cal Poly Pomona. Some faculty attend meetings of the Math Department, and physics faculty incorporate topics into their courses that address the Mt. SAC Electronics and Computer Engineering Technology Program and the Airframe and Aircraft Power Plant Maintenance Technology Program.

8. Physics faculty are active members of AAPT, APS, the American Society for Engineering Education, and the local TYC21 organizations, attending professional meetings of these organizations and incorporating activities described in *The Physics Teacher* in their classes. In addition the faculty participate in Chautauqua workshops and NSF workshops addressing physics pedagogy. Two faculty regularly participate in research programs at local universities.

9. The physics program at Mt. SAC places several students per year in summer internships at JPL, Cal Tech and other REU programs. The Special Projects, Physics 99, course allows students to perform special research projects, typically two per year, such as the design and construction of hovercrafts or the testing of new tutorial software. Student design projects are incorporated within the physical science course and engineering physics. Some additional research activities are available to students as they participate in campus SPS competitions.

10. Students enrolled in the Teacher Preparation Physical Science Course prepare activities that they present to fourth graders in nearby elementary schools. Physics and engineering faculty regularly participate in visitations to local high schools during the schools' college recruitment days. The SPS chapter also annually hosts a High School Outreach Day. One physics faculty member is active in the Speakers Bureau on the Mt. SAC campus and presents talks to local community groups.

Keys to Making the Changes

1. ***A Student-Centered Environment.*** The physics program at Mt. SAC maintains an environment fostering a student learning community. The accessibility of the faculty offices to the classrooms, the assignment of research projects, and the active SPS chapter provide many opportunities for the students to interact with the faculty. The designation of the student study room and large hallways provide students with a place to congregate between classes. Opportunities for student employment within the physics program as tutors, lab assistants, and paper graders strengthen the learning community.

2. ***Team of Committed Physics Faculty.*** The multimember Physics Department comprises a team of well-qualified and diverse physics faculty who are receptive to new ideas and are resourceful. A strong mentoring program is in place for new and part-time faculty. Every three years the faculty collectively examine each of the physics courses and subsequently prepare future program goals and a plan to accomplish these goals. The faculty are cognizant of funding sources for physics education initiatives and have successfully prepared proposals for external funding from NSF, NASA, and Hewlett-Packard.

3. ***Strong Administrative Support.*** The administration encourages the physics faculty to participate in professional development activities, providing faculty with a paid sabbatical every seven years. The dean of natural sciences encourages faculty to implement teaching innovations and will seek funding, either internally or externally, to implement and maintain these changes. In an effort to respond to the increased demand

for more STEM classes and to enhance cooperation across the STEM disciplines, the administrators were successful in getting two recent bond issues passed. These bonds will fund construction and renovation of science buildings by 2005, producing a quadrangle of four buildings housing the STEM programs.

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Rose State College

Institutional Setting

Rose State College, Midwest City, OK, offered its first classes Sept. 21, 1970. Originally named Oscar Rose Junior College in memory of the well-known Midwest City-Del City Superintendent of Schools, the school was renamed Rose State College in 1983. In 1973 the college became a member of the Oklahoma State System of Higher Education. The college has grown from an initial enrollment of 1,700 in 1970 to a regular fall enrollment of approximately 8,000 in 2002. The demographics of the student body are similar to most suburban community colleges except that the number of Native Americans is slightly higher. The campus now includes 21 buildings on approximately 116 well-groomed acres. The college is located in Midwest City, a suburb of Oklahoma City, and is adjacent to Tinker Air Force Base. The college has a typical administrative structure beginning with a board that is appointed by the governor down to departments that are headed by a departmental coordinator.

The physics program is a unit within the Division of Engineering and Science which is administered by a dean and associate dean. The division offers nine associates of science degrees and six associates of applied science degrees. There are three options available to students within the physics program—chemistry, engineering, and physics although almost all students choose the physics option.

The physics program provides a wide range of courses including a one-semester physics course for liberal arts majors, a one-semester course in astronomy, a one-semester physical science course, a one-semester applied physics course, a two-semester algebra-based physics sequence, a two-semester separate physics laboratory sequence, and a two-semester calculus-based physics sequence. In addition, the physics program also offers an advanced physics laboratory course for engineering and physics majors, an acoustics course for nonscience majors, and a modern physics course for physics majors. RSC has two full-time faculty members and several adjunct faculty members.

What Has Been Done

Over the last few years, the physics program at Rose State College has developed a successful program. To accomplish this program change, RSC's physics program has done the following:

1. To revitalize and rebuild a dying physics program, RSC hired an energetic and dedicated faculty member in 1999. A second physics faculty member was hired in 2002 to help in the development of the physics program and to accommodate the increase in physics enrollment.
2. The physics laboratory and demonstration equipment was consolidated from various locations into a single dedicated physics lecture/laboratory room. Adequate support was provided to purchase additional laboratory and demonstration equipment to complement the existing equipment. New and greatly expanded spaces for physics and astronomy laboratories will be in place for the fall 2003.
3. There have been additions, expansions, and upgrading of computer facilities, student access to these facilities, and necessary software in the physics area. A portion of one of the stockrooms in the physics laboratory has been turned into a computer room with four Internet-accessible, networked computers for student and laboratory use.

4. By having great flexibility in scheduling, the RSC physics faculty has been able to offer lecture and laboratory courses that meet student availability and has led to increased enrollment. Physical and multimedia demonstrations are used extensively by faculty and accompany all courses.
5. A special two-credit hour, advanced physics laboratory course was created to provide additional laboratory experiences for physics and engineering majors. A three-credit hour course on modern physics was added to help the physics and engineering majors prepare for transfer to four-year institutions.
6. A new course in acoustics and a second course in astronomy were being added in fall 2003.
7. Individual student research projects are encouraged. These honors projects have resulted in a great deal of student interest as well as collegial interest in the physics program.
8. One-on-one student-faculty interactions are encouraged. The physics faculty are available at all times to their students and spend many hours outside of class interacting with students.

Indicators of Success

The physics program at Rose State College has a number of strong indicators to demonstrate their success over the last few years.

1. RSC has a large number of physics majors. It has had six or more students during each of the last two years who have received an associate degree in physics and an even larger number who have transferred to four-year institutions as physics majors.
2. The RSC physics program has a large number of STEM majors. The strength of the physics program has led to a steady increase in engineering majors with more than 10 students now electing to obtain an associate in engineering degree every year. The number of students obtaining associate degrees in mathematics and life sciences is also rising according to STEM faculty, due in part to a strong physics program.
3. There has been a remarkable increase in physics enrollment during the last three years in all courses in physics. The calculus-based sequence has grown particularly fast in the last three years leading to the hiring of an additional engineering faculty member.
4. The number of females taking physics has increased during the last three years exceeding the national average in the calculus-based and algebra-based sequences. The number of minority students taking physics is much greater than the general RSC student population and the national average, with the calculus-based course now having more than 50% of its students as minorities.
5. The RSC physics program has received strong administrative support in the form of funding for equipment and facilities. Additional funds have been obtained to greatly increase the use of computers in the physics program.
6. Strong collegial support from other faculty members in mathematics, engineering, life sciences, and other physical sciences has led to a common goal in the STEM programs. Faculty members work together to conduct science educational programs for the community and conduct K-12 school visits giving science shows and talks.
7. The dedication of the faculty has fostered a strong student-learning environment. Physics students feel they are part of the physics program and are valuable members of

the physics team. Students know that the faculty are concerned about their learning of physics, are willing to help them learn both inside and outside of class, and will help them make the transition to their transfer institutions after finishing at RSC.

8. The physics faculty has implemented honors components in several of their physics courses. An honors physics student has been awarded the Outstanding Honors Project at Rose State College for the last three years.

Keys to Making the Changes

There are several "keys" that have allowed the RSC physics program to make the programmatic changes that have led to its success.

1. ***Aligned and In-tune Administrative Awareness and Support of the Physics Program.*** The administration at Rose State College, from the division dean level all the way up through the college president, support the physics program and are aware of faculty efforts. Interaction between the faculty members in the physics program and administrators at all levels is collegial and open. There is a sense of sincere interest and pride in the accomplishments and recent growth of the physics program among all administrators. The administration makes every reasonable effort to provide support to the physics program with funds, physical facilities, and moral support.
2. ***Charisma and Dedication of Physics Faculty***. The enthusiasm and love of the subject matter exhibited by the faculty in the physics program is quite infectious, resulting in a corresponding interest and zeal for the subject among students in the program (particularly among those students who take the calculus-based sequence). The faculty have built a student-friendly environment in the physics area and they encourage students to utilize both the facilities and them in their studies.
3. ***Collegial Spirit among Faculty.*** There exists a strong sense of team effort among the STEM faculty members. Most of these faculty members joined Rose State College about the same time, creating a foundation for a cohesive, team-oriented faculty that work well together and can be in place for many years to come. These faculty members take pride in each other's accomplishments and have a philosophy that successes in one program benefit all of the programs in math, engineering, and the sciences. These faculty members are willing to work together to juggle both physical and financial resources so that students get the best possible experience throughout the division.
4. ***Strong Student Support of the Physics Program.*** There exists an extraordinary amount of student support for the physics program. Students feel a sense of ownership in the program and clearly feel that the physics program faculty are on their side. There is a strong sense of community among the students who take courses in the physics program.

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Findings from the 2003 SPIN-UP/TYC Background Survey of Two-Year College Physics Programs

by Michael Neuschatz and Mark McFarling
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Introduction

The SPIN-UP/TYC Project, standing for Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges, was funded in 2002 by the Advanced Technological Education Program of the National Science Foundation, and conducted by the American Association of Physics Teachers (AAPT) to help identify best practices in physics instruction at the two-year college level. The study was linked to a parallel AAPT SPIN-UP project focusing on four-year colleges and universities. A central part of the project was the use of a carefully designed screening survey to establish objective criteria for selecting exemplary two-year college sites to be visited.

In order to situate the campuses that responded to this survey in the universe of all two-year schools, the Statistical Research Center (SRC) at the American Institute of Physics (AIP) was contracted to conduct a background survey that included a representative sample of all two-year college physics programs nationwide. In addition to the sample, the background survey also gathered information on every program that had responded to the in-depth site-selection survey.

This report will focus on the characteristics of all responding schools that composed the representative sample, and their similarities and differences with the schools that responded to the site-selection survey, and to the handful that were chosen for site visits. The purpose is both to draw an accurate picture of the current situation of the average two-year college physics program, and to identify the ways in which the 70 departments providing information on the site-selection survey and the 10 sites that were chosen for visits were similar to two-year college physics programs in general, and the ways in which they were exceptional.

The large background survey consisted of a systematic sample of one in four campuses across the nation offering physics, as identified in the AIP *Two-Year College Academic Workforce Study,* which had been completed in 2001. Out of the 263 sample cases, we heard from 178, or 67%. Included in this number were a handful of the 70 schools that had responded to the more detailed site-selection survey, conducted separately in a mailing to the roughly 1,000 presidents of schools that hold membership in the American Association of Community Colleges, and an overlapping mailing to roughly 700 members of AAPT. In order to ensure sufficient numbers to make accurate comparisons between these two groups, we surveyed the rest of these 70 schools as well, hearing from 65, or 93%. Among the respondents were nine of the 10 campuses that were ultimately visited by the SPIN-UP/TYC Team.

Background Data

Tables 11, 12, and **13** provide a comparison of background data from the following three groups involved in the study:

1. The representative sample of all two-year college campuses that offered physics, hereafter referred to as “the sample;”
2. The subset of all two-year college physics programs that responded to the separate

site-selection survey and thus constituted the pool from which the visited schools were selected, which we will call the (site selection) "pool;" and

3. The subset of group 2 schools that were visited by the SPIN-UP/TYC teams, which we call the "visited sites."

As these tables show, there was broad similarity in structural characteristics between the pool and the visited sites, although the small number of cases in the latter group makes comparison somewhat less reliable. Still, the only major exceptions were that the visited sites were on average slightly larger in terms of number of physics faculty, but had fewer women among their ranks. There was also slightly different minority enrollment in the two groups. Otherwise, we find broad structural similarities between these two groups. This is important, because it suggests that differences in physics departments' programs and practices were not simply a product of differing environments and background conditions, such as school or program size, faculty characteristics, and the like. Rather, those program differences, which qualified the 10 schools for site visits, were likely the result of clear and probably conscious policies and curriculum initiatives.

On the other hand, **Tables 11–13** also show greater differences on these same background variables between the pool and the sample schools. This is not so surprising, given the way in which pool schools were self-selected, but it does mean that careful thought needs to be given in devising ways to generalize the findings about what works best, since some of the differing background factors may facilitate reform, while others may present barriers to instituting new approaches. Among the larger differences are:

1. ***Campus type***—While most departments were at autonomous, standalone two-year schools, a significant minority was part of a larger community college system. In such cases, "pool schools" were more likely to be the main campus of the system, while sample schools were more likely to be subcampuses. This has implications for issues of resources and control.
2. ***School size***—Parallel to the preceding finding, pool schools were on average about 25% larger in terms of overall student enrollments than the nationwide average.
3. ***Physics program size***—Concomitantly, physics programs at pool schools tend to be somewhat larger, with more physics faculty and more sections of physics offered, than sample schools.
4. ***Faculty***—There tended to be somewhat more women at pool schools, and slightly more people who had earned a PhD.
5. ***Part-time faculty***—The use of part-time faculty was a bit higher at pool schools.

However, there were also a few important ways in which we found no differences between physics programs at sample schools and pool schools. There was broad similarity in the regional distribution of campuses around the country in the two groups. And while schools from urban areas were over-represented in the pool and schools from small towns were underrepresented, there was no significant difference in the proportion of minority enrollment at the two groups of schools. Finally, faculty turnover seemed broadly similar, measured by the average number of

Table 11. Campus Background Data

	Sample Schools	Site Selection Survey Respondents ("Pool" Schools)	Visited Campuses
Total Number of Campuses in Study	263	70	10
Number Responding to AIP Survey	178	65	9
Response Rate (%)	67%	93%	90%
Number of Students Enrolled at Campus: Mean	3,983	5,017	4,748
Median	2,729	3,853	4,067
Racial Composition			
African American	10%	11%	8%
Hispanic	9	8	12
Asian American	4	6	6
Native American	1	1	1
White (Inferred)	76	74	73
Type of Campus			
Stand-Alone	63%	68%	89%
Main Campus of a System	11	21	11
Sub-Campus in a System	15	6	0

NCES IPEDS 2001-02 Data, AIP 1996 Physics in the Two-Year Colleges

Table 12. Physics Program Faculty Characteristics

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Number of full-time physics faculty (mean)	1.7	1.9	2.4
Of which, % tenure-track	18%	17%	*
Number of part-time physics faculty (mean)	.9	1.4	1.5
% of part-timers among faculty	26%	33%	34%
% of women among faculty	15%	21%	13%
% of faculty with a Ph.D.	33%	38%	*
Number of years teaching at this school			
Full-Time (mean)	11	11	*
Part-Time (mean)	2	2	*

*Low number and missing data put responses below acceptable reliability level

AIP Statistical Research Center 2001-02 Survey of Two-Year College Physics Programs years that both full- and part-timers had been teaching at their current campus. However, there was a hint that the pool schools might currently be experiencing a faster growth trajectory than is typical in the sample—in the latter, the number of positions being recruited for this year and next was only half the number of faculty reported to have left in the previous two years, while among the pool programs, the recruitment number was almost twice the number of recent departures.

Program Data

The first question on the survey asked department chairs to rank in importance the primary goals of their physics program. As **Table 14** shows, transfer students are the primary focus of all three groups of departments. However, among the few departments that see their main focus elsewhere, more of the sample than the pool sites saw their priority as preparing students for entry into the industrial workforce.

While goals were fairly consistent across all three groups, efforts to introduce significant curricular and other program changes showed much wider variation. While all of the visited schools and three-fourths of the pool sites reported some type of reform initiative in the past five years, the proportion for sample schools was just under half. And, as **Table 15** shows, the same holds for the number and variety of reforms undertaken. Visited schools report the most, and sample schools the least, types of changes and kinds of courses involved. And overall, sample schools signaled an average of 2.3 changes of the types listed to their various physics courses over the past five years, compared to 5.2 such changes for the pool and 9.3 for the visited sites.

Table 13. Physics Course Information

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Number of physics sections offered, Fall 2001			
Mean	5.4	6.4	6.6
Median	4	5	5
Distribution of courses (as % of all sections offered)			
Calculus-Based	30%	35%	28%
Algebra/Trigonometry-Based	37	33	36
Conceptual	13	12	18
Applied/Technical	7	8	4
Physics/Physical Science for Education Majors	5	6	6
Other Physical Science	5	6	8
Other	3	1	0

AIP Statistical Research Center 2001-02 Survey of Two-Year College Physics Programs

Table 14. Physics Program Priorities

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Adjusted % citing this goal as *most important*			
Preparing students for transfer	72%	79%	100%
Preparing students for work	13	6	0
Preparing students to be K-12 teachers	4	1	0
Preparing students as future citizens	7	8	0
Other	4	6	0
% citing as second most important			
Preparing students for transfer	12%	12%	0%
Preparing students for work	45	37	11
Preparing students to be K-12 teachers	20	28	67
Preparing students as future citizens	19	18	22
Other	4	5	0

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This is exactly what would be expected given the survey design—many of the pool schools were probably more motivated to respond to the site-selection survey precisely because they were more involved in reform efforts than the average sample school, and had more to report. And the visited sites were selected from the pool specifically because of the intensity and breadth of their reforms.

Table 15 reveals that the greatest differences between the three categories of schools were in areas like changes in the pedagogical approach used in conceptual physics courses, which were found in roughly two-thirds of the visited schools, one third of the pool schools, and less than a fifth of the sample schools. Such contrasts were found at the other end of the course spectrum as well, for instance in revisions to the lab curriculum of the calculus-based introductory course, undertaken by two-thirds of the visited sites, over one-half of the pool schools, but less than a third of the same schools.

In addition to detailed descriptions of the changes undertaken by each of the three types of schools, the survey provides broader contrasts about which courses are most often targeted for reform and which kinds of reform efforts are most commonly undertaken. Not surprisingly, **Table 16** shows that the most widely taught courses, calculus-based and algebra/trig-based introductory physics, are most likely to be the subject of reform efforts. However, it is worth noting that the largest contrast is in the proportion of site select schools that had added and/or revised the content of courses aimed specifically at introducing physics to future K-12 teachers. This is clearly related to the high percentage of these schools that cited this as their second most popular goal.

Table 17 also shows that laboratories are most often the focus of reform efforts, specifically involving major revisions in lab curriculum and/or upgrades in equipment. Almost as common were changes in the pedagogical approach used in various courses. Interestingly, departments across the country seemed to be as ready to add entire new courses as they were to change the content of existing courses. And finally, few departments felt it necessary to remove courses to

Table 15. Curricular Changes Over the Past Five Years

	Sample Schools		"Pool" Schools		Visited Campuses	
Responding schools	178		65		9	
% making at least one change	47%		75%		100%	
Type of Course	**Of schools that made changes, % that:**		**Of schools that made changes, % that:**		**Of schools that made changes, % that:**	
	Added Course	**Removed Course**	**Added Course**	**Removed Course**	**Added Course**	**Removed Course**
Conceptual	16%	6%	8%	2%	0%	0%
Alg/Trig-based	6	4	6	2	0	0
Calculus-based	10	5	8	0	22	0
Technical	6	6	14	6	11	0
For K-12 teachers	8	1	14	0	56	0
Other	12	1	4	0	4	0
	Changed Existing Course: Content	**Pedagogy**	**Changed Existing Course: Content**	**Pedagogy**	**Changed Existing Course: Content**	**Pedagogy**
Conceptual	12	18	14	35	22	67
Alg/Trig-based	18	35	27	49	22	44
Calculus-based	16	27	29	37	33	33
Technical	8	15	14	16	11	33
For K-12 teachers	6	8	12	22	22	56
Other	2	1	4	4	11	11
	Upgraded Lab: Equipment	**Curriculum**	**Upgraded Lab: Equipment**	**Curriculum**	**Upgraded Lab: Equipment**	**Curriculum**
Conceptual	18	18	31	20	44	33
Alg/Trig-based	51	45	71	51	89	67
Calculus-based	46	31	65	55	67	67
Technical	12	15	16	16	22	22
For K-12 teachers	8	10	12	14	11	33
Other	2	1	8	4	11	11

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offset the new ones they added, pointing to generally growing size and breadth in the physics curriculum.

Such reform efforts cost money, and one key determinant of whether and to what extent they can be launched is where funding for implementation can be found. As **Table 18** illustrates, by far the most important source of funding was tapping general college resources for purchasing equipment and supplies, and that here the visited schools were far more successful than either of the other two categories. Reallocation of funds already assigned to the physics program was the second most used source, and here the pool and visited schools actually came in below the

Table 16. Types of Course Most Frequently Impacted in Curricular Changes

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% of schools indicating a change in at least one course	47%	75%	100%
Of schools that made a change, type of course changed:			
Conceptual	48%	59%	78%
Algebra/Trigonometry-based	75	92	89
Calculus-based	69	86	100
Technical	31	43	44
For K-12 teachers	19	37	89
Other	15	10	11

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Table 17. Most Frequently Indicated Aspect of Change to Curriculum

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% of schools indicating at least one curricular change	47%	75%	100%
Of schools that made a change, % that:			
Added a course	45%	39%	56%
Removed a course	18	10	0
Changed course content	33	55	56
Changed course pedagogy	51	74	100
Upgraded lab equipment	60	76	89
Revised lab equipment	55	71	78

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average indicated by the sample schools. However, the smaller results that emerged in the latter sites suggest the limited nature of this particular resource. This conclusion is also reinforced by the fact that many departments, of all types, described internal reallocation as a minor source of funds.

Other sources of funding, including general college funds to offset lost time or to add faculty or staff and extramural funding were much less commonly available. Here again, visited schools were most often successful, followed by pool schools and lastly sample schools. Somewhat surprisingly, that contrast was greatest with college funding to pay for faculty salaries. What all these results suggest is that the most active departments are those that are especially adept at "prospecting" for funds within their larger institutions, likely building influence and alliances with those controlling the spigot, rather than going outside to foundations, industry, and so forth.

Table 18. Major Sources of Funding for Curricular Change

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
Internal reallocation of departmental resources	34%	28%	22%
College funds from outside the physics program for equipment and supplies	49	50	89
College funds from outside the physics program for personnel, personnel time, etc.	7	13	22
Funding from outside the college	16	22	22
Other types of support	1	2	0

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Noncurricular Initiatives

Best practices include far more than changes in the classroom and laboratory. Our survey asked about four different kinds of activity that could serve to invigorate two-year college physics programs: recruitment and retention, supplying career information to students, tracking student outcomes, and other programmatic efforts.

Regarding the first of these, we found that almost two-thirds of departments claimed to be making at least some effort to increase recruitment and improve the retention of students. Among the pool schools and visited sites, this rose to 89% and 100%, respectively. However, larger differences emerge when we look at how many of these specific measures departments had adopted. While sample schools checked on average 1.2 different recruitment or retention activities, the number almost doubles to 2.1 among pool schools and almost triples to 3.3 among the visited sites.

Table 19. Recruitment and Retention Activities

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% taking any measure	66%	89%	100%
Average number of different measures implemented	1.2	2.1	3.3
Open house	9%	14%	22%
Summer workshop for K-12 teachers	8	15	44
Student or faculty visits to local schools	23	34	44
Targeted recruitment of STEM students	24	42	56
Targeted recruitment of underrepresented students	11	31	44
Workshops for local K-12 teachers	10	29	56
Special intro sections for potential physics majors	4	0	0
Host prospective physics students and families	5	5	11

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However, no single activity was adopted by a large fraction of the schools. As **Table 19** illustrates, the most commonly employed practices were targeted recruitment of likely science, technology, engineering and mathematics (STEM) majors, used by 24% of the departments overall, and visits by faculty and students to local high schools, used by 23%. The latter is a form of local outreach that has been recently touted in meetings and workshops on building and sustaining a strong two-year college science program. No other recruitment/retention strategy was implemented by more than 11% of the sample departments surveyed. On the other hand, pool and visited schools were much more active, with between a third and a half offering workshops for both K-12 students and teachers and engaging in targeted recruitment of underrepresented students.

A better job seemed to be done when it came to providing career information to their students. Almost three-fourths of the departments reported that at least one of the five dissemination methods listed on the survey was used, and a sixth of the schools offered an additional channel they had developed to deliver such information. The average number of such methods employed by departments in each of the three categories was much more even—1.4, 2.0, and 2.8 at sample, pool and visited schools, respectively—than was the case for curricular changes or recruitment and retention. However, this may be in part because some of the avenues required little active effort on the part of the physics program itself. As is evident in **Table 20**, the most common approach, taken by about half the programs, was to rely on the school's career services office. In second place, just over a third distributed career materials from the professional societies. Still, 19% arranged trips to local industries and 13% had industry representatives visit the campus. And in every case, pool and visited sites tended to be more active in feeding this information to students than was the case for the typical two-year college campus.

Table 20. Channels Used to Provide Career Information to Students

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% using any channels	77%	92%	100%
Average number of different channels used	1.4	2.0	2.8
Alumni visits to physics program	10%	22%	22%
Field trips to local industries	19	28	44
Career services offices	48	60	78
Visits from industry representatives	13	26	33
Materials from professional societies	35	45	67
Other	18	22	33

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We also asked about a potpourri of other efforts that departments might make to enrich their physics program and enhance the experience for their students. **Table 21** shows the 16 different items we listed on the questionnaire, along with an option for the department to list other activities that they engage in. Once again, about three-quarters of the departments mentioned at least one thing that they did, and once again, virtually all of the pool and visited sites did so. As with recruitment and retention measures, the number of initiatives employed by campuses in the each of the three categories varied considerably, from 2.0 at sample schools to 4.2 at pool schools and 7.1 at the visited sites.

Table 21. Other Program Enhancement Activities

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% citing any activities	75%	94%	100%
Average number of different types of activities cited	2.0	4.2	7.1
Regular student advising for STEM students	24%	55%	78%
Faculty or peer mentor	19	23	22
Required meetings with advisor	10	15	11
Student study room or lounge	15	28	11
Physics or STEM club	10	28	78
Industrial internships	5	15	44
Summer research program	9	32	56
School year research program	9	17	22
School year co-op program	8	23	57
Outside advisors on advisory committee	2	5	11
Students on advisory committee	1	2	0
Alternative physics courses for different majors	14	15	44
Targeted courses for technology students	34	39	33
Courses for education majors	20	39	78
Track outcomes of physics majors	9	34	56
Track outcomes of STEM majors	8	34	67
Other	6	14	44

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From **Table 21** we can see the most commonly cited initiatives, with two of the most popular being curricular: a third of the departments offered courses geared to STEM majors distinct from transfer-oriented courses, and a fifth offered courses aimed specifically at future K-12 school teachers. Surprisingly, only a quarter of schools mentioned offering advising to STEM students as regular part of their program, and only a fifth assigned a faculty or peer mentor as a matter of course. However, the programs deemed outstanding and selected for site visits were far more likely to have worked on fostering a nurturing atmosphere by, for example, developing clubs for physics or STEM majors, and they also are more likely to offer industry internships, co-op education opportunities, or summer work placements.

Finally, we asked about departmental efforts to track student outcomes. Only 36% of the sample schools, compared to 60% of the pool and 78% of the visited sites, engaged in any form of such tracking. As **Table 22** illustrates, the most common type of tracking effort reported was periodic surveys of past students, followed by queries to students on their immediate plans after leaving the two-year school and maintaining current mailing or email addresses for students after they leave.

Table 22. Types of Information Maintained on Student Outcomes

	Sample Schools	"Pool" Schools	Visited Campuses
Responding schools	178	65	9
% with any outcome tracking	36%	60%	78%
Employment/transfer outcomes	15%	29%	44%
Mailing or email addresses of former students	12	19	22
Updates supplied by former students	6	23	11
Newsletter/informational meetings to former students	3	3	0
Periodic surveys of former students	18	34	56
Other	3	14	33

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All in all, the nationwide survey of two-year college physics programs found substantial differences in the effort being mounted at the fraction of programs that chose to respond to the detailed site-selection survey on "best practices," compared with what was on average being done at more "typical" physics programs around the country. We also found some fairly significant structural differences between these two categories. There were also a number of notable differences between the schools that responded to the site-selection survey and the 10 programs actually selected for site visits, and here the structural differences were more muted. This points to faculty and administration policy, energy and organization at the 10 sites as playing a key role in broadening and strengthening their physics programs.

In addition to the information displayed in the preceding tables, the survey asked each respondent to provide greater detail and any evaluative comments they cared to share in open-ended answers to a series of questions on their experience in trying to enhance their program and improve their instructional effectiveness.

Appendices

APPENDIX A
SPIN-UP/TYC–Core Research Questions, Indicators & Manual for Site Visit Teams

The SPIN-UP/TYC principal investigators developed five core research questions that addressed the project goals and guided each team's review and study of selected two-year college sites.

Core Research Questions

Each site visit team will prepare a report addressing the following core questions:

1. What type of classroom environments and course structures are effective in preparing two-year college students for success
   a. at the transfer institution? (academic/technology students)
   b. in the workplace? (technical/technology/vocational students)
   c. for self improvement? (non credit students)

   What activities and practices of the physics program and faculty effectively address the educational and career needs of the diverse student population characterizing two year colleges?
2. What institutional and faculty activities and practices are effective in promoting change
   a. in the classroom?
   b. in the physics program?
3. What institutional and faculty initiatives are effective in recruiting and retaining
   a. STEM majors?
   b. women and under represented populations?
   c. future K-12 teachers, especially STEM teachers?
4. What formal (articulation agreements, bridging program courses) and informal (professional interactions) mechanisms are most effective in insuring a seamless transition for students from the two year college to
   a. the four year institution?
   b. the workplace?
   c. both of these?
5. What institutional and faculty initiatives are effective in establishing cooperative activities with
   a. local schools (pre college), private and public?
   b. civic clubs and/or youth organizations (e.g., Boy Scouts of America)?
   c. the general public?

To address the defined goals of the SPIN-UP/TYC project, 10 program indicators were identified to help define an exemplary TYC physics program.

The project leadership for the purposes of the SPIN-UP/TYC project defined what they viewed to constitute an exemplary physics program at a two year college.

Indicators for an Exemplary Two Year College Physics Program

SPIN-UP/TYC considers a two-year college physics program exemplary if:

1. The enrollment in physics courses offered at the two-year institution is stable at a level that the physics program and administration consider satisfactory or shows significant and sustained growth toward that number.
2. Most of the students completing their physics studies in an academic program at the two-year college transfer to a four-year institution with many of the transfers pursuing a bachelor's degree in physics and physics education. Most of the students completing physics studies in a technical program successfully receive an associate in applied science degree or a certificate in a technical program, with many students successfully finding employment in a field relating to their technical studies.
3. Morale is high among physics faculty (full-time and part-time) and physics students. The physics program regards its full-time and part-time faculty and students enrolled in physics as important members of the physics program team. Physics faculty have a collective voice concerning course offerings as well as course content and methodology and opportunities for professional development on campus and off. The college administration works closely with physics faculty to help them realize budgetary needs and initiate changes in the classroom or program. The physics/science program provides an environment fostering informal interactions between faculty and students and between students and students, such as designated student lounges, student resource centers, special speaker seminars, faculty-student socials, and a campus chapter of the Society of Physics Student or other physics/science focused clubs.
4. Other science, math, engineering and technology (STEM) faculty and the divisional chairs, deans and president respect the physics program and all college students find the program attractive. The physics faculty works with other STEM faculty to provide quality science education at the college, implement instructional or programmatic reform, develop specialized courses of study (such as technical physics), and serve as a strong science resource team for area public schools and the general community.

   Physics faculty are visible participants/leaders in student-initiated collegiate activities and serve as mentors for students, including students not planning to pursue physics as a major field of study. Course offerings within the physics program target ***all*** students, including those preparing to transfer to a four-year college or university; those acquiring skills needed for a new occupation or a current occupation; and those fulfilling personal interests and/or improving basic skills. Annually the physics program, in cooperation with other STEM faculty, hosts a physics/science focused speaker or event attracting science and nonscience faculty and students.
5. The physics faculty work cooperatively with STEM faculty and the college administration in the development and promotion of science-related events or projects, on-campus and off, targeting the general college student population and the college's service community.

6. The physics faculty, in cooperation with other STEM faculty, attract and retain women and underrepresented populations as STEM majors, particularly physics.
7. The physics faculty regularly participates in on-campus and off-campus professional development activities addressing introductory and/or technical physics content and pedagogy.
8. The physics program routinely assesses the needs and learning styles of its students and their misconceptions concerning physics, and evaluates the success of the physics program in addressing these needs and misconceptions. The faculty counsel entering students and administer entry-level exams so as to assess the "readiness" of the new physics students. The program provides tutors, special resources and course supplements to address the needs of the diverse student population, characteristic of the two-year college. In addition the physics program provides honors courses and opportunities for independent study within the physics program.
9. The physics faculty work cooperatively and collaboratively with the faculty of science departments, engineering departments and health-related programs of four year transfer institutions and representatives from business and industry concerning course content and offerings in introductory and technical physics.
10. The physics faculty, in collaboration with other STEM faculty, provide courses that recruit and target the science preparation of future teachers.

To help guide the site visit teams and to provide key information to the team members, the SPIN-UP/TYC project developed a Site Visit Team Manual. Each team member got the site visit manual before their site visits and used it during their site visit process.

SPIN-UP/TYC Site Visit Team Manual
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APPENDIX B
The Training and Planning Conference (TPC)

The TPC was hosted by Trinity University in San Antonio, TX, July 25–27, 2002. Fred Loxsom and the Physics Department of Trinity University provided facilities, support, and refreshments throughout the TPC. Bus transportation was provided by Lee College.

Goals of the TPC: The conference will

1. discuss how the SPIN-UP/TYC project is a natural next step for TYC21 and NTFUP/SPIN- UP activities
2. help participants define the role of site visits in identifying and describing "best practices" in two-year college (TYC) physics programs
3. train participants to collect and report in-depth information that can be used to verify and explain information collected through formal and informal surveys of TYC physics programs

Objectives of the TPC: During the conference, the participants will

1. analyze the meaning of the SPIN-UP/TYC Core Research Questions
2. critique and refine SPIN-UP/TYC Indicators describing a successful TYC physics program
3. propose a set of site visit protocol questions addressing the SPIN- UP/TYC Core Research Questions and Indicators of a successful TYC physics program
4. participate (by teams) in trial site visits
5. prepare (by teams) and critique site visit reports as to project goals
6. review the current documentation profiling TYC physics departments (e.g. 1998 AIP report on "Physics in the Two-Year Colleges")

TPC Participants and Staff

Twenty-three two-year college and four-year college/university faculty and one industrial physicist attended the TPC as participants with a number of staff and support staff members to conduct and run the TPC. These individuals were:

Regina Barrera, Lee College, Baytown, TX – Project Support
Maria Bautista, Kapi'olani Community College – Honolulu, HI
Tim Dave, Chabot College – Hayward, CA
John Enger, Northwest College – Powell, WY
John Griffith, Linn-Benton Community College – Albany, OR
Sandra Harpole, Mississippi State University – Starksville, MS
Shannon Hart, Applied Materials, Austin – Santa Clara, CA
Jack G. Hehn, American Institute of Physics, College Park, MD - Training Session Leader and Project Resource Person
Bill Hogan, Joliet Junior College – Joliet, IL
Ruth Howes, Ball State University – Muncie, IN
Karen Johnston, Momentum Group, Ft. Worth, TX – External Evaluator

Len Jossem, Ohio State University – Columbus, OH
Bill Kelly, Iowa State University – Ames, IA
Bernard Khoury, American Association of Physics Teachers, College Park, MD – Project Resource Person
Todd Leif, Cloud County Community College – Concordia, KS
Fred Loxsom, Trinity University, San Antonio, TX – Host of the TPC
Martin Mason, Mt. San Antonio College – Walnut, CA
Mary Beth Monroe, Southwest Texas Junior College, Uvalde, TX – Project Director and Co-PI
Marvin Nelson, Green River Community College – Auburn, WA
Tom O'Kuma, Lee College, Baytown, TX – Principal Investigator and Co-PD
Thomas Olsen, Lewis and Clark College – Portland, OR
Marie Plumb, Jamestown Community College – Jamestown, NY
Chuck Robertson, University of Washington – Seattle, WA
Conley Stutz, Bradley University – Peoria, IL
Richard Swanson, Sandhills Community College – Pinehurst, NC
Fred Thomas, Sinclair Community College – Dayton, OH
Bill Waggoner, Metropolitan Community College – Omaha, NE
Andy Wallace, Angelo State University – San Angelo, TX
David Weaver, Chandler-Gilbert Community College – Mesa, AZ
Denise Wetli, Wake Technical Community College – Durham, NC
Ali Yazdi, Jefferson State Community College – Birmingham, AL

Pre-Conference Homework Questions

Prior to the TPC, each participant was sent pre-conference homework questions to prepare them for the conference and to give them some feeling for what a site host might have to do to prepare for a site visit.

1. One of the areas of discussion that we will include as part of the site visits concerns the number of women and under representative minorities who take physics courses.
    a. From the AIP report, what are the percentages of women and underrepresentative minorities who take physics at the TYC?
    b. How does this compare with these groups at the four-year institution (FYC)? at high schools?
    c. How does the number of women and underrepresentative minorities taking physics compare to the number of women and underrepresentative minorities attending TYCs? four-year institutions (FYCs)? high schools?
    d. Compare these numbers to your institution's numbers for women and underrepresentative minorities.

Similar type questions could be asked about preparing future teachers and technology students.

2. One of the areas of discussion that we will include as part of the site visit concerns the number of STEM majors who transfer to four-year institutions and then later complete

their baccalaureate degree in a STEM discipline.

a. How many STEM majors have you had at your institution over the last 2 years? Compare this number to the number of students taking physics at your institution?

b. For TYC participants, what percentage of these STEM majors transferred to a four-year institution? What percentage completed a baccalaureate degree?

c. For FYC participants, what percentage of STEM majors transferred to your institution from a TYC? What percentage completed a baccalaureate degree?

Our project will seek to identify and describe successful and exemplary TYC physics programs within our country. To better understand "exemplary" we should first consider the average or typical TYC program.

3. Therefore prepare a short paragraph that describes the typical physics program at a two-year college within our country.

Brief Form of Agenda for the TPC

Wednesday, July 24		
Participants arrive		
4:00–5:00 p.m	Staff Meeting	
7:00–8:30	Supper at Crumpets for those who can attend	
Thursday, July 25		
6:30–7:30 a.m.	Breakfast at AmeriSuites	
7:30–8:00	Bus to Trinity University	
8:00–9:00	Welcome	Mary Beth Monroe
9:00–9:45	NTFUP and SPIN-UP	Ruth Howes
	The Need for SPIN-UP/TYC	Tom O'Kuma
9:45–10:00	Question and Answer	
10:00–10:15	Break	Refreshments
10:20–Noon	Realizing the Vision for SPIN-UP/TYC	Mary Beth Monroe
	Participant Team Activities	
Noon–1:30 p.m	Lunch	Campus Cafeteria
1:30–3:30	Training Exercises	Jack Hehn
	Session I 1:30-2:30	
	Session II 2:30-3:30	
3:30–4:00	Break	Refreshments
4:00–4:45	Details of Trial Site Visits	Monroe/O'Kuma
4:45–6:00	Planning the Site Visits I	Participant Teams
6:00	Return to AmeriSuites	
7:00–8:30 p.m.	Dinner at La Fogata	
8:30–	Planning the Site Visits II	Participant Teams
Friday, July 26		
6:30–7:30 a.m	Breakfast at Hotel	
8:00 a.m.–3:00 p.m	Trial Site Visits	San Antonio College or Coastal Bend College
3:00–6:00	Arrive at Trinity University	General Assembly
	Writing the Site Visit Reports I	Participant Teams
6:00	Return to AmeriSuites	
7:00–8:30	Dinner at Tom's Ribs	
8:30–	Writing the Site Visit Reports II	AmeriSuites
Saturday, July 27		
7:00–7:45 a.m.	Breakfast at AmeriSuites	
7:45–8:00	Bus to Trinity University	
8:00–9:40	Preparation of Oral Reports	Participant Teams

9:40–10:00	Break	Refreshments
10:00–Noon	Critiques	Jack Hehn
Noon–1:30 p.m.	Lunch on campus	Campus Cafeteria
1:30–5:00	Project Site Visit Protocol	Monroe/O'Kuma
5:00	Return to AmeriSuites	
7:00–9:30	River Walk (dinner on your own - bus will provide transportation)	
10–10:30 p.m.	Staff Meeting	

Sunday, July 28
Participants Depart a.m.

Annotated Details of the Agenda

Thursday Morning Session: TPC—"The Next Step"

Welcome & Introductions, led by Mary Beth Monroe

MBM gave us an official welcome, identified the goals and objectives of the TPC, and led the introductions of the participants and staff.

NTFUP and SPIN-UP, talk given by Ruth Howes

RH gave us a brief history of NTFUP and its findings so far. She described the SPIN-UP project and its findings and identified a missing piece in the undergraduate physics picture, the TYC piece.

TPC/The Need for SPIN-UP/TYC, talk given by Tom O'Kuma

TO identified the need for the TPC and the SPIN-UP/TYC project by addressing how little we know about TYC physics and what makes a successful/exemplary physics program.

Realizing the Vision for SPIN-UP/TYC, talk given by Mary Beth Monroe

MBM starting with TYC21 project identified what the SPIN-UP/TYC project would accomplish and how the TPC and the participants were essential in that process.

TPC/Teams on Research Questions, session led by Mary Beth Monroe

Participants were placed into eight teams with three participants per team. During the rest of the conference, participants did most of their activities as a team. In an effort to help participants develop an understanding of the core questions to be explored during site visits, the eight teams of participants were asked to determine what data needs to be collected during the site visit addressing the core question and what questions should be asked that also will help provide documentation along the lines of the core questions/topics. The eight teams turned their questions in during the conference.

Conference Teams

Marie Curie Team: Marv Nelson, Chuck Robertson, Bill Waggoner
Albert Einstein Team: John Enger, Len Jossem, Todd Leif
Niels Bohr Team: Sandra Harpole, Marie Plumb, Ali Yazdi
Albert Michelson Team: Shannon Hart, Rick Swanson, David Weaver
Richard Feynman Team: Maria Bautista, Ruth Howes, Martin Mason
Lise Meitner Team: Tim Dave, Tom Olsen, Andy Wallace
Enrico Fermi Team: John Griffith, Conley Stutz, Fred Thomas
Wolfgang Pauli Team: Bill Hogan, Bill Kelly, Denise Wetli

Thursday Afternoon: Site Visit Training Sessions—Jack Hehn, Trainer

The objectives of these sessions were:

- Participants will review and comment on the 10 Indicators of "A Successful Two-Year College Physics Program."
- Each participant will articulate specific questions for each indicator.
- Team specific and collective dialogue will take place seeded by scenarios.
- Session will lead to formal team preparation for the trial site visits.

The outcome from these sessions will be:

Each participant will provide by 6 p.m., July 25, 2002, at least three written questions for each Indicator. Your questions will be collected, reviewed, collated, and provided to you to aid in the site visit process.

Session 1—Introduction to the Exercises and Outcomes

During this session, teams will participate in the:

Review of the Research Questions – detailed discussion of the five research questions; and

Review of the Indicators – detailed discussion of the 10 indicators and what they mean in the site visit process.

Additionally, each team will evaluate the following scenario:

Sun Baked Community College Scenario (Q1)

The process followed for each scenario was the following:

Read the scenario, individually
Answer the three questions at the bottom of the page
Discuss the scenario and answers with your team
Discuss the scenario with the TPC participants

Scenarios developed by and used by Jack Hehn in the TPC

Q1: Sun Baked Community College
(Is the Institutional Mission Unique?)

You are welcomed to Sun Baked Community College by Herman Braces, the new President. Herman has stepped up the career ladder every three years and this is his fourth and largest institutional appointment. He is very interested in serving the needs of the community and sees his new institution as providing premier job skills training. He is proud of the fact that his new community college has a very high minority enrollment—minority enrollment having more than tripled in the last 10 years. Herman tells you at length how his Natural Science Division is building new programs to make sure that students can get jobs in a high tech environment. He points out a new Environmental Technology Associates Degree that has support from NSF ATE and tells you about two other programs in Chemistry. He does not mention the Physics program. (You wonder if he understands why you are on the campus.) Herman tells you to let him know if you need any more information or support, and he will put his Vice-President right on the issue.

You have talked to the two physics faculty members and believe that they have come to agree with the call for increasing emphasis on so-called "soft skills" (teamwork, oral and written communication, complex problem solving, etc.) in physics and science education, and they would like to enhance the program of study in this direction. But they express open skepticism about lowering academic standards and have some doubts about how their own pedagogical skills might be brought to bear in these areas. They point out that institutional academic standards seem to have been declining for nine or 10 years and "fewer students seem to be going on to college." The faculty members are quite proud of the three to four students each year that go on to major in science and mathematics at four-year colleges in their state. They bemoan the fact that few of these students seem to be minorities.

What questions do you develop to learn more about the situation?
What do you write in your report?
Do you offer any recommendations while you are on the site visit?

The second scenario addressed by the participants was Sacagawea Community College Scenario.

Q2: Sacagawea Community College
(How does change happen?)

There are now three faculty members at Sacagawea Community College. Coach Buzz Whacker was hired in 1963 when the institution was founded; Mr. Bob Gadget was hired four years ago after a downturn in the semiconductor industry caused him to rethink his career plans; and Dr. (George) G. Whiz was hired last year after finishing a Ph. D. specializing in Physics Education Research at Pacific Big U. Bob Gadget is currently serving as program leader. Whacker has announced that he may retire in a few years if the stock market continues to rally and his farm income continues to grow.

The written institutional report says that course enrollments are stable, new courses are being developed, and student evaluations has been consistent and are improving.

You learn that Prof. G. Whiz, on his own initiative, has revised the department's introductory course for potential majors (and Engineers) many of whom will transfer to Pacific Big U. Whiz has introduced several new pedagogical methods and revised the scheduling of activities from separate lecture and lab periods to a coordinated workshop-like environment. There is evidence of success: (1) a doubling of student enrollment, (2) increased FCI scores, and (3) increased student evaluations. You learn that Buzz Whacker has taught the algebra-based course for a long time and two courses in remedial mathematics, but the mathematics department has decided to increase their part-time faculty and no longer needs his help.

Next semester Buzz Whacker is scheduled to teach the major's course and spring pre-registration seems to be far below expectation. G. Whiz will begin a new Physical Science Course for Future Teachers and registration for that course seems unusually high for a new course. The other sections, including Gadget's Astronomy courses, have lost a few students to the new course but are at reasonable levels for pre-registrations.

What questions do you develop to learn more about the situation?
What do you write in your report?
Do you offer any recommendations while you are on the site visit?

Session 2

The third scenario addressed was *Old Iron Belt Community College Scenario (Q3).*

For this scenario each team member has a student interview. Each participant was given the following instructions. After you have read the scenario, talk about what you learned about the student and the program, but do not show the pages to each other.

Q3: Old Iron Belt Community College
(Which students did you talk to?)

Team Member #1 — **Interview: 21 year old, African American, Female**
Engineering (Electronics) Major
Inner-city high school, graduated in top 10% of her class

Comments:

I have attended Old Iron Belt for two semesters. I have made one B and the rest A's. I am just not comfortable here. There are few people here like me. I don't think many of my friends went on to college. The faculty and staff don't have much experience with people from the middle of the big iron city. Sometime they make me uncomfortable. They don't know when they say things that hurt. I don't think they mean to or want to. Their examples are always little red sports cars with two children in the back. They talk about a soccer games on Saturday morning and then going to gymnastics class. I think they try to understand, but they don't. When I drive out here, it's like driving into another country. I am trying to get ready to go to Iron State U up in State College. I have to come out here to take the science and mathematics that I need, but it isn't easy to come out here and be in another country. The courses are OK. I think I'm doing fine. I'm wondering if it will be different when I go to Iron State U. I want to be a great engineer someday; it's been my dream since I was very young.

What questions do you develop to learn more about the situation?
What do you write in your report?
Do you offer any recommendations while you are on the site visit?

Old Iron Belt Community College
(Which students did you talk to?)

Team Member #2 — **Interview: 21 year old, Chinese American, Female**
Engineering (Electronics) Major
Suburban high school, graduated in top 5% of her class

Comments:

I have attended Old Iron Belt for two semesters. This is a great school. All of my friends started here with me. We went to high school down the street. We all wanted to get our science and mathematics and core stuff out of the way before we go up to Iron State U up in State College. The faculty members are great. They spend time with you. You can talk to them in their offices. They want you to come by and talk. They don't give us as much homework as they did in high school. I am taking Calculus over; it's a snap. I want to get a very good preparation before I leave for the big Engineering school. They say it is very impersonal up there. I want to be a great engineer someday.

What questions do you develop to learn more about the situation?
What do you write in your report?
Do you offer any recommendations while you are on the site visit?

Q3: Old Iron Belt Community College

(Which students did you talk to?)

Team Member #3 — **Interview: 21 year old, Hispanic American, Male**
Engineering (Civil) Major
Small high school, graduated in top 20% of his class

Comments:

I have attended Old Iron Belt for two semesters. This is a strange place to me. I'm not used to going to school part of a day and on different days during the week. None of my friends could go to College. They had to get jobs and start paying back their family. Most of them just want to find a place and start a family. They want a trade that will make the family proud. I went to high school down state in a very small village. I wanted to get my science and mathematics and core stuff out of the way before I go up to Iron State U up in College Town. The faculty members here try hard, but they don't have much experience. You can talk to them in their office, but they keep saying the same thing they said in class. They think they can say it slower, but it doesn't help. They want you to come by and talk. I appreciate that. They give us lots of homework. I have to work 40 hours, and I don't have a lot of time to do homework. My family needs my check. I've been working since I was 10 years old. I am trying to take Calculus, but I think I need to drop back some. I want to get the preparation I need before I leave for the big Engineering school. They say it is very impersonal up there. I want to be a great engineer someday.

What questions do you develop to learn more about the situation?
What do you write in your report?
Do you offer any recommendations while you are on the site visit?

The fourth and fifth scenarios were *Caddo Community College Scenario and Big Flatland Community College*).

Q4: Caddo Community College
(How do you describe the physics program?)

We work six weekends or more with teachers every semester. We do all kinds of things with the PTRA in the area. We're a long way from the city, you know. We do three Eisenhower workshops every summer—one in mathematics, one in physical science, and one in chemistry. We used to do two Woodrow Wilson workshops before they went out of business. We've got the best SPS Chapter in the state! They make three or four trips every year to science meetings and give a lot of papers. They go out to elementary schools and do programs for kids. The kids love them. They eat enough pizza to keep the guy across they street in business. The SPS Chapter leads a Physics Olympics for the high schools in the region and gets over 200 students onto campus. Look at these pictures on the bulletin board…see all of those smiling faces! Lots of those kids will come to Caddo Community College next year.

I teach four courses: algebra-based physics, calculus-based physics, the second semester of Engineering Physics at night, and a course for X-ray technicians in the spring. I use standard text books (gives you the author's names), give daily quizzes, have the students work about 125 problems per semester for homework, have 10 labs that are graded rigorously, and give a final exam. I have good statistics on the final exam because I have given the same exam for 16 years. I don't have much equipment so I do similar labs in most of the courses. My problem books let me grade homework in a reasonable amount of time. I learned a lot of tricks when I was teaching in high school about a decade ago. I don't really have time to go to meetings because I am the only physics teacher. I spend my summer working in Montana as a Hot Shot on the fire lines, so I don't have much time to work on new lesson plans.

When you look at the atmosphere and excitement here…all the students in the halls all morning long…all the neat stuff going on weekends, you'll think you've gone to physics heaven.

What questions do you develop to learn more about the situation?
What do you write in your report?
Do you offer any recommendations while you are on the site visit?

5: Big Flatland Community College Scenario

Then the participants were asked to do the following:

Participant Indicator Questions—For each of the 10 indicators, each team (and team member) developed a series of questions that they would ask different groups during a site visit. The three target groups for these questions were:
Administration, Faculty, and Students

Thursday Late Afternoon and Evening Sessions

Details of the Site Visits, discussion led by Mary Beth Monroe and Tom O'Kuma
  Each team was assigned to one of the two trial visit sites. Details about the two-year college site was provided including a Physics Program Questionnaire, college catalog and any other information the local site host thought valuable
Planning the Site Visit Session I, teams read through the provided information about the site and discussed what questions to ask during trial site visits
Planning the Site Visit Session II, teams created the questions to ask during their trial site visit and reviewed the site visit process.

Friday Morning and Early Afternoon—Trial Site Visits

Trial Site Visit: San Antonio College

San Antonio College (SAC) Characteristics
  SAC is a large, urban TYC
  SAC has three full-time physics faculty members with several adjunct faculty members and has some support staff
Pre-Visit
  SAC filled out the Physics Program Questionnaire—copies were provided to the four teams before the visit
  SAC provided college catalogs as part of their background information
Trial Site Visit
  Site Visit Agenda—the agenda was agreed to by the project director and the local host before the trial site visit
Groups Visited
  Jerry O'Connor, Chair
  STEM Faculty—FT faculty Mark Davenport, Charlie Overstreet, two adjunct physics faculty, and Engineering and Math faculty
  Administration—Dean of Arts & Sciences
  Students—interviewed some who were currently taking classes
  Staff—Physics Laboratory Technician, Department Secretary, and Computer Lab Technician
Site Tour—a tour to all relevant facilities
Host SV Chair received copies of site visit reports

Trial Site Visit: Coastal Bend College

Coastal Bend College (CBC) Characteristics

CBC is a small, rural TYC

CBC is a minority institution

CBC has no full-time physics faculty member with two STEM faculty members teaching courses in physics

Pre-Visit

CBC filled out the Physics Program Questionnaire—copies were provided to the four teams before the site visit

CBC provided college catalogs as part of their background information

Trial Site Visit

Site Visit Agenda —the agenda was agreed to by the project director and the local host before the trail site visit

Groups Visited

Ken Stevenson and Yvette Janecek—two STEM faculty who teach physics

STEM Faculty—Chair of Science/Ag Division

Administration—President of CBC and Vice President for Occupational Programs

Students—two calculus-based alumni and two recent trigonometry-based students were interviewed by site visit teams

Site Tour—a tour to all relevant facilities

Host SV Chair received copies of site visit reports

Friday Late Afternoon and Evening Sessions—Trial Site Visit Reports

Each team wrote a trial site visit report based on their experiences during the trial site visits. Since each team member attended some different parts of the site visit, strong collaboration was necessary to complete many parts of the trial site visit report. Four reports were written per trial site visit

Coastal Bend College was visited by the following four teams:

Marie Curie Team

Albert Einstein Team

Niels Bohr Team

Albert Michelson Team

San Antonio College was visited by the following four teams:

Richard Feynman Team

Lise Meitner Team

Enrico Fermi Team

Wolfgang Pauli Team

Starting Friday afternoon when they arrived back from the trial site visits, each team spent the remainder of Friday afternoon and Friday evening after supper writing their team's site visit report.

Saturday Morning Session: Oral Reports and Critiques

Oral Reports, led by Jack Hehn

Each team prepared an oral report on one aspect of their site visit. For each of the four categories of reports, a team from each site visit presented their thoughts to the group.

- *General Physics Program*—the Coastal Bend College (CBC) report was given by the Marie Curie Team; the San Antonio College (SAC) report was given by the Richard

Feynman Team

- *Physics and STEM Faculty*—the CBC report was given by the Albert Einstein Team; the SAC report was given by the Lise Meitner Team
- *College Administration and Others*—the CBC report was given by the Niels Bohr Team; the SAC report was given by the Enrico Fermi Team
- *Students*—the CBC report was given by the Albert Michelson Team; the SAC report was given by the Wolfgang Pauli Team

A Panel of Three (Jack Hehn, Bernard Khoury, and Karen Johnston) critiqued each oral report and commented on the oral presentations.

The entire group commented on individual oral reports and the collective reports.

Lessons Learned—as a result of the trial site visits the teams developed 17 questions or Lessons Learned from their experiences. These 17 Lessons Learned will be incorporated in the site visits by the site visit teams.

Wrap Up Session, led by Mary Beth Monroe

Lessons Learned as a Team Member on a Site Visit

1. Need trend data (physics data as subset) enrollment, faculty, students in physics, laboratory, course history.
2. Faculty characteristics (vita, career assignments), coupled to faculty development. Part-timers vs. Full-timers
3. SVT—Probe issues with multiple sources during visit. More time on task (observe class?)
4. SVT may play a role in fostering change during visit and after (confirming value, funding, etc.)
5. Read between the lines (with students).
6. Encourage student selection process to get diversity (representative of college?). Alumni
   students critical.
7. Honor role of student during SV.
8. Science prep of future teachers—probe, data (available?)
9. Physics as a service dept.
10. Must visit other STEM faculty.
11. Must triangulate on data.
12. SVT influence on campus—responsibility, proactive is the SVT a "driver" for change? Role of moving the conversation.
13. SVT must be an advocate for physics.
14. Exit interview value.
15. Jewels on campus make sure physics dept. is aware of these (e.g. support services that encourage transfer in nontraditional areas).
16. Categories and synthesis—diversity in institutions.
17. After session: Mechanisms that produce an SV report.

Saturday Afternoon Session: TPC Wrap-Up

Site Visit Discussion, led by Tom O'Kuma

Site Visit Teams—participants shared their views on who should compose the site visit teams and how they should operate during the site visits

Site Selection Instrument—participants provided input on the philosophy of and questions on the Site Selection Instrument (which is used to help determine TYC sites to be visited)

Site Selection Criteria—participants shared their thoughts on the criteria for selecting TYC sites to be visited and what comprises an outstanding TYC physics program

Site Selection Protocol—participants exchanged their thoughts on what protocol should be used in the site selection process

Physics Program Documents, led by Tom O'Kuma

Contract—participants provided input on the contract to be made with site hosts

Physics Program Questionnaire—participants provided many ideas on how to make the questionnaire more useful for the site visit team

Letter to Program "Chair"—participants made suggestions on the official letter sent to site host

Physics Program Survey, led by Tom O'Kuma

Participants provided input on the philosophy of and the questions on the TYC physics program survey to be conducted by the AIP

Post-TPC Questions

In follow-up to the conference, project leaders asked participants to answer two questions:

1. One of your homework questions asked you to be prepared to describe a typical two-year college. In what ways did your description of the typical TYC change as a result of last week's conference?
2. The other homework questions addressed data concerning your physics program. Most of you reported that it was very hard (sometimes impossible) to get this information. Having gone through the exercise yourself, what suggestions would you offer to the two-year college site host (PPC) in advising him/her where to best look for this data?

TPC Evaluation—Highlights: Karen Johnston, Evaluator

- The TPC tasks and activities were designed to align with conference objectives, and all conference objectives were addressed.
- The TPC could be described as "constructivist" in nature; that is, participants developed team-based site visit protocols/procedures for the trial site visit and collaborated on preparing the trial site visit reports.
- The TPC tasks and activities focused directly on developing tools for the site visit and skills of the participants as site visitors.
- The participant recruitment process resulted in the selection of a group of two-year college, four-year college/university, and industrial physicists with a wealth of expertise in physics education programs and a wide range of experience at two-year colleges. Sixty-three percent (15 out of 24) of the participants were from two-year colleges, and eight of the 16 participants were active members of the TYC21 Project.
- The project leadership worked diligently and thoughtfully throughout the conference. They presented SPIN-UP/TYC project as important to the physics community, a natural outgrowth of other national two-year college projects and a collaborative initiative, with a research foundation, between two-year and four-year colleges faculty members.
- The conference planning activities and the work of the conference have produced a solid initial draft of materials to be used as tools in scheduling and conducting a site visit.
- The conference created a cadre of physicists able to conduct site visits at two-year colleges, ready to prepare a case study document from site visit reports and committed to the SPIN-UP/TYC project.

TPC Evaluation: Recommendations

- Develop a set of guidelines (checklist) that identifies the critical components that make a site visit professional and discuss these guidelines with faculty in preparing for each site visit.
- Keep faculty engaged in meaningful ways in the project's progress during the visitation phase. Developing a sense of "shared success" in this project will add value to the outcome products of the project.
- Insure that expectations of the faculty prior to, during and after the site visits are clear and unambiguous.

APPENDIX C
Site Selection Criteria & Site Selection Instrument

The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges (SPIN-UP/TYC) will identify and visit two-year colleges that have exemplary physics program with demonstrated excellence in one or more areas. We are seeking two-year colleges that can document the success of their physics programs and provide evidence of the excitement and cooperation among their physics and STEM (science, technology, engineering and mathematics) faculty. These visits will help the project to identify the "exemplary practices of two-year college physics programs." Criteria that will guide the principal investigators in the selection of campuses to visit are listed below.

General Selection Criteria:

1. Diversity as to Size of Physics Program
2. Diversity as to Size of Campus Student Enrollment and/or College District
3. Diversity as to Geographic Location (including location within the country and site status as to urban or rural)

Specific Selection Criteria:

4. **Success in Recruitment** (at the two-year college level) and **Retention** (at the two-year and four-year institution level) of physics and other STEM students—most TYC sites selected will have documented success in transferring students to four-year colleges that are physics or STEM majors.
5. **Success in Recruitment** (at the two-year college level) and **Retention** (at the two-year and four-year institution level) of Future Teachers of Science and Math—one or more TYC sites will be selected that have documented success in transferring students to four-year colleges who are future K-12 teachers, particularly physics and STEM teachers in middle and high schools.
6. **Success in Recruiting Women and Under Represented Populations** (these include traditionally recognized minorities and nontraditional students)—several TYC sites will be selected that have documented success in attracting women and under represented minorities in their physics classes
7. **Success in Implementing Innovations** (the innovations should have documented impact on the physics program as a whole)—TYC sites will be selected that have documented success in implementing innovations into the courses and/or curriculum within their physics programs
8. **Success in Addressing the Needs and Learning Styles of Special Student Populations** (special populations included under prepared students, technical-vocational students, students who work full-time, and students who are middle-aged or older)—most selected TYC sites will have documented success in implementing curriculum or supplemental curriculum/services (either at the institutional or program level) positively impacting the recruitment and retention of these special population students in physics.

Some TYCs will be selected based on an acceptable program in all Specific Selection Criteria 4–8 and a strong program in at least one of the Specific Selection Criteria. SPIN-UP/TYC will keep in mind the General Selection Criteria when making the final designation of TYCs selected for site visits. The "TYC Physics Site Selection Instrument" will serve as the principal indicator in the selection of the two-year colleges to be visited.

The "TYC Physics Site Selection Instrument"

The SPIN-UP/TYC project is interested in identifying "outstanding" physics programs at two-year colleges. We appreciate your cooperation in helping us establish a database of physics programs for the TYCs in the country. Choose the answer to each question that best describes your physics program.

1. How has the number of students taking physics in your program changed in the last five years?
   ____ Increased more than or equal to 10%
   ____ Increased less than 10%
   ____ Stayed approximately the same
   ____ Decreased

   How has the number of students at your institution changed in the last five years?
   ____ Increased more than or equal to 10%
   ____ Increased less than 10%
   ____ Stayed approximately the same
   ____ Decreased

2. In the last five years, how has the number of programs on your campus that require students to take physics changed?
   ____ The number of programs has increased
   ____ The number of programs has remained the same
   ____ The number of programs has decreased

3. How many full-time physics faculty members does your TYC campus have?

____	One	____	Five
____	Two	____	Six
____	Three	____	Seven
____	Four	____	Eight or more

   How many part-time physics faculty members does your TYC campus have?

____	One	____	Five
____	Two	____	Six
____	Three	____	Seven
____	Four	____	Eight or more

4. We are interested in the number of science, technology, engineering, and math (STEM) students that transfer from your TYC to a four-year institution. For the last five years, what is the average number of STEM students per year per physics faculty member who have transferred to a four-year institution?
   ____ Zero
   ____ Between 0 and 15
   ____ Between 15 and 30
   ____ Greater than 30

   Over the last five years, how has this average number of STEM students per year per faculty member changed?
   ____ Decreased
   ____ No Change
   ____ Increased by less than 10%
   ____ Increased by more than 10%

5. Over the last five years, what has been the average percentage of female students in your physics class?
____ Less than 15%
____ Between 15% and 30%
____ Greater than 30%, which is better than the national average
____ Female students are over represented among our physics students compared to the student body at our institution.

How has the number of female students taking physics changed over the last five years?
____ Decreased
____ No change
____ Increased by less than 10%
____ Increased by more than 10%

6. Over the last five years, what has been the average percentage of underrepresented minorities in your physics class?
____ Less than 5%
____ Between 5% and15%
____ Greater than 15%, which is better than the national average
____ Underrepresented minorities are over represented among our physics students compared to the student body at our institution.

How has the number of underrepresented minority students taking physics changed over the last five years?
____ Decreased
____ No change
____ Increased by less than 10%
____ Increased by more than 10%

7. Over the last five years, what is the average number of students per year enrolled in physics at your campus who plan to become K-12 teachers?
____ Less than 2
____ Between 2 and 5
____ Between 5 and 15
____ Greater than 15

How has the number of pre-service K-12 teachers who take one of your physics courses changed over the last five years?
____ Decreased
____ No change
____ Increased by less than 10%
____ Increased by more than 10%

8. How many of your physics faculty (full-time and part-time) are making serious efforts to improve the quality of the courses they teach (reading the physics education literature and trying to apply it, restructuring a course to incorporate recent scientific and technological developments, developing a new course to interest different audiences, etc.)
____ All of them
____ Most of them
____ A few of them
____ None of them

For those faculty making serious efforts to improve the quality of the courses they teach, do they have documented evidence of any improvement?
____ Yes, all of them
____ Yes, one or a few of them
____ No

Please briefly explain what changes were made in their courses.

____
____
____

Which national assessment tools do your faculty use regularly in their teaching? Please check all that apply.
____ Force Concept Inventory ____ Force & Motion Conceptual Evaluation
____ Mechanics Baseline Test
____ Conceptual Surveys of Electricity, Magnetism, or Electricity and Magnetism
____ Others (please identify)

____

9. Do your faculty, institution, and/or external group periodically evaluate how effective your program is in preparing physic students for success at transfer institutions?
____ Yes, periodically
____ Yes, but not on a regular basis
____ No

For success in the workforce?
____ Yes, periodically
____ Yes, but not on a regular basis
____ No

10. When was the last major upgrade in laboratory equipment for your introductory course?
____ Five years ago or more
____ Between two and five years ago
____ It was done within the last two years

When was the last major revision in the laboratory curriculum for your introductory course?
____ Five years ago or more
____ Between two and five years ago
____ It was done within the last two years

Please briefly explained what changes were made in their laboratory curriculum.

____
____
____

11. Does your Physics Program offer special courses or components of courses for physics students, such as honors courses or components, projects, courses for future teachers or others?
____ Yes, several
____ Yes, one
____ No

Does your Physics Program offer courses or components of courses for technology students?
____ Yes, several
____ Yes, one
____ No

12. On the average, how many times each year do each of your physics faculty participate in professional development opportunities off campus?
____ More than five
____ Three to five
____ One or two
____ Zero

13. How many extracurricular activities does your Physics Program or TYC offer to your physics students that enhance their physics experience (such as a Society of Physics Students chapter, other STEM clubs, field trips, involvement in physics activities on campus, science teams, or others)?
____ More than two
____ One or two
____ None

14. If you have technology students in your physics courses, does your Physics Program work with technology programs on campus and/or local businesses and industries to enhance student education and the transition for students to the workforce?
____ Yes
____ No
____ Not Applicable

15. Does your Physics Program work with local four-year institutions and/or local school districts to enhance student education and the transition for students through their formal education?
____ Yes
____ No

16. Which of the following groups have a major impact on your physics course offerings, their content and their methodology? (Check all that apply.)
____ all physics faculty
____ other STEM faculty
____ physics students
____ non-physics students
____ administration
____ alumni
____ physics faculty at transfer institutions
____ members of the industrial/business communities
____ members and publications of the general physics/physics education community
____other (identify)

____

17. What do you think is your TYC Physics Program's "claim to fame" as an outstanding physics program? Please be specific and provide details.

Name of Your Institution: ______________________________

Contact person at your institution and their mailing and email addresses:

Your name (if not the contact person): ______________________________

Please send your results by U.S. mail, FAX or email to:

Mary Beth Monroe, Project Director	or	Thomas L. O'Kuma, PI
SPIN-UP/TYC		SPIN-UP/TYC
Physics Department		Physical Sciences
Southwest Texas Junior College		Lee College
2401 Garner Field Road		P.O. Box 818
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830-591-7224		281-425-6522
830-591-7345 FAX		281-425-6425 FAX
Mbmonroe@swtjc.cc.tx.us		tokuma@lee.edu

APPENDIX D
TYC Site Host Institution Documents

Before a site visit could be performed, the site host had to complete the following three documents:

Contract:

The SPIN-UP/TYC Project makes the following agreement with the Physics Program at

____________________________________:
Two-Year College

____________________________________ will cover all local transportation
Two-Year College

during the visit for the three-member site visit team.

The Physics Program will make appropriate hotel reservations for the site visit team. SPIN-UP/TYC will cover all travel, hotel and meal expenses for the site visit team (including transportation from the airport to the hotel).

The Physics Program will provide the site visit team with written responses to a set of questions about the Physics Program at least two weeks prior to the site visit.

In consultation with the site team leader, the Physics Program chair/coordinator/faculty member (PPC) will set up a schedule of appointments with small groups of faculty (both in the Physics Program and outside the program as appropriate), students (both STEM majors and non-STEM majors and special groups such as pre-service teachers, alumni etc.), support staff (including student workers), and administrators.

After the site visit, the site visit team will provide the PPC with a written report of the team's findings within two weeks of the site visit. The report is written for the Physics Program. The PPC may share the report with the institution's administration at the discretion of the PPC. SPIN-UP/TYC will seek the permission of the PPC before using any of the data in the report in a way that links the data directly to the TYC Physics Program. SPIN-UP/TYC may ask for additional data and comments as it prepares a Case Studies document.

__________________________ date: ____________________
Mary Beth Monroe

__________________________ date: ____________________
Physics Program Chair/Faculty Member

Physics Program Questionnaire for SPIN-UP/TYC Site Visits

The SPIN-UP/TYC site visit will be much more productive both for SPIN-UP/TYC and for the host TYC Physics Program if the site visit team members have some information about the host TYC Physics Program in advance of the actual visit. Please provide the information described below. (If you have this information in a different format, for example, for a recent program review or self-study, please feel free to substitute that report for the format given below.) The TYC Physics Program Questionnaire provides insights on many aspects of the information we would like to receive.

1. Personnel

   Please list:

   A. faculty by rank (if your TYC has rank) and give years in service

   B. the numbers of support staff, (for example, program secretary, laboratory or demonstration coordinator, etc.) and indicate if these staff are full-time or part-time.

2. Students

   Please list:

A. the number of STEM (science, technology, engineering and math), physics and future teacher majors you had each year and the numbers of STEM, physics, and future teacher majors who transferred to a four-year institution each year for the last five years. Any data you have on entering STEM, physics, and future teacher majors or enrollment by class for different years would be helpful, as would information on demographic characteristics of your students. (For example, do you have a large number of non-traditional or transfer students? How many minority or women students are physics students? Do your students come from public schools? Rural schools? Private schools? Do you have any information on their entry test scores or their high school grade point averages? Have most of them taken AP physics?) This information will allow the site visit team to acquire a clearer picture of your physics program.

B. the typical enrollments in each of the physics courses offered by your Physics Program. The number of STEM, physics and future teacher majors you currently have by class (first-year and sophomores). (Precise figures are not necessary.) It would be helpful to have a brief phrase describing each course and its primary audience. Alert us to any historical trends in the data.

C. typical career paths for your STEM, physics, and future teacher majors. Roughly what fraction go directly into the workforce, to K-12 teaching, to graduate school, to professional school, etc. Again alert us to any historical trends in that data.

D. project/student research participation and student assistant opportunities for students in your Physics Program.

3. Provide a brief narrative about your Physics Program (including the program for STEM, physics, and future teacher majors and courses for nonmajors and for technical and vocational majors), particularly focusing on what you consider to be the most important components and novel features that you believe are particularly successful. We would also like to learn about how the Physics Program planned for and implemented innovative features and how they are being evaluated and sustained. The following questions should be addressed:

A. What changes have you made during the last five years to improve the experiences of your physics students in your Physics Program?
B. How did you implement change? How did you make this change?
C. How did you get faculty to work on new programs?
D. How did you obtain resources to support change? Was the funding you received internal to your TYC? Did you receive external funding? If so, please explain.
E. What evidence do you have that your changes are successful?

4. Provide a brief narrative on activities of your physics faculty, including the following questions:
   A. Describe activities that your physics faculty engage in with other STEM faculty or non STEM faculty on and off campus (with four-year institutions, other TYCs, local school districts and local businesses/industries).
   B. What off campus professional development activities have your physics faculty participated in recently?
   C. To what professional organizations do your physics faculty belong? Are they active and have they attended local, state, or national meetings of these organizations?

5. If you have other general information about your Physics Program including recruiting brochures, course catalog information, college and physics program (if there is one) mission statements, course or faculty evaluation forms, and so on, we would appreciate receiving copies of that information.

6. What academic or psychological services (such as tutoring or help with test anxiety) does your Physics Program or your two-year college provide to students? What services does your two-year college provide to your current and future physics students that are particularly useful to your Physics Program? For example, some physics programs benefit greatly from the active recruiting services offered by their colleges (such as College Recruitment Day for local school districts).

7. Does your Physics Program play a significant role in the preparation of K-12 teachers? Describe the role your Physics Program has in the preparation of K-12 teachers. What collaborative activities exist between your college's educational program and/or the school/department of education at your transfer four year institutions? Please list any specific courses or parts of a course that target preparation of future elementary or secondary teachers.

8. Please feel free to send along other information that you believe might give us a good picture of your Physics Program.

Letter to Local Site Host:

Appendix D

Dear (Physics Program Chair/Coordinator/Faculty Member):

The purpose of the site visits of the SPIN-UP/TYC project is to investigate successful Two Year College Physics Programs. The site visits are supported by Strategic Programs for Innovations in Undergraduate Physics at Two Year Colleges (SPIN-UP/TYC) with funding from the Advanced Technological Education Program of the National Science Foundation and through the American Association of Physics Teachers.

SPIN-UP/TYC seeks to answer five questions:

1. What type of classroom environments and course structures are effective in preparing two-year college students for success
   - d. at the transfer institution? (academic/technology students)
   - e. in the workplace? (technical/technology/vocational students)
   - f. for self improvement? (non credit students)

   What activities and practices of the physics program and faculty effectively address the educational and career needs of the diverse student population characterizing two-year colleges?
2. What institutional and faculty activities and practices are effective in promoting change
   - c. in the classroom?
   - d. in the physics program?
3. What institutional and faculty initiatives are effective in recruiting and retaining
   - d. STEM majors?
   - e. women and under represented populations?
   - f. future K-12 teachers, especially STEM teachers?
4. What formal (articulation agreements, bridging program courses) and informal (professional interactions) mechanisms are most effective in insuring a seamless transition for students from the two-year college to
   - d. the four-year institution?
   - e. the workplace?
   - f. both of these?
5. What institutional and faculty initiatives are effective in establishing cooperative activities with
   - d. local schools (pre college), private and public?
   - e. civic clubs and/or youth organizations (e.g., Boy Scouts of America)?
   - c. the general public?

Some secondary (but important) issues:

Many physics programs may have their faculty involved in innovations. In this case, it is critical that other members of the division and the college support them in tangible ways, such as tenure and program implementation. What is the minimum level of support needed for substantive change? What support from the rest of the division and college is absolutely essential? How long does it take to produce lasting change within a physics program? How do the Physics Program and the Institution measure the effect of innovations in the Physics Program?

The documentation submitted by the Physics Program before the visit should provide data on what the program thinks it has accomplished. The site visit is needed to look for elements such as morale of faculty and students and institutional support that do not appear in formal reports. The visit is not intended to evaluate directly the strengths and weaknesses of the Physics Program. We do, however, want to achieve a realistic picture of what was done, how it was done, and how it is working. The eventual goal is to be able to characterize those elements that are important (or in some cases crucial) for planning, developing, implementing, and sustaining successful Two Year College Physics Programs. We must keep in mind that what constitutes a successful program is subject to local interpretation though, of course, there will be many features common to all physics programs.

The attached contract explicitly states the terms under which the site visit will be conducted. Please sign it, return it to me, and keep a copy for your files. Also attached are several questions whose answers should be provided to the SPIN-UP/TYC project before the site visit. The Site Visit Team will consist of three physicists including one of the principal investigators of the SPIN-UP/TYC project. We will try to select members of the team from institutions geographically close to yours.

The SPIN-UP/TYC project appreciates you agreeing to participate in the SPIN-UP/TYC site visit program. Your contribution will help other two-year college physics programs design constructive responses to the changing environments in which they find themselves.

Sincerely,

Mary Beth Monroe,
Project Director, SPIN-UP/TYC Project

APPENDIX E

Writing and Planning Conference

The WPC was held at the Sinclair Center (part of Sinclair Community College) in Dayton, Ohio, June 26-29, 2003. AAPT provided logistic support with Roxanne Muller as the key person for the WPC.

The Writing and Planning Conference (WPC) will

1. Discuss the findings in the Case Studies and the formats/models used for each Study;
2. Review and comment on findings of AIP survey of TYC Physics Programs;
3. Define the target audience(s) for the SPIN-UP/TYC Final Report;
4. Prepare draft of SPIN-UP/TYC Final Report; and
5. Make recommendations concerning the appropriate next steps for the physics TYC community.

WPC Participants

Nine two-year college and four-year college/university faculty attended the WPC as participants with a number of staff and support staff members to conduct and run the WPC. These individuals were:

John Griffith, Linn-Benton Community College, Albany, OR
Sandra Harpole, Mississippi State University, Starksville, MS
Jack Hehn, American Institute of Physics, College Park, MD – Project Resource Person
Warren Hein, American Association of Physics Teachers, College Park, MD – Co-Principal Investigator
Karen Johnston, Momentum Group, Ft. Worth, TX – External Evaluator
Mary Beth Monroe, Southwest Texas Junior College, Uvalde, TX – Project Director and Co-PI
Roxanne Muller, American Association of Physics Teachers, College Park, MD – Project Support
Marvin Nelson, Green River Community College, Auburn, WA
Tom O'Kuma, Lee College, Baytown, TX – Principal Investigator and Co-PD
Bill Waggoner, Creighton University, Omaha, NE
David Weaver, Chandler-Gilbert Community College, Scottsdale, AZ
Denise Wetli, Wake Technical Community College, Durham, NC

Brief Form of the Agenda for the WPC

<u>Thursday, June 26</u>

6:30–7:30 p.m. Dinner, Lovell Room (top floor) Crowne Plaza Hotel
7:30–9:30 p.m. General Session 1
Welcome and Introductions – Monroe
Background – O'Kuma
Discussion of Case Studies – Hein
Definition of Audience for the Final Report –Monroe
Development of the Outline for the Final Report – Monroe

9:30 p.m.	PIs develop writing plan for the conference

Friday, June 27

6:45 a.m.	Hotel shuttle to Sinclair Center
7–8 a.m.	Hot breakfast in Sinclair Center's dining room
8–9:15 a.m.	General Session 2 Review of AIP Survey – O'Kuma Discussion of Writing Plan for the Conference Assignment of Writing Groups
9:15–9:30	Break
9:30–11:30	Writing Session One
11:30–12:30	Report of Writing Session One
12:30–2 p.m.	Lunch, Sinclair Center's dining room
1:30–5:15 p.m.	Writing Session Two
3:30–3:50	Break
5:20–6:00 p.m.	Progress Report
6:30	Shuttle back to hotel or leisurely walk to hotel
7–8:30 p.m.	Dinner, TBA

Saturday June 28

6:45 a.m.	Shuttle to Center
7–8 a.m.	Hot breakfast in Sinclair Center's dining room
8:00–Noon	Writing Session Three
10:00–10:20 a.m.	Break
12:00–1:30 p.m.	Lunch, Sinclair Center's dining room
1:30–5:15 p.m.	Writing Session Four
3:30–3:50 Break	
5:20–6:00 p.m.	Progress Report
6:30	Shuttle back to hotel or leisurely walk to hotel
7–8:30 p.m.	Dinner, TBA

Sunday June 29

6:45 a.m.	Shuttle to Center
7–8 a.m.	Hot breakfast in Sinclair Center's dining room
8–10 a.m.	General Session 3
	Finalizing the Draft of the Report
10–10:20 a.m.	Break
10:20–11:45 a.m.	General Session 4 Recommendations for Distribution of Report - Hein Recommendations for the Next Steps – O'Kuma
11:45–Noon	Closing Remarks - Monroe Collection of Written Efforts Adjournment
	Shuttle back to the hotel

Annotated Agenda for the WPC

Thursday Evening Session: "Priming the Pump"

Welcome and Introductions, led by Mary Beth Monroe

- Introduction of participants, Project Resource person, External Evaluator, and Project Support person
- Review of the Conference Outcomes

Background Information for WPC, presented by Tom O'Kuma

- Review of SPIN-UP/TYC Goals, Research Questions and Indicators
- Review of Site Visit Process
  - The TPC
  - TYC Site Visit Solicitation and Selection Process
  - Process for Conducting the 10 Site Visits
  - Process for Writing the Site Visit Reports
- Review the Case Study Process
- Case Studies and Survey of TYC Physics Programs Lead to the Final Document

Discussion of the Case Studies, led by Warren Hein

- Handed out additional case studies bringing total for reference to nine
- Led discussion of the style, format, and content of the case studies

Definition of Audience for the SPIN-UP/TYC Final Document, led by Mary Beth Monroe

- Discussion of Who Should be the Readers of the Final Document
- How Do We Write the Final Document to Address this Diverse Audience

Development of the Outline for the Final Report, led by Mary Beth Monroe

- What should be in the Final Document?
- How should the information be organized?

Reading Assignment for the rest of the evening

Friday Early Morning Session: "Survey Tells Us"

Results from the Preliminary Findings from the 2003 SPIN-UP/TYC Background Survey of Two-Year College Physics Programs conducted by the Statistical Research Center of the American Institute of Physics were discussed. These findings were from three comparison groups —a large Sample of TYCs (178 of 263), Pool of TYCs (65 of 70) who had responded to the SSI and the site Visited TYCs (9 of 10). Some of the findings from the survey were:

- 72% of the Sample, 79% of the Pool, and 100% of the Visited TYCs rated preparing students for transfer as their most important goal
- 47% of the Sample, 75% of the Pool, and 100% of the Visited TYCs indicated a curricular change in at least one course during the last five years; specifically, by course

Type of Course	Sample TYCs	Pool TYCs	Visited TYCs
Conceptual	48%	59%	78%
Alg/Trig-Based	75%	92%	89%
Calculus-Based	69%	86%	100%
Technical	31%	43%	44%
K-12	19%	37%	89%

- Concerning laboratory reform that occurred within the last five years, the responses were:

Laboratory equipment:

Type of Course	Sample TYCs	Pool TYCs	Visited TYCs
Conceptual	18%	31%	44%
Alg/Trig-Based	51%	71%	89%
Calculus-Based	46%	65%	67%
Technical	12%	16%	22%
K-12	8%	12%	11%

Laboratory curriculum:

Type of Course	Sample TYCs	Pool TYCs	Visited TYCs
Conceptual	18%	20%	33%
Alg/Trig-Based	45%	51%	67%
Calculus-Based	31%	55%	67%
Technical	15%	16%	22%
K-12	10%	14%	33%

- Only 16% of the Sample, 22% of the Pool, and 22% of the Visited TYCs indicated that they used external funding to support curricular changes
- 66% of the Sample, 89% of the Pool, and 100% of the Visited TYCs indicated that they had implemented recruiting and retention activities
- 77% of the Sample, 92% of the Pool, and 100% of the Visited TYCs indicated that they provided one or more activities on career information to their students

Friday Late Morning Session: "What's Our Plan"

Discussion of Writing Plan for the Conference which include these themes:

- What are the main topics for the final document?
- What are some of the "key ideas" about TYC that the audience needs to know?
- What makes an exemplary TYC physics program?
- What impact do we want the Final Document to have?

Discussion of the Target Audience for the Final Document that include these groups:

- TYC faculty and administration
- FYC physics community
- Policy makers
  - Professional societies
  - Funding agencies
  - Government agencies

Initial Discussion on the "key ideas" by the WPC participants

Assignment of Writing Groups

- Focus on Students – Warren Hein, Leader; Denise Wetli; and David Weaver
- Focus on Faculty – Tom O'Kuma, Leader; Sandra Harpole; and Marv Nelson
- Focus on Administration – Mary Beth Monroe, Leader; John Griffith; and Bill Waggoner

Friday Afternoon Session: Writing Session One

The writing groups addressed the statement "an outstanding physics program would have the following characteristics…"

At various times during the session, the WPC participants would critique each other's ideas and statements. After lengthy discussion, each team would write down statements that would best represent their and the other WPC participants views.

Saturday Morning Session: Writing Session Two

The WPC Writing Teams finished their initial drafts of the Focus chapters. In each chapter, the teams compared some of the results of the case studies to their idea of the "outstanding physics program characteristics."

Saturday Afternoon Session: Writing Session Three

At the beginning of this session, the WPC participants discussed the other ideas that they thought should be included in the final document to complete what a TYC physics program should encompass. After a critiquing session of determining what should be included, the ideas included:

- The TYC Story – written by Warren Hein, Denise Wetli and David Weaver;
- What is a TYC Physics Program? – written by Mary Beth Monroe, John Griffith, and Bill Waggoner; and
- The TYC Involvement with K-12 Education – written by Tom O'Kuma, Sandra Harpole, and Marv Nelson.

During this session the teams based their initial statements on the ideas expressed by the WPC participants and based on the resources available. In "The TYC Story," the writers conveyed some of the following messages:

- The two-year college can make changes quickly;
- The two-year college is connected and responsive to their local communities;
- Students at two year colleges benefit from small classes, reduced expenses for higher education, and a student-centered environment; and
- The two-year faculty members generally have larger teaching loads than their four year college counterparts.

In the "Physics Program," the writers directed their writings toward the following messages:

- The two-year college physics program is more than courses taught;
- Contrasting the meaning of the word "department" at the two- and four-year colleges;
- Perception of the quality of the physics courses at two-year colleges.

In the "TYC Involvement with K-12 Education," the writers addressed messages on:

- Emphasize that two-year colleges focus on the science preparation of future teachers;
- New courses or re-developed courses in physics may be needed at the two year colleges to address the needs of future teachers;
- In offering in-service professional development, two-year colleges can/should develop strong ties with local school districts, seek to get in-service teachers connected with pre-service teachers, and engage in-service teachers in offering workshops, etc.

By late afternoon, the writing teams again presented their initial thoughts for critique by all. Based on this lively discussion, the teams continued their writing on these three "big ideas."

Sunday Morning Session: Finishing Up

The WPC participants completed their writing assignments.

Sunday Morning: Future Planning Session

The participants of the WPC made the following suggestions on "what to do next" for TYC physics:

- Consider a follow-up project to conduct at least 10 more TYC site visits, particularly to technical institutions.
- Consider conducting professional development workshops on the "best practices" that were evidenced in these site visits.
- Consider conducting a conference for physics faculty members and their administrators.
- Continue conducting a large array of projects at AAPT.
- Consider developing a meeting for two year college faculty in tandem with an AAPT meeting, similar to the efforts of the PER community.
- Find a way to insure that our efforts focus on the student – the impact on learning.
- Consider ways to develop new leadership within the two-year college physics community.

Final Document: Outline

Based on the extensive comments and discussions from the WPC, the participants came up with the following general outline for the Final Document.

Chapter 1 – Introduction
- What is the purpose of this document
- Why was SPIN-UP/TYC Needed?
  - -- Goals and Objectives
  - -- Key Individuals
- Site Visits
- Survey

Chapter 2 – TYCs and Their Physics Program
- The TYC Story
- The TYC Physics Program

Chapter 3 – Focus on Faculty
Chapter 4 – Focus on Students
Chapter 5 – Focus on Administration
Chapter 6 – Special Issues
- TYC Involvement with K-12 Education
- Other

Chapter 7 – Recommendations
Appendix
- Core Research Questions and Indicators
- Case Studies – 10 Case Studies

- Site Selection & Site Visits
- Survey of Physics Program
- WPC and the Participants

TYC Physics Resource List

WPC Comments and Suggestions

The External Evaluator who was present for the entire WPC and observed all the proceedings made the following suggestions:

- Develop and employ procedures to insure that the final document reflects good scholarship.
- Identify a process and timeline for producing the final report.
- Determine how the research questions and indicators will be folded into the final report.
- Engage someone to read the final document for the purpose of identifying ambiguous terminology and comments that would be improved by expanding on the statements.

WPC Summary Comments

The External Evaluator summarized the WPC as follows.

"A simple statement may best convey the evaluator's assessment of the SPIN-UP/TYC project as it enters its final stage. The quality and quantity of work accomplished in this project exceeds expectations, and the ability of the PIs to keep pace with a most ambitious work schedule reflects well on them individually and as a team. Every signal suggests that SPIN-UP/TYC is a successful endeavor and one worthy of the taxpayer support it received."

APPENDIX F
Survey of Two-Year College Physics Programs

1. Please update any incorrect information:

   Your name:____

   Your title: ____

   Your division: ____

   Your department: ____

   Your institution/campus: _______________________________________

   Your Email: ____

2. What are the goals of your campus's physics program? Please rank all that apply with 1 being the most important. (Please specify only one #1 choice.)

   ___ preparing students for transfer to a four-year college or university

   ___ preparing students for the industrial workforce

   ___ preparing students as K-12 teachers

   ___ preparing students as future citizens

   ___ Other (please explain):

   ____

   ____

   ____

Curricular and Program Reform

3. Have you made **significant** changes in your campus's physics curriculum or program over the last five years? (Curricular or program changes include the introductory laboratory.)

   ___ Yes (if yes, please continue to question 4)

   ___ No (if no changes were made, please skip to question 7)

4. For each area in which changes were made, please specify whether the changes were made in content (including if you added or removed an entire course) or in the way in which the courses are taught (pedagogy). Please explain in Part II.

Part I.	Added Course	Removed Course	Changed Content	Changed Pedagogy	Changed Both
a. Conceptual or non-algebra physics:	____	____	____	____	____
b. Algebra-based introductory course:	____	____	____	____	____
c. Calculus-based introductory course:	____	____	____	____	____
d. Technical or technology physics course:	____	____	____	____	____
e. Courses for K-12 teachers:	____	____	____	____	____
f. Other course (specify) ________ :	____	____	____	____	____

Part II. For any Program Change (other than adding or removing course) – please describe:

____
____
____
____

5. Tell us about **the most significant change** you made in your curriculum or program over the last five years. Please include information such as: What motivated or prompted the change, what was the change intended to accomplish, how did you go about making the change, and what measures or indicators do you have to evaluate how successful this change was?

____
____
____
____

6. How were the costs of this change financed? (Indicate whether it was a major source, minor source or not a source).

___ Internal reallocation of resources within the physics program
___ College funds from outside the physics program for equipment, supplies, etc.
___ College funds from outside the physics programs for personnel, personnel time, etc.
___ Funding from outside the college
___ Other types of support

Recruitment and Retention

7. Which, if any, of the recruiting and retention activities below does your program pursue? Please check up to three that are most important to your program.

___ hold an annual (or more frequent) physics program open house
___ hold summer workshops for K-12 students
___ faculty or students regularly visit local schools
___ targeted recruitment or retention of students likely to major in science, technology, engineering and mathematics (STEM), particularly physics
___ targeted recruitment and retention of under-represented students
___ hold or conduct workshops for local K-12 teachers
___ group potential physics majors in special section of the introductory course
___ host individual prospective students and their families in the physics area
___ Other (please explain):

____
____
____

8. Tell us about the one recruitment and retention activity that you consider the most successful in attracting and keeping students and what made it successful. Please touch on whether this activity affected STEM majors, women and minorities, and future K-12 teachers, and if so, in what ways.

____
____
____

9. Which of these do you use to provide career information to your physics students? (Please check any that apply.)

____ alumni visits to the physics program
____ field trips to local industries
____ the college career services office
____ colloquia or visits by representatives from industry
____ career materials from the professional societies
____ Other (please explain):

____
____

10. Which, if any, of the following does your physics program do? (Please check any that apply.)

____ advise STEM students as a regular part of your program
____ assign a faculty or peer mentor to each student
____ require that students interact with their advisor more than twice a semester/quarter
____ provide a dedicated study room or lounge for physics students
____ have an active physics or STEM club
____ place students in industrial internships
____ place students in summer research programs
____ provide research opportunities to students during the academic year
____ provide cooperative work experience opportunities to students during the year
____ have a physics program advisory committee including folks from outside the program
____ have a physics program advisory committee that includes physics students
____ offer alternative courses for various majors who are physics students
____ offer courses for technology majors in addition to traditional academic majors
offer courses for future K-12 teachers
____ track your physics majors once they leave your TYC
____ track STEM or technology majors once they leave your TYC

Other activities that enhance your physics program? (please describe)

____
____

11. What type of information does you physics program currently maintain on its past students?

    (*Check all that apply.)*

    ___ Information on employment or transfer plans when they finish your courses

    ___ Mailing or email addresses for students after they finish your courses

    ___ Files of updates from past students by email or phone

    ___ Mailing list for program newsletter or information

    ___ Periodic survey of past students

    ___ None of the above

    ___ Other (please specify)

    ____

    ____

12. What, if anything, have you found to be most effective in insuring successful transition of students from the two-year college to the four-year institution and/or the workplace?

    ____

    ____

    ____

    ____

13. Have you established cooperative activities with local schools, civic clubs and youth organizations, and the general public? If so, please describe them.

    ____

    ____

    ____

14. What are your physics program's greatest strengths?

    ____

    ____

    ____

15. What changes would you like to make in your physics program?

    ____

    ____

    ____

16. Any comments/suggestions/explanations you would like to make?

    ____

    ____

    ____

APPENDIX G
Presentations, Publications, and Workshops on SPIN-UP/TYC

A. Presentations on SPIN-UP/TYC

1. AAPT Summer Meeting in Boise, ID – August 2002

Using the Results: Next Steps and Getting Involved, organized by the National Task Force on Undergraduate Physics (NTFUP)
Ruth H. Howes (Ball State University) and Mary Beth Monroe

SPIN-UP (Strategic Programs for Innovations in Undergraduate Physics) has studied the condition of undergraduate physics programs in all kinds of colleges and universities through site visits and a survey, the results of which have been presented in this session. We have focused on thriving departments with successful undergraduate programs. Not all undergraduate physics programs are thriving. The National Task Force on Undergraduate Physics is preparing to use the results of SPIN-UP to help other departments change constructively. We report on future plans and opportunities for AAPT members to become involved in improving undergraduate physics programs.

A report on the SPIN-UP/TYC project, as a parallel effort evolving from the SPIN-UP project, highlights the goals, research questions, and indicators of the project. The report summarizes the similarities and differences between physics programs as four-year institutions and two-year colleges, effecting the need for a special Training and Planning Conference for SPIN-UP/TYC visiting teams.

2. AAPT Winter Meeting in Austin, TX – January 2003

SPIN-UP/TYC Project (Poster)
Thomas L. O'Kuma (Lee College); Mary Beth Monroe and Warren Hein

The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges (SPIN-UP/TYC) project is an 18-month long project to conduct 10 site visits and will survey physics programs at two-year colleges, nationwide, for the purpose of collecting information that will specifically identify and describe two-year college physics programs that are shaping the future. This poster will exhibit information of the first six months of the project, including: the Training and Planning Conference held at Trinity University in July 2002; the site selection process, and the national survey.

3. AAPT Summer Meeting in Madison, WI – July 2003

SPIN-UP/TYC Site Visits (Poster)
Thomas L. O'Kuma (Lee College); Mary Beth Monroe and Warren Hein

The SPIN-UP/TYC project has completed its 10 site visits to exemplary physics programs at two-year colleges. Information about the process of selecting the sites and conducting the site visits will be displayed. Preliminary results based on the 10 site visits will be displayed concerning exemplary physics programs. The national survey of two-year college physics programs has also been completed. Preliminary results from the survey will also be displayed.

4. ATE Conference in Washington, D.C. – October 2003

SPIN-UP/TYC Project (Poster)
Thomas L. O'Kuma (Lee College); Mary Beth Monroe and Warren Hein

5. AAPT Winter Meeting in Miami Beach, FL – January 2004

5a. *SPIN-UP/TYC: A Project Report* (Invited Paper)
Mary Beth Monroe (Southwest Texas Junior College)

During the last 18 months, the SPIN-UP/TYC project has investigated and analyzed the role of undergraduate physics instruction at two-year colleges in encouraging students, particularly women and minorities, to pursue undergraduate degrees in physics and other STEM disciplines. As a secondary goal, the project also sought to identify the basic mechanism of change among physics programs at community colleges. Site visits to 10 two-year colleges across the country produced 10 Case Studies. In addition, a survey was conducted among two-year colleges nationwide. These findings will be reported. Descriptions of the selection process used to identify site visit colleges and the training of physics faculty (community college and university faculty) as visiting team members will also be presented.

5b. *Background Info: How Do Exemplary TYC Physics Programs Compare?* (Invited Paper)
Michael Neuschatz (American Institute of Physics) and Mark McFarling

As part of its effort to select, visit and document 10 exemplary two-year college physics programs, the SPIN-UP/TYC project enlisted AIP's Statistical Research Center to conduct a background survey covering instructional goals, curricular reform, and recruitment and retention efforts on a representative sample of all TYC physics programs in the United States. We heard back from 67%, and we were able to link up their responses to data on curriculum, program size, faculty background, and many other factors gathered in earlier nationwide surveys conducted in 2001 and 1996. The assembled database provides a picture of both what the standout programs have in common, and the ways in which they differ from other TYC physics programs across the country.

5c. *Young and Growing: Factors That Influence EMCC's Physics Program* (Invited Paper)
Dwain Desbien (Estrella Mountain Community College)

The Estrella Mountain Community College (EMCC) physics program began in earnest in the fall of 2001 with the hiring of the first full-time physics instructor. The program has grown steadily since the beginning. Several important factors have helped the EMCC physics program get off the ground. These include strong administrative and STEM faculty support, use of PER- based curriculum and classroom management strategies, and successful recruitment and retention of students (including women and underrepresented groups). This talk will discuss how this support was developed and what is in place to ensure the continued support of the physics program. Examples of how support was developed will be shared along with difficulties encountered while building the support.

5d. *Success with a Different Drummer: The GRCC Physics Program* (Invited
Keith Clay (Green River Comm. College)

Spurred on by Arnold Arons' advice to ignore the demands of universities, Green River Community College (GRCC) faculty emeritus Marv Nelson set out to recreate a physics program from the ground up. Today, GRCC physics classes do not distinguish between lecture and lab periods, the liberal arts physics class operates without a textbook, and all students are engaged in inquiry-based learning every day. Five sections of calculus-level physics classes have waiting lists, special classes for future teachers are full to capacity, and GRCC is the only community college in the area to offer modern physics. GRCC physics was deeply honored to be among the model departments chosen by the SPIN-UP/TYC program. And so far the universities seem to like our graduates, too.

5e. *Success and Challenges in the Mt. San Antonio College Physics Program* (Invited Paper)
Martin Mason (Mt. San Antonio College)

The Mt. San Antonio College physics department was selected as an exemplary physics program by the SPIN-UP TYC program. The heart of the physics program at Mt. San Antonio College is the learning community composed of the physics faculty, the engineering faculty, the physics lab technician, and the students. Several main elements nurture this community including: physical proximity of the offices, labs, classrooms, and newly designated student study room makes the faculty easily accessible to the students; the teaching methodology and the PER-based curriculum used in the classes not only enhances the learning of physics but by its cooperative nature, enhances the feeling of a community of learners within each classroom and within the program as a whole; Student research projects are provided through design projects incorporated in each physics laboratory, the Special Projects 99 course, and the summer REU opportunities at local universities; The Society of Physics students is a vibrant organization on campus that helps to tie the students together and give them a sense of identity in the program.

5f. *SPIN-UP/TYC Project* (Poster)
Thomas L. O'Kuma (Lee College), Mary Beth Monroe, Warren Hein

The SPIN-UP/TYC Project has conducted 10 site visits to outstanding TYC Physics Programs. From these site visits, case studies about the 10 have been written. Materials about the project, the site visits, and copies of the case studies will be displayed and available. Additionally, a national survey of TYC physics programs has been conducted for the project by the AIP Statistics Division. Results of that national survey will be displayed and available. Three of the outstanding TYC physics programs visited will also be displayed, with descriptions of their physics programs.

5g. *Success with a Different Drummer: The GRCC Physics Program* (Poster)
Keith Clay (Green River Community College)

A couple of decades ago, Green River Community College (GRCC) faculty emeritus Marv Nelson set out to recreate a physics program from the ground up. Today, GRCC physics classes do not distinguish between lecture and lab periods, the liberal arts physics class operates without a textbook, and all students are engaged in inquiry-based learning every day. Five sections of calculus-level physics classes have waiting lists, special classes for future teachers are full to capacity, and GRCC is the only community college in the area to offer modern physics. GRCC physics was deeply honored to be among the model departments chosen by the SPIN-UP/TYC program. The poster will emphasize programs for future elementary and secondary teachers.

5h. *Success and Challenges in the Mt. San Antonio College Physics Program* (Poster)
Martin Mason (Mt. San Antonio College)

The Mt. San Antonio College physics department was selected as an exemplary physics program by the SPIN-UP/TYC program. A team of SPIN-UP/TYC evaluators visited and prepared a report on the strengths of the program. These strengths include: the physical proximity of faculty offices and student common spaces; a common commitment to facilitate student appreciation and learning of physics; a PER-based curriculum; student research projects; and an active SPS chapter.

6. AAPT Summer Meeting in Sacramento, CA – August 2004

6a. *SPIN-UP/TYC: A Final Report* (Invited Paper)
Warren Hein (American Association of Physics Teachers), Mary Beth Monroe, and Tom O'Kuma

The SPIN-UP/TYC project investigated and analyzed the role that undergraduate physics instruction at two-year colleges plays in encouraging students, particularly women and minorities, to pursue undergraduate degrees in physics and other STEM disciplines. As a secondary goal, the project sought to identify the mechanisms by which change occurs in physics programs at two-year colleges. The project also investigated the role of the physics program in the preparation of pre-service K-12 teachers. Site visits were conducted at 10 two-year college exemplary physics programs which resulted in 10 case studies. In addition, a survey was conducted by the AIP Statistics Research Center of a sample of physics programs at two-year colleges nationwide. This presentation will discuss the methodologies used in the project and share findings of this investigation that are also available in the final published report of the project.

6b. *Challenges and Opportunities—Physics at Gainesville College* (Invited Paper)
J.B. Sharma (Gainesville College)

Gainesville College is a two-year college in the greater Atlanta area. Elements of educational technologies and PER-based curricula began to be adapted into the program in the ’90s. Strong administrative and IT support have been critical in the development of the program. A new science building, which contains the new physics flex classroom cum laboratory, has allowed the fusing of the lab and lecture portions of the course. The physics learning flex-space has stations equipped with networked computers, and all the apparatus students will need for experiments. In addition, there is a Smartboard, a set of wireless polling keypads, a set of GPS units and simulation and data analysis software. There is an active K-12 outreach and special topics courses are offered. Enrollments have steadily grown over the years and for the first time, two sections of calculus-based physics will be offered this coming fall.

6c. *Delta College’s Physics Program* (Invited Paper)
Scott Schultz (Delta College)

Delta College is a two-year community college located in the tri-city area of Michigan. This talk will outline our program and present some of our practices that have allowed the physics discipline to adapt to meet the needs of our students and maintain a healthy learning environment. As part of the SPIN-UP/TYC program we took some time to analyze what we were currently doing and what we would like to do in the future. This was especially timely as we were in the process of hiring two-tenure track physics instructors.

6d. *Development of the Rose State College Physics Program* (Invited Paper)
James Gilbert (Rose State College)

The RSC physics program began its revitalization in the fall of 1999. The program has grown steadily, beginning with a newly hired faculty member and a single classroom, which housed most lectures and all laboratories. It currently has two faculty members, a full-time laboratory assistant, newly renovated lecture and laboratory rooms with additional laboratory facilities, and much expanded laboratory and classroom equipment and computers. The curriculum, including lecture and laboratory courses, along with student related research projects have also been developed and expanded though out the program’s development. The students of the RSC physics program represent a very diverse populace, including military students, along with servicing a wide variety of students’ academic and professional needs. The physics faculty are also involved with off-campus programs and affiliations, such as high school collaborations and “adopt-a-school” programs. This talk will discuss the evolution and facets of the program, which contributed to its selection as an exemplary physics program by the SPIN-UP/TYC.

6e. *SPIN-UP/TYC Project: Some Results* (Poster)
Thomas O’Kuma (Lee College), Mary Beth Monroe, Warren W. Hein

The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges Project (SPIN-UP/TYC) is an 18-month program that conducted 10 site visits to outstanding physics programs around the country. Additionally, a national survey of two-year college physics programs was conducted by AIP for the project. The results of the 10 site visits and the national survey will be displayed with information on the project findings available for interested individuals. In-depth information about some of the 10 outstanding two-year college physics programs visited will be available at additional posters.

6f. *SPINUP-TYC—Challenges and Opportunities in the Gainesville College Physics Program* (Poster)
J.B. Sharma (Gainesville College)

Gainesville College is a two-year college in the greater Atlanta area. Elements of educational technologies and PER-based curricula began to be adapted into the program in the 1990s. Strong administrative and IT support have been critical in the development of the program. A new science building, which contains the new physics flex classroom cum laboratory, has allowed the fusing of the lab and lecture portions of the course. The physics learning flex-space has stations equipped with networked computers, and all the apparatus students will need for experiments. In addition, there is a smartboard, a set of wireless polling keypads, a set of GPS units and simulation and data analysis software. There is an active K-12 outreach and special topics courses are offered. Enrollments have steadily grown over the years. Handouts of some activities developed will be available for interested folks.

6g. *Delta College's Physics Program* (Poster)
Scott Schultz (Delta College)

Delta College's Physics Program continues to develop to meet the needs of its current student body. New classes and new delivery techniques have been developed over the last few years. SPIN-UP/TYC chose our program to conduct a case study to determine what factors have enabled our program to succeed. This poster session will outline our program and their findings.

6h. *Development of the Rose State College Physics Program* (Poster)
James Gilbert (Rose State College)

This poster will contain various community highlights, students' awards, pictures, etc. pertaining to the Rose State College Physics program. Other materials will be available for all interested individuals, such as College related pamphlets, informational programs, curriculum literature, degree plans, etc.

7. ATE Conference in Washington, D. C. – October 2004

SPIN-UP/TYC Project (Poster)
Thomas L. O'Kuma (Lee College); Mary Beth Monroe and Warren Hein

8. AAPT Winter Meeting in Albuquerque, NM – January 2005

8a. *SPIN-UP/TYC: A Perspective* (Invited Paper)
Thomas O'Kuma (Lee College), Mary Beth Monroe, Warren Hein.

The SPIN-UP/TYC project has completed the majority of its goals. In this talk, the following will be discussed: details on why the project was needed, what needed to be done to achieve the goals of the project, and what we learned from the data that was collected during the project.

8b. *Physics at HCC: Community Outreach, Student Learning and Teacher Education* (Invited Paper)
Russell Poch (Howard Community College)

Located between Baltimore and Washington, D.C., Howard Community College has approximately 7,000 students. Due to its academic reputation and affordable cost, nearly half of Howard County undergraduates attend HCC. Strong administrative support for physics has provided funds for MBL equipment and faculty professional development activities. One physics professor has played an active role in county K-8 education and taught grant-funded teacher education workshops. Funds have been obtained to support and upgrade the laboratories with new technology. Both physics faculty members (and one half-time geology) were praised by students as being very concerned for and supportive of their success. The NSF-funded TYC workshops have provided the training for the faculty to incorporate learning and outcomes assessments measures. Serving on a statewide committee, the physics professors have developed a Physical Science and Earth/Space Science course for a transferrable AAT degree (K-8 teachers) with a Physics Secondary Education program to follow.

8c. *Experiencing Growth: Physics at the Wolfson Campus of MDC* (Invited Paper)
Guillermina Damas (Miami Dade College, Wolfson Campus)

Located in downtown Miami and serving a diverse, multicultural population, the physics program at the Wolfson Campus of Miami Dade College was selected as an exemplary program by the SPIN-UP/TYC program. Several factors have contributed to the success of the program. These include a state-of-the-art, student-friendly learning environment with full technological capabilities and tutoring services, strong administrative support, strong cooperation among faculty and staff, a bridging course for students who do not have high school physics, and the incorporation of successful innovations in the classroom and laboratories inspired by the NSF-funded TYC workshops. Retention rates are high, enrollment is on the rise, and there is evidence that students transfer successfully to four-year colleges and universities.

8d. *Preparing Math & Science Teachers at Amarillo College* (Invited Paper)
Arthur Schneider (Amarillo College)

While critical shortages continue in the area of mathematics, physics, and the sciences in general, community colleges are beginning to fill the important role of preparing young future teachers, especially in the physical sciences. With emphasis on grants, collaboration with universities, and regional education service centers, progress is being made in the almost impossible task of training enough science teachers for the future. What kind of teachers are you preparing? The complete teacher education program and its link to physics and the Sciences & Engineering Division at Amarillo College will be reviewed. Successes and challenges will be discussed, as will the AAPT recognition as an exemplary program with the SPIN-UP/TYC site visit.

8e. *SPIN-UP/TYC Project: The Latest Results* (Poster)
Thomas O'Kuma (Lee College), Mary Beth Monroe, Warren Hein

The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges Project (SPIN-UP/TYC) is an 18-month program that conducted 10 site visits to outstanding physics programs around the country. Additionally, a national survey of two-year college physics programs was conducted by the American Institute of Physics for the project. The results of the 10 site visits and the national survey will be displayed with information on the project findings available for interested individuals. In-depth information about some of the 10 outstanding two-year college physics programs visited will be available at additional posters.

8f. *Keys to Making Successful Changes in Physics at HCC* (Poster)
Russell Poch (Howard Community College)

Howard Community College (HCC) was selected as an exemplary program by the SPIN-UP TYC program. Founded in 1970, HCC is located in the planned community of Columbia, MD, conveniently located between Baltimore and Washington, D.C. Currently HCC has about 7,000 students. HCC's first full-time physics faculty member was hired in 1972, with another faculty member (half-time geology) added in 2002. A lab manager, assistant instructor for physics and chemistry labs, and several adjunct faculty complete the physics staff. Successful changes have been made at HCC by focusing on student learning, strong administrative and community support, cooperation among faculty and administration, active outreach to pre-college teachers, and faculty involvement in the development of science curriculum to meet state teacher training standards. The poster session will focus on the key ways HCC has overcome challenges and implemented changes successfully.

9. AAPT Summer Meeting in Salt Lake City, UT – August 2005

9a. *Active Learning in Physics at Lord Fairfax Community College* (Invited Paper)
William Warren (Lord Fairfax Community College)

Active-learning methods have been used successfully at Lord Fairfax Community College since 1992. They have been extended to all levels of physics offered at LFCC (conceptual, algebra/trig-based and calculus-based). In 2002, LFCC was selected as a Project SPIN-UP/TYC case study, due largely to the wide application of active learning methods. The process of implementing and evaluating these pedagogic changes will be reviewed.

9b. *Implementing Innovated Physics Curriculum into Two-Year College Programs* (Invited Paper)
Joshua Phiri (Florence-Darlington Technical College), Sebastian L. Hui

We have adapted the Introductory College Physics for the 21st Century (ICP21) curriculum as our major instructional material for our physics courses in our Engineering Technology Integrated Curriculum and the College Transfer Program. The physics content in this curriculum is based on the latest research and techniques in physics education. Student active learning is the foremost component in the modules with emphasis placed on understanding of basic concepts and applying them. In addition, we have been using a Project Driven Learning Process that encourages problem solving and teamwork skills. The open-ended industry based projects take on many modes of presentation to ensure the creativity of students. Multiple possible solutions to the Project Scenario lead students to the correct applications of physics principles, design features and mathematical calculations. The student teams are required to turn in a written report and to make a Power Point presentation of its solution to the entire class for each project. Allowing the students to make presentations to their peers leads to deeper understanding of the physics concepts. In this talk we will share some of the ideas that we have used to motivate students to become actively involved in their own learning. We will share several factors that have contributed to our success and for our being selected as an exemplary program by the SPIN-UP/TYC program. Our physics program has also been selected as a field of study by WGBH Education Foundation for its Getting Results exemplary practices program.

9c. *SPIN-UP/TYC Project: Final Findings* (Poster)
Thomas L. O'Kuma (Lee College), Mary Beth Monroe, Warren Hein

The Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges Project (SPIN-UP/TYC) is a three-year program that conducted 13 site visits to outstanding physics programs around the country. Additionally, a national survey of two-year college physics programs was conducted by AIP for the project. The results of the 13 site visits and the national survey will be displayed with information on the project findings available for interested individuals. In-depth information about some of the 10 outstanding two-year college physics programs visited will be available at additional posters.

B. Publications about SPIN-UP/TYC and Related Activities

Thomas L. O'Kuma, Mary Beth Monroe, and Warren Hein, *Strategic Programs for Innovations in Undergraduate Physics at Two-Year Colleges: Case Studies and Survey Findings* (AAPT, College Park, MD, 2004).
More than 1,100 copies of this 50-page booklet have been distributed.

Brochures
"SPIN-UP/TYC Project," Lee College (Baytown, TX), 2002 (updated 2003).
More than 1,500 copies of this tri-fold brochure have been distributed.

"Training and Planning Conference," Lee College (Baytown, TX), 2002.
More than 200 copies of this 24-page brochure have been distributed.

"TYC Physics Programs Site Visits," Lee College (Baytown, TX), 2003.
More than 800 copies of this tri-fold brochure have been distributed.

"Writing and Planning Conference," Lee College (Baytown, TX), 2003.
More than 150 copies of this 12-page brochure have been distributed.

C. Workshops where SPIN-UP/TYC Activities Were Presented

At the following workshops/programs, information about the SPIN-UP/TYC Project was presented as part of the activities of the workshop/program. Normally, this meant that 15 minutes to an hour was spent on describing SPIN-UP/TYC activities and/or results.

1. Two-Year College Quantum Optics ATE Program (QO PEPTYC)

1a. QO PEPTYC Session at University of Texas – Brownsville – October 2002
SPIN-UP/TYC Project (Invited Paper)
Thomas L. O'Kuma (Lee College), Jerry O'Connor, Yvette Janacek, and David Weaver
The SPIN-UP/TYC Project was described. David Weaver described his experiences as a participant at the Training and Planning Conference (TPC). Jerry O'Connor and Yvette Janacek described their experiences as the site host for one of the trial site visits conducted during the TPC.

1b. QO PEPTYC Session at Southwest Texas State University – March 2003
SPIN-UP/TYC Project (Invited Paper)
Mary Beth Monroe (Southwest Texas Junior College)
The SPIN-UP/TYC Project was described and the tri-fold project brochure was handed out and discussed.

1c. May Institute in College Station, TX – May 2003
State of Physics and Exemplary TYC Physics Programs (Invited Paper)
Thomas L. O'Kuma (Lee College) and Scott Schultz
As part of the State of Physics talk, the SPIN-UP/TYC Project was briefly described with emphasis on the 10 exemplary TYC physics program visited. Scott Schultz from Delta College (MI) discussed the project from his perspective as one of the 10 visited sites.

1d. QO PEPTYC Session at Texas Tech University – October 2003
State of Physics and SPIN-UP/TYC (Invited Paper)
Thomas L. O'Kuma (Lee College) and David Weaver
As part of the State of Physics talk, the SPIN-UP/TYC Project was briefly described with emphasis on the Case Studies findings. David Weaver described his experiences as a participant at the Writing and Planning Conference. The tri-fold brochure on the site visits was handed out and discussed.

1e. QO PEPTYC Session at Tarleton State University – March 2004
SPIN-UP/TYC Results (Invited Paper)
Thomas L. O'Kuma (Lee College) and Carolyn Haas
Some of the results of the SPIN-UP/TYC project was described and the booklet on the Case Studies and the AIP Background Survey findings were handed out and discussed. Carolyn Haas described her experiences as an Advisory Committee member during the SPIN-UP/TYC process.

At the following workshops, information about the SPIN-UP/TYC Project was presented as part of the activities of the workshop. Normally, this meant that 15 minutes to an hour was spent on describing SPIN-UP/TYC activities and/or results.

2. Physics Workshop for the Twenty-First Century Project
State of Physics (Invited Talk)
Thomas L. O'Kuma (Lee College)
As part of the State of Physics talk, the SPIN-UP/TYC Project was described. The tri-fold project brochure was given to the participants.

2a. Modeling & PER Workshop at Mt. San Antonio College – November 2002

2b. TIPER and JiTT Workshop at Miami Dade College, Wolfson Campus – March 2003

2c. LabVIEW and LabPro Workshop at Lee College – April 2003

2d. HTML, Physlet & TIPER Workshop at Joliet Junior College in June 2003

2e. Digital Video Analysis Workshop at Joliet Junior College in July 2003

2f. LabVIEW and LabPro Workshop at Mt. San Antonio College – November 2003
State of Physics (Invited Talk)
Thomas L. O'Kuma (Lee College)
As part of the State of Physics talk, the SPIN-UP/TYC Project was described. The booklet on Case Studies and AIP Background Survey of Physics Programs and the tri-fold project brochure was given to the participants.

2g. Modeling & Research Based Problem Solving Workshop at Miami Dade College, Wolfson Campus – February 2004

2h. Microcomputer Based Laboratory Workshop at Estrella Mountain Community College – April 2004

2i. Project Based Physics Workshop at Lee College –June 2004

2j. LabVIEW and LabPro Workshop at Gainesville College – November 2004

2k. ISLE and TIPER Workshop at Monroe Community College – April 2005

2l. ICP21 and TIPER Workshop at Mt. San Antonio College – June 2005

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