

Connecting Mathematics, Science and Technology

1. Project Overview

Sinclair Community College (Dayton, OH) submits this proposal with its partner Lakeland Community College (Kirtland, OH). The **goal** is to develop and disseminate low-cost laboratory apparatus and innovative, competency-based, activity-based, interdisciplinary curriculum materials that integrate mathematics, science, and technology. The **project objectives** are to:

1. Develop four curriculum modules incorporating 24 Authentic Learning Tasks to be distributed to high school and community college faculty using inquiry-based activities that apply rigorous mathematics and science to realistic technological tasks.
2. Offer four in-depth Summer Institutes based on the curriculum modules to 72 Ohio high school and community college faculty.

As a result of this project, the following outcomes will be realized:

- **Product Outcomes**, Four curriculum modules incorporating laboratory apparatus and innovative, competency-based, activity-based learning through 24 Authentic Learning Tasks (a series of discrete learning events that build experience and competencies related to the module's goals) will be created in the following curriculum modules:
 1. Algebra
 2. General Mathematics and Trigonometry
 3. Science/Physics
 4. Technology and Electronics
- **Immediate Outcomes**, A cadre of 72 Ohio mathematics, science, and technology faculty with improved knowledge and pedagogic skills.
- **Intermediate Outcomes**, A cadre of 72 mathematics, science, and technology faculty, 90% of whom apply their new knowledge and skills in their classrooms.
- **Long-term Outcomes**, Over the next five years an estimated 16,000 Ohio students will have completed the curriculum modules resulting in:
 - Improved student knowledge in mathematics, science, and technology knowledge.
 - Improved student success and retention.

This project will be implemented in two major phases: Curriculum Development and Summer Institutes.

Phase 1: Curriculum Development will be accomplished using a module curriculum development process established by the National Center of Excellence for Advanced Manufacturing Education at Sinclair (funded by National Science Foundation grant DUE 9454571). The module development process “emphasizes a hands-on, competency-based process, where skill-building activities are simultaneously coupled with fundamental theoretical knowledge” (Sinclair Community College, 1996). The Sinclair PIs have extensive experience in the process. *Leading developers of educational hardware and software will participate.* Curriculum products will be commercially distributed.

Phase 2: Summer Institutes A series of four institutes and follow-up sessions will be offered for 72 mathematics, science, and technology faculty from Ohio high schools and two-year colleges. The project team will disseminate the results to a national audience through articles, publications, and presentations. *Ohio's Systemic Initiative Discovery has pledged \$25,000 in matching funds for the Summer Institutes.* (See attached letter of support.)

2. Goals and Objectives

The **goal** of this Connecting Mathematics, Science and Technology proposal is to develop and disseminate low-cost laboratory apparatus and innovative, competency-based, activity-based, interdisciplinary curriculum materials that integrate mathematics, science, and technology. The **project objectives** are to:

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Immediate Outcomes	A cadre of 72 Ohio mathematics, science, and technology faculty with improved knowledge and pedagogic skills
Intermediate Outcomes	A cadre of 72 mathematics, science, and technology faculty, 90% of whom apply their new knowledge and skills in their classrooms
Long-term Outcomes	Over the next five years an estimated 16,000 Ohio students will have completed the curriculum modules resulting in: <ul style="list-style-type: none"> • Improved student knowledge in mathematics, science, and technology knowledge • Improved student retention

In 1995 the National Science Foundation provided funding for the National Center of Excellence for Advanced Manufacturing Education at Sinclair Community College. Although the National Center of Excellence focuses on *manufacturing education*, it has had several major offshoots at Sinclair, which are not directly related to manufacturing. One major spin-off was created by Mr. Robert Chaney and Dr. Frederick Thomas who had significant roles as Cluster Captain for Curriculum Development and Principal Investigator respectively. They saw the need to transfer the lessons learned into a competency-based, activity-based, and modularized curriculum approach and realized the benefits of improving mathematics and physical science by incorporating hands-on authentic learning experiences. They convinced Sinclair administrators of the benefits and with college funding created the ***Math-Science-Technology Center***.

The ***Math-Science-Technology Center*** provides technical assistance to faculty to infuse hands-on, real world, authentic laboratory experiences into the Sinclair mathematics and science curriculum to strengthen the core liberal arts courses that are included in associate degrees in engineering technology. By strengthening these core courses, the associate degree programs in engineering technology are made stronger.

In addition to having a national influence, the National Center of Excellence for Advanced Manufacturing Education has had several major spin-off impacts at Sinclair Community College.

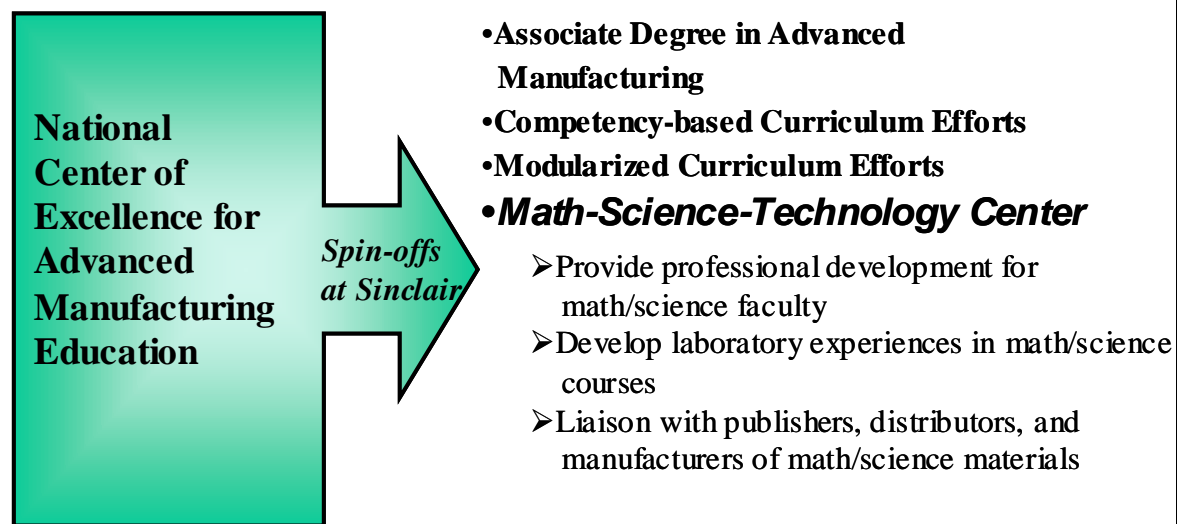


Figure 1: Impacts of the National Center of Excellence for Advanced Manufacturing Education

Through a series of classroom activities using calculator-based control systems, the ***Math-Science-Technology Center*** is transforming mathematics education at Sinclair in fundamental ways and *establishing mathematics as the focal point* for related improvements in science and technology education. For example, Sinclair's Mathematics Department now incorporates hands-on laboratory components into all statistics courses and into several sections of Technical Mathematics I and II (core mathematics courses required in most engineering technology associate degrees). The pedagogic shift required basic changes in staffing, room assignments, and—most of all—in classroom facilitation techniques, but it has shown significant

results. These curriculum changes have resulted in 17.6% improved student success rates (grades A, B, or C) in statistics courses.

Student success in statistics courses has improved 17.6% over five years as a result of incorporating hands-on laboratory components.

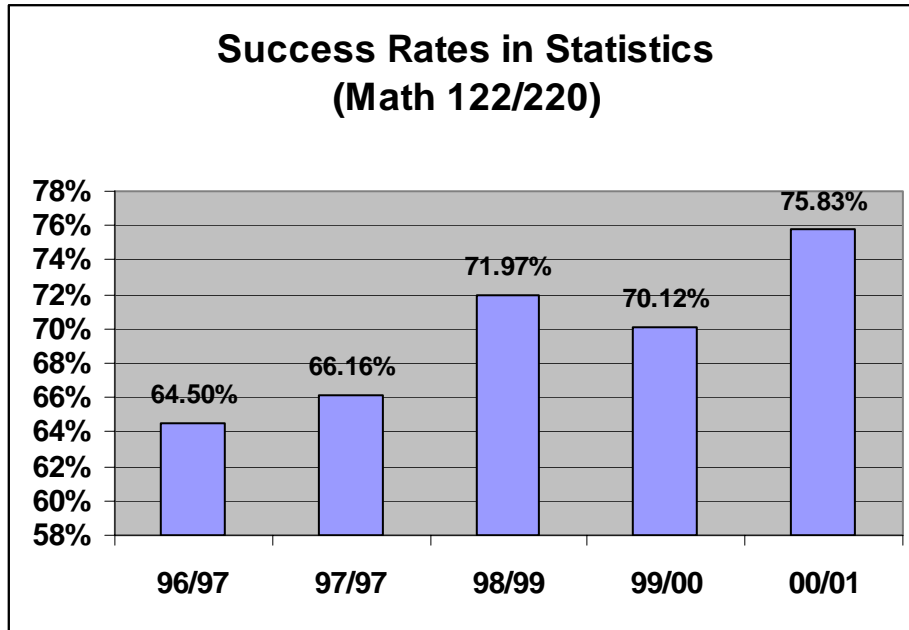


Figure 2: Student Success Rates in Sinclair Statistics Courses

As one mathematics faculty member reports:

"Even many of the best students had trouble at first when I asked them to apply mathematics in authentic, hands-on tasks, but they really get into it. Students at all skill levels like seeing how math is used and they're learning more than before. I could never go back to my old way of teaching."

The following photograph illustrates the type of math/science laboratory apparatus created and used by faculty to involve hands-on learning.

Simple, low-cost laboratory apparatus designed and constructed by faculty are being incorporated in Sinclair mathematics and science courses.



Figure 3: Photo of the Science/Math Laboratory Apparatus Built by Faculty

The following are two examples of how these hands-on experiences are incorporated into mathematics and physics.

- **Mathematics example:** “Too few students think of algebra and trigonometry as exciting and practical subjects, but a simple control system project can improve their views dramatically. Using a model airplane servomotor, a small flashlight, and other easily available parts with a total cost of about \$20, we can equip students with a calculator-controlled (or computer-controlled) light pointer. Like technicians setting up a new system, students use the algebra of linear functions (plus considerations of domain and range) to program the flashlight to shine in any specified direction. In an extension activity, students modify the system to function in automatic mode. For example, I tell students, ‘Set up a light pointer that will take the input from your range finder and turn this flashlight to follow a student walking across the room.’ Students must do the trigonometry and algebra, create the equations and enter them as functions in a calculator. One thing I like very much about the process is the fact that we faculty can really be a classroom facilitator or guide on the side, helping students to keep moving forward. Students right away know if they are correct or not by seeing if the system works and they like it when we as faculty help them troubleshoot any errors that may keep the system from working.” (Sinclair mathematics faculty)

- **Physics example:** “Kinematics, the mathematical description of motion, often seems abstract and useless to technical students, yet the concepts are essential as a bridge between mathematics and Newtonian physics. Kinematics also has many direct applications in technical fields such as robotics, material handling, packaging, and manufacturing. In one activity, my students measure the distance a small car moves when it is powered for one second and then predict how far it will move if powered for two seconds. They soon discover that accurate predictions require a more detailed investigation of the car's accelerated motion, and that leads to a technological challenge to automate the system. I say to students: ‘If a range finder measures the distance from the car to a wall as x , what equation can you program into your calculator to find t , the time the motor should run so the car just reaches the wall.’ In a more advanced challenge, students actually automate the forward, back, right, and left movements of a radio-controlled car.” (Sinclair physics faculty)

Brief automation tasks such as these provide a practical method by which faculty can bring technological applications into mathematics and science classrooms. The tasks are very consistent with the way mathematics and science are actually used by engineers and technicians. Students are provided with an existing physical system, then challenged to modify and improve that system, and test their results. These activities support the learning of traditional content (for example, the concepts of motion and forces), but they are more unique in their attention to the links between academics and technology.

This classroom facilitation process is in close alignment with the *National Science Education Standards* (National Research Council, 1996) which calls for developing "abilities of technological design" that include problem identification, consideration of alternate solutions, implementation, evaluation, and communication." Control system activities are also very closely aligned with the *NCTM Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000) which emphasize the importance of helping students learn to apply mathematical problem-solving techniques in contexts outside the mathematics classroom. The *ITEA Standards for Technological Literacy* (International Technology Education

Association, 2000) are even more explicit in their emphasis on the importance of teaching the design process and of teaching about the links between technology and other fields, including mathematics and science.

Moreover, the *AMATYC Crossroads in Mathematics Standards for Two-Year Colleges* provides very strong support for the rigorous use of applied mathematics as practiced in this project. Speaking of technical programs, the AMATYC standards say:

“The mathematical preparation of technical students should focus on applications. The effectiveness of their education will be very limited, however, if they do not become proficient in performing basic mathematical skills and have an intuitive understanding of fundamental mathematical principles. The mathematics studied by students as part of their technical programs must support them if their careers change, or if they decide to study additional more sophisticated mathematics,” (American Mathematical Association of Two-Year Colleges, 1995).

Sinclair's **Math-Science-Technology Center** has expanded its activities beyond Sinclair Community College to include all aspects of mathematics and physical science at the upper secondary and introductory college levels as they are applied in the fields of engineering, technology, and other related areas. At the request of the Ohio Board of Regents, during the summers of 1999 – 2001, Mr. Robert Chaney and Dr. Frederick Thomas conducted four SAM (science and mathematics) Discovery Institutes for faculty from junior high schools, high schools, and two-year colleges in Ohio. The two-week summer institutes, held at Sinclair and Lakeland Community Colleges, focused on integrating real-world experiments with calculator-based control systems into mathematics and science courses. These SAM Discovery Institutes were a success and proved the pedagogic concept, but did not yield curriculum products that faculty could take back and use in the classrooms. Although participants enjoyed using their skills and imagination to create activities, most do not have time to develop a variety of student learning activities from scratch.

3. Project Plan

On August 12, 1999 the U.S. Secretary of Education commissioned The National Commission on Mathematics and Science Teaching for the 21st Century. Chaired by astronaut and former Ohio Senator John Glenn, the Commission analyzed the state of mathematics and science teaching in the United States and issued recommendations for improvement. The final report, entitled, *Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century*, paints "a vision of high-quality teaching." The following key tenets are excerpted from this vision (National Commission on Mathematics and Science Teaching for the 21st Century, 2000):

- *High-quality teaching requires that teachers have a deep knowledge of subject matter. "For this there is no substitute."*
- *The process of **inquiry**, not merely "giving instruction," is the very heart of what teachers do. Inquiry not only tests what students know, it presses students to put what they know to the test. It uses **hands on approaches** to learning, in which students participate in activities, exercises, and real-life situations to both learn and apply lesson content. It teaches students not only what to learn but how to learn.*
- *High-quality teaching, especially in the sciences, focuses on the skills of **observation, information gathering, sorting, classifying, predicting, and testing**. A good science or mathematics teacher encourages students to try new possibilities, to venture possible explanations, and to follow them to their logical conclusions.*

The report further recommends creating "Summer Institutes" as a near-term solution to teacher professional development. It recommends two-week Summer Institutes to "address the most pressing problems, such as providing opportunities for upgrading content knowledge for out-of-field teachers, conducting subject-based workshops for all science and mathematics teachers, integrating technology into the teaching of mathematics and science, introducing new teaching methods, and improving skills for teaching specific subject matter by grade," (National Commission on Mathematics and Science Teaching for the 21st Century, 2000).

The Project Director and Principal Investigators from Sinclair and Lakeland have designed this project in alignment with the Glenn Commission report. Through a series of four summer institutes, 72 high school and community college faculty will be engaged in professional development activities that will deepen their knowledge, enhance their understanding on the role of and practical applications of hands-on, inquiry-driven learning. These concepts will also be integrated into existing pre-service science education courses that articulate with the Wright State University College of Education. The project will be implemented in two major phases: (1) Curriculum Development and (2) Science and Mathematics (SAM) Summer Institutes.

Phase 1: Curriculum Development

A central component of the curriculum will be the use of control systems, an important engineering concept with educational roots in Seymour Papert's Logo "turtle" (Pappert, 1980). Like students programming Papert's turtle to move around on the floor and like modern technicians in the workplace, the inquiry-based learning activities actively engage students in using mathematical functions as they plan, test, and refine physical events.

Inexpensive, easy to build laboratory apparatus for learning activities on control systems provide a marvelously simple, direct, and effective way of improving student success. Control system activities engage learners in using mathematics and science in the classroom in much the same way that engineers, medical technicians, and others use embedded computers to control many operations of automobiles, hospital instruments, home appliances, and industrial machinery.

The modules and Authentic Learning Tasks developed will use graphing calculators and the calculator-based laboratory interface. The use of calculators have important advantages, particularly because of the low cost per student and because large numbers of mathematics

teachers are comfortable with the technology. There are also several ways in which hand-held calculators emulate the widely used technology of embedded computers more effectively than do desktop computers.

During this first phase of the project, the Project Director and Principal Investigators will develop four curriculum modules incorporating the laboratory apparatus and innovative, competency-based, activity-based learning. Twenty-four Authentic Learning Tasks (a series of discrete learning events that build experience and competencies related to the module's goals) will be created in the following curriculum modules: Algebra, General Mathematics and Trigonometry, Science/Physics, and Technology and Electronics.

The modules will have application for in-service professional development of existing faculty through Summer Institutes. They will also have application for the pre-service development of future faculty. Sinclair faculty will integrate the modules into existing pre-service science education courses that articulate with the Wright State University College of Education. Over the past three years, faculty members from Sinclair and Wright State have co-developed four inquiry-based science and mathematics courses that are offered at both institutions for pre-service teachers. The modules developed under this NSF project will be integrated into Physics 245—Concepts in Physics. Marlon Aldridge, Senior Personnel on this project and faculty member teaching this course will work with colleagues at Wright State to integrate the modules. Mr. Aldridge will also develop special outreach programs within Dayton's inner-city high schools recruiting minority students into the 2+2 teacher education programs at Sinclair and Wright State.

Curriculum development will be accomplished by using a module curriculum development process established through the National Center of Excellence for Advanced

Manufacturing Education at Sinclair (funded by the National Science Foundation, DUE 9454571). This structured approach for developing competency-based curriculum is ideal for this project because it will enable the Principle Investigators, who are subject-matter experts, to develop curriculum that is educationally sound. This module development process will be used to create, pilot-test, and publish the competency-based curriculum modules.

The module development process “emphasizes a hands-on, competency-based process, where skill-building activities are simultaneously coupled with fundamental theoretical knowledge” (Sinclair Community College, 1996). According to this nationally tested curriculum development process, the contextual Authentic Learning Tasks will integrate theory with practice, providing students experience in applying the new knowledge through experiments with the laboratory apparatus. Each of the four modules will consist of:

- A facilitator’s guide.
- Participant’s journal.
- Six Authentic Learning Tasks.
- Video clips shot in a business/industry that illustrates the basic concepts.
- Student evaluation methods.

Lyndon McIntyre, Professor of Electronics and Computer Engineering Technology Department at Sinclair, will be reassigned to design circuit boards and test systems. Marlon Aldridge, Assistant Professor of Physics at Sinclair, will integrate the curriculum modules into pre-service science education courses at Sinclair and Wright State University. Consulting assistance is included in the budget for external faculty to participate in curriculum development.

Faculty member proudly gets his science/math laboratory apparatus to complete the task that was programmed into the graphing calculator.



Figure 4: Photo of the Science/Math Laboratory Apparatus Built by Faculty

The Project Director and PIs will work with a technical writer/editor to create the curriculum manuscripts. Once the draft materials are completed, the Project Director will submit them to peer reviewers from AMATYC, AAPT, and other faculty professional associations. Video clips will be produced to augment the Authentic Learning Tasks. The video clips will be shot in a business and industry settings to illustrate the basic concepts. Materials will be pilot tested by participants of the SAM Summer Institutes. Final published materials will be created based on the peer review and pilot testing. The curriculum modules and video clips will be distributed on CDs.

Also during the Curriculum Development phase, the Project Director and PIs will negotiate with Norland Research, Vernier Software & Technology, and other companies to establish dual use agreements with regard to the development and marketing of new hardware and associated software. Initial contact with these companies has been very favorable. For this proposal, the following agreements have been established (see attached letters of participation):

- **Norland Research** will provide robot frames and components at a "substantially discounted rate" and will provide technical consulting "without charge."
- **Vernier Software & Technology** will offer an \$800 mini-grant program for participants, a discount on its products, free products for use during the institutes, and ongoing cooperation with the Project Director during curriculum development.

Phase 2: Science and Mathematics (SAM) Summer Institutes

2.1 Recruitment

The intended audiences for the workshops are two-year college tenure track science and mathematics faculty and high school science and mathematics teachers from Ohio. The institutes will be publicized to college faculty through direct mail as well as publications and electronic resources of the American Mathematical Association of Two-Year Colleges (AMATYC), American Association of Physics Teachers (AAPT), and the American Society for Engineering Education (ASEE). Another key publication is the *Curriculum and Faculty Development Newsletter for Two-Year College Physics Teachers*—a newsletter published by Joliet Junior College with NSF funding. In addition, the summer institutes will be marketed to high school teachers through the regional and state affiliates of the National Science Teachers Association, the National Council of Teachers of Mathematics, and the International Technology Education Association. Finally, brochures will be directly mailed to mathematics and physics departments at two-year colleges and high schools. To be selected, a faculty member should:

- Have three years experience teaching science or mathematics.
- Have teaching assignments primarily in applied mathematics, sciences, and technology.

- Agree to pilot test the curriculum modules.
- Promise to use the materials to improve student learning experiences.

Faculty from underserved populations will be recruited in two ways. First, faculty in Ohio's 29 Appalachian counties will be targeted for recruitment. One Summer Institute will be offered in Chillicothe—a mid-sized city in Appalachian Ohio with appropriate lodging and instructional facilities. Faculty from urban schools and colleges serving large minority populations will also be targeted for recruitment as well.

This project will have a major impact on the way students learn science and mathematics in high schools and community colleges throughout Ohio—including 29 Appalachian counties.

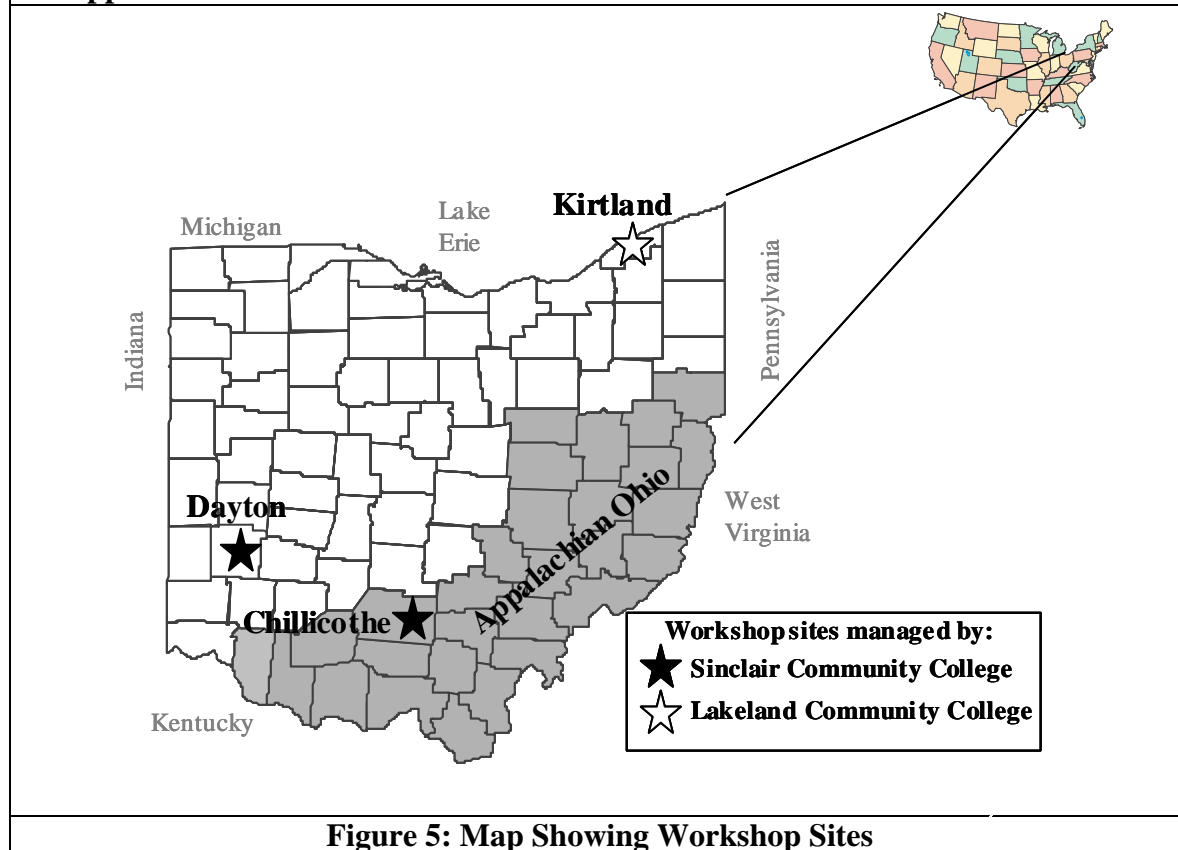


Figure 5: Map Showing Workshop Sites

The Project Director will work with the Ohio Appalachian Center for Higher Education to reach out to colleges and schools within the region. The Ohio Appalachian Center for Higher Education is a consortium of public colleges and universities within the twenty-nine county

Appalachian region of Ohio, established by the Ohio General Assembly in 1993. The mission is to increase the level of educational attainment of residents in this region.

Interested participants will be asked to return their application form to the Project Director by mid-February of each year. The Project Director will mail copies of each application to the selection committee with instructions to rank, in numerical order, the top applicants for each of the sites and return them to the Project Director. The selection committee will be comprised of the Project Director, Sinclair's Principal Investigators, and the Principal Investigator at Lakeland Community College. The Project Director will compile these lists to find the highest-ranking applicants. Selection of participants will be based on: (1) applicant experience, (2) geographic distribution, (3) size and type of institutions (Appalachian-serving, urban, rural, suburban), (4) numbers of faculty from underserved populations (women, minorities), and (5) interdisciplinary teams from high schools and colleges. The team will strive to obtain approximately a 50-50 split of college and high school participation. A geographic and ethnic mix of faculty participants is desired. Alternate participants will be chosen in the event that any of the selected applicants are unable to participate. Selected participants and alternates will be notified of their status by April 1 of each year.

SAM Summer Institutes

The two-week SAM Summer Institutes will be offered according to the following schedule. ***Ohio's Systemic Initiative Discovery has pledged \$25,000 in matching funds to support the Summer Institutes.***

SAM SUMMER INSTITUTE SCHEDULE		
	SUMMER 2003	SUMMER 2004
Sinclair Community College (offered in Dayton)	Mid-June 2003 18 faculty	---
Sinclair Community College (offered in Chillicothe in Appalachian Ohio)	---	Mid-June 2004 18 faculty
Lakeland Community College	Early-July 2003 18 faculty	Early-July 2004 18 faculty

Faculty stipends are included in the budget for two key reasons. First, high school teachers often seek summer jobs to augment their salaries and community college faculty often teach during the summer session. The stipends will encourage participation. The stipend payment schedule will be structured to assure classroom implementation and follow-up after the summer institute. Faculty will receive two-thirds of the stipend at the conclusion of the institute. They will receive the final one-third after pilot-testing and demonstrating classroom use of the laboratory apparatus and instructional materials, cooperating with classroom evaluation, and participating at the Saturday follow-up session.

Second, continuing faculty advancement is often tied to earning graduate credit after a bachelors and/or master's degree. The participating faculty may use the stipend to pay for graduate credit for successful completion. *The University of Dayton School of Education has agreed to offer three graduate-level credits at a preferred rate to faculty that successfully complete the summer institute.* The \$60/day stipend included in the budget is nearly equal to the cost of tuition for three credits at the University of Dayton.

The daily agenda for the two-week SAM Summer Institutes is shown in the following table.

WEEK 1 AGENDA				
MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
<ul style="list-style-type: none"> • Introductions, orientation, and administivia • Sharing activity-based pedagogic philosophy • Example classroom activities • Conduct Authentic Learning Task activity • Building a servo pointer • Regression on the TI-83 graphing calculator • Calibrating servo pointer • Conduct Authentic Learning Task activity • Introduce SAM—the Science and Mathematics Robot 	<ul style="list-style-type: none"> • Introduction to control circuits • Electrical safety • Building a breadboard circuit • Conduct Authentic Learning Task activity • Binary numbers • Using the breadboard circuit to control LEDs, relays, buzzers, motorized vehicles, lights, etc. • Conduct Authentic Learning Task activity • Groups plan original Authentic Learning Tasks for their disciplines based upon models presented 	<ul style="list-style-type: none"> • Solder a permanent version of the control circuit on a printed circuit board • Test and troubleshoot the circuits • Wiring the circuit to control DC motors, etc. • Conduct Authentic Learning Task activity • Other examples using the permanent circuit • Conduct Authentic Learning Task activity • Groups plan original Authentic Learning Tasks for their disciplines based upon models presented 	<ul style="list-style-type: none"> • Introduction to TI-Graph Link® • Modify the breadboard circuit to control a stepper motor • Conduct two Authentic Learning Task activities • Participant teams draft original Authentic Learning Tasks for their disciplines based upon models presented • NSF Proposal writing workshop 	<ul style="list-style-type: none"> • Conduct Authentic Learning Task activity • Inter-group presentations and feedback • Evaluation and wrap-up of Week 1
WEEK 2 AGENDA				
MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
<ul style="list-style-type: none"> • Constructing robot PIC control circuit • Making connections • Testing circuit • Assembling the SAM platform • Conduct Authentic Learning Task activity 	<ul style="list-style-type: none"> • Modifying the robot servo motors • Attaching motors and wheels • Finishing robot construction and testing • Conduct Authentic Learning Task activity • Calibrate SAM 	<ul style="list-style-type: none"> • Programming the robot • Controlling robot with probes and additional servers • Conduct two Authentic Learning Task activities • Participant teams develop original Authentic Learning Tasks using robot 	<ul style="list-style-type: none"> • Links between school and business • Conduct Authentic Learning Task activity • Participant teams develop original Authentic Learning Tasks using robot 	<ul style="list-style-type: none"> • Inter-group presentations and feedback • Plans for pilot testing, Authentic Learning Tasks, follow-up, and for continuing interaction • Workshop evaluation and closure

As part of the selection process, the participants will agree to pilot test the curriculum modules in their classrooms. Using pre-tests, post-tests, and survey instruments, student learning gains and student impressions will be collected. In addition, faculty will complete a survey instrument evaluating the modules, Authentic Learning Tasks, and video clips.

Follow-up

Two forms of follow-up will be used after each of the four SAM Summer Institutes. First the project staff will actively use electronic communications including the Sinclair Physics Department web site (http://www.sinclair.edu/departments/phy/Fred/CBL_Control.html) to establish learning communities. The site currently has extensive information on science and math robots and laboratory apparatus. On this web site a communications forum will be created so that all participants can post and receive e-mail. The web site will also become a repository for any lesson plans, blueprints and schematic diagrams, and other teacher-designed materials. In addition, approximately three months after the SAM Summer Institute, the participants will reconvene for a two-day follow-up session. Each of the 72 teachers will share pilot test data, lessons learned, and discuss strengths and weaknesses of their new approaches.

The following tables indicate the tasks and implementation timeline for the project.

IMPLEMENTATION TIMELINE FOR PROJECT ACTIVITIES				
PROJECT ACTIVITIES <i>Responsible Person</i>	2002			
	Sept.	Oct	Nov	Dec
Conduct initial planning meeting <i>PIs and technical writer/editor</i>	■			
Conduct development team meeting #1 (two days) to identify Authentic Learning Tasks for Algebra <i>PIs and technical writer/editor</i>	■			
Write first set of Authentic Learning Tasks (Algebra) <i>Technical writer/editor</i>		■		
Review first draft of Algebra Authentic Learning Tasks <i>PIs, technical writer/ editor, peer reviews</i>			■	
Revise and finalize draft of Algebra Authentic Learning Tasks, including a plan for developing video clips and student assessment instruments <i>Technical writer/editor</i>			■	
Conduct development team meeting #2 (two days) to identify Authentic Learning Tasks for General Mathematics and Trigonometry <i>PIs and technical writer/editor</i>			■	
Write second set of Authentic Learning Tasks (Math/Trig) <i>Technical writer/editor</i>			■	■
Review first draft of Math/Trig Authentic Learning Tasks <i>PIs, technical writer/editor, peer reviews</i>				■

PROJECT ACTIVITIES <i>RESPONSIBLE PERSON</i>	2003											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Finalize draft of Math/Trig Authentic Learning Tasks, including a plan for developing video clips and student assessment instruments <i>Technical writer/editor</i>	█											
Conduct development team meeting #3 (two days) to identify third set of Authentic Learning Tasks for Science/Physics <i>PIs and technical writer/editor</i>	█											
Write third set of Authentic Learning Tasks (Science/Physics) <i>Technical writer/editor</i>	█	█										
Recruit participants for SAM Summer Institutes <i>PIs</i>		█	█	█	█							
Review first draft of Science/Physics Authentic Learning Tasks <i>PIs, technical writer/ editor, peer reviews</i>		█										
Finalize draft of Science/Physics Authentic Learning Tasks, including a plan for developing video clips and student assessment instruments <i>Technical writer/editor</i>			█	█	█							
Conduct development team meeting #4 (two days) to identify Authentic Learning Tasks for Technology and Electronics <i>PIs and technical writer/editor</i>				█								
Write fourth set of Authentic Learning Tasks (Tech/Electronics) <i>Technical writer/editor</i>				█								
Review first draft of Tech/Electronics Authentic Learning Tasks <i>PIs, technical writer/ editor, peer reviews</i>					█							
Finalize draft of Tech/Electronic Authentic Learning Tasks, including a plan for developing video clips and student assessment instruments <i>Technical writer/editor</i>						█						
Delivery of all Authentic Learning Tasks in electronic format to PIs <i>Technical writer/editor</i>						█						

PROJECT ACTIVITIES RESPONSIBLE PERSON	2003											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conduct 2 week SAM Summer Institutes (Dayton and Kirtland) focusing on construction of equipment and its trial use through several Authentic Learning Tasks <i>PIs and faculty and high school participants</i>												
Develop and shoot a limited number of video clips for pilot testing <i>PIs</i>												
Conduct presentations <i>Professional Conferences</i>												
Pilot test with an estimated 100 students existing pre-service science education courses <i>Sinclair Senior Personnel</i>												
Pilot test Authentic Learning Tasks, including a limited number of video clips <i>Workshop participants and PIs</i>												
Conduct 2 day SAM follow-up activities (Dayton and Kirtland) <i>Workshop participants return with additional faculty/teachers</i>												
Develop shooting schedule for video clips for Algebra Authentic Learning Tasks <i>PIs</i>												
Develop/shoot Algebra video clips <i>PIs</i>												

PROJECT ACTIVITIES <i>RESPONSIBLE PERSON</i>	2004											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Develop/shoot Algebra video clips <i>PIs</i>	■	■										
Develop shooting schedule for video clips for Math/Trig Authentic Learning Tasks <i>PIs</i>	■											
Develop/shoot Math/Trig video clips <i>PIs</i>		■	■									
Pilot test Authentic Learning Tasks, including a limited number of video clips <i>Workshop participants and PIs</i>	■	■	■	■								
Recruit participants for SAM Summer Institutes <i>PIs</i>		■	■	■	■							
Develop shooting schedule for video clips for Science/Physics Authentic Learning Tasks <i>PIs</i>		■	■	■								
Develop/shoot Sci/Phys video clips <i>PIs</i>			■	■	■							
Develop shooting schedule for video clips for Tech/Electronics Authentic Learning Tasks <i>PIs</i>				■	■							
Develop/shoot Tech/Elec. video clips <i>PIs</i>					■	■						
Make revisions based on previous pilot testing <i>PIs</i>						■						
Conduct 2 week SAM Summer Institutes (Chillicothe and Kirtland) focusing on construction of equipment and its trial use through several Authentic Learning Tasks <i>PIs and faculty and high school participants</i>							■					
Pilot test Authentic Learning Tasks and remaining video clips <i>Workshop participants and PIs</i>									■	■	■	■

PROJECT ACTIVITIES RESPONSIBLE PERSON	2004											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Conduct 2 day SAM follow-up activities (Chillicothe and Kirtland) <i>Workshop participants return with additional faculty/teachers</i>												
Make final product revisions <i>PIs and technical writer/editor</i>												
Disseminate Products <i>Through website, Sinclair and Lakeland Bookstores, Norland, etc.</i>												

4. Experience and Roles of Senior Personnel

Faculty and staff from two Ohio institutions will partner for the project: Sinclair Community College and Lakeland Community College.

Sinclair Community College (Dayton, OH)

Sinclair Community College will be the fiscal agent for this project. Founded in 1887, Sinclair is an open door, comprehensive two-year college located in the urban inner city of Dayton, Ohio. Sinclair is Ohio's largest community college (over 22,200 students) and one of the largest in the United States. As one of 20 members of the League for Innovation in the Community College, Sinclair is generally regarded to be in the national forefront of two-year colleges. Sinclair was recently selected as one of 12 Vanguard Learning Colleges for "its outstanding record of achievement in learning-centered education." Sinclair's **Math-Science-Technology Center** was established to provide technical assistance to faculty to infuse hands-on, real world, authentic laboratory experiences into the Sinclair mathematics and science curriculum to strengthen the core liberal arts courses that are included in many associate degrees in engineering technology.

Lakeland Community College (Kirtland, OH)

Founded in 1967, Lakeland was the first college in Ohio founded by a vote of the people. The main campus is located just 25 minutes east of downtown Cleveland in Kirtland. The college is accredited by the North Central Association of Colleges and Secondary Schools and is a member of the Ohio College Association and the National Commission on Accrediting. Full-time faculty members hold degrees from more than 50 major universities; a large percentage of faculty members have earned Ph.D. designations. The student/faculty ratio is 17:1. There are 76 degree and certificate programs to choose from, with over 1,000 classes offered. Academic divisions include Arts and Humanities, Business, Engineering Technologies, Science/Health, Social Science and Public Service Technologies, and Counseling.

The Engineering Technologies Division is one of the most comprehensive in Ohio. A Bachelor of Science degree is offered on the Lakeland campus through the University of Toledo. Twelve associate degrees are offered in the division.

Project Principal Investigators

Project Director, Robert Chaney, has a Master's degree in Mathematics from Miami University, and has been a member of the Mathematics Department at Sinclair Community College since 1992. He has been very active in working to incorporate Authentic Learning Tasks into the teaching of mathematics, particularly for business and engineering technology students, and has been a frequent presenter at meetings around the country. Together with Frederick Thomas, he wrote the article, "Calculator-Based Control Systems," for Texas Instrument's *Eightysomething*, arguing that modern calculators can now provide career-related learning activities that follow in the tradition of Seymour Pappert. Mr. Chaney will be the overall administrator for the project involved in developing the curriculum modules, creating the

workshop content, marketing and recruitment, selecting participants, facilitating the Summer Institutes, and disseminating the results.

Principal Investigator, Frederick Thomas, has a Ph.D. in Science Education with a minor in Comparative and International Education from Indiana University, and has taught for over 25 years at the secondary and college levels in the U.S. He has significant multicultural experiences having lived in and taught in other countries. Since 1984, he has been with the Physics Department at Sinclair Community College and has been extensively involved with efforts to coordinate the teaching of mathematics, physics, and technology. Frederick Thomas will be involved in developing the curriculum modules, creating the workshop content, marketing and recruitment, selecting participants, facilitating at the Summer Institutes, and disseminating the results.

Principal Investigator, Kay Cornelius, is Assistant Professor of Mathematics at Sinclair Community College. She has been a member of the faculty since 1997. She earned her B.S. in Civil Engineering from Michigan State University and M.Ed. in Mathematics from Wright State University. Ms. Cornelius will be involved in developing the workshop content and as a Summer Institute facilitator.

Lakeland Community College's Principal Investigator, David Durkee is Assistant Professor of Mechanical Engineering. He earned his Ph.D. at Northwestern University and B.S.M.E. from Grove City College (PA). In addition he has 18 years experience with AT&T/Lucent Bell Laboratories. Mr. Durkee will manage the logistics and facilitate the Summer Institutes in Kirtland.

Project Senior Personnel

Senior Personnel, Lynden McIntyre, Professor of Electronics and Computer Engineering Technology, has been a faculty member at Sinclair since 1989. He holds an A.S. in Electronics Engineering Technology from Northwestern Michigan College and a B.S., M.A. in Electronics Engineering from Central Michigan University. Mr. McIntyre will lend his extensive knowledge in circuit design to the project.

Senior Personnel, Marlon Aldridge is Assistant Professor of Physics and has been a faculty member since 1998. He earned a B.S. in Physics from Morehouse College and a M.S. in Physics from Wright State University. Mr. Aldridge leads Sinclair's efforts in Project SUSTAIN with Wright State University. Project SUSTAIN is aligning the required science and mathematics courses at the two institutions creating a 2 + 2 program for elementary and secondary teachers. Mr. Aldridge will integrate the curriculum modules into pre-service science education courses at Sinclair and Wright State and manage the pilot testing with pre-service teachers.

5. Evaluation Plan

This project will be evaluated through a comprehensive outcome assessment plan. The Project Director will manage the evaluation process submitting annual reports to NSF and the project team regarding development areas of the project, project strengths, and recommendations for improvement.

During the Curriculum Development Phase of the project, the modules and video clips will be pilot tested in classrooms of 72 participating faculty. An estimated 4,300 students will participate (72 faculty using the products in three classes with 20 students per class). Using pre-tests, post-tests, and survey instruments, student learning gains and student impressions will be

collected. In addition, the 72 faculty will complete a survey instrument assessing their impressions of the products. The curriculum materials will also be integrated into existing pre-service science education courses that articulate with the Wright State University College of Education. Using pre-tests, post-tests, and survey instruments, student learning gains and student impressions will be collected. The Summer Institutes will be extensively evaluated. The following project evaluation matrix provides a detailed description.

<i>PROJECT EVALUATION MATRIX</i>				
OBJECTIVES	MEASUREMENT ACTIVITY	DATA COLLECTION APPROACH	KEY INDIVIDUALS	SCHEDULE
Objective 1: To develop four curriculum modules incorporating 24 Authentic Learning Tasks to be distributed to high school and community college faculty using inquiry-based activities that apply rigorous mathematics and science to realistic technological tasks.	First draft of four modules of Authentic Learning Tasks peer reviewed by members of AMATYC, AAPT, and other faculty professional associations	Survey forms to evaluate draft modules (qualitative and quantitative data)	Project Director Peer Reviewers	Module 1: October 2002 Module 2: January 2003 Module 3: March 2003 Module 4: May 2003
	Pilot testing with an estimated 2,160 students in 36 Ohio high schools and community colleges	Pre-tests, post-tests, and survey instruments, student learning gains, and student impressions	Participating faculty who attended 2003 SAM Summer Institutes	September 2003 – April 2004
	Pilot testing with 36 faculty in Ohio high schools and community colleges	Survey forms to evaluate draft modules (qualitative and quantitative data)	Project Director Participating faculty who attended 2003 SAM Summer Institutes	September 2003 – April 2004

PROJECT EVALUATION MATRIX (CONTINUED)				
OBJECTIVES	MEASUREMENT ACTIVITY	DATA COLLECTION APPROACH	KEY INDIVIDUALS	SCHEDULE
Objective 1 (Continued): To develop four curriculum modules incorporating 24 Authentic Learning Tasks to be distributed to high school and community college faculty using inquiry-based activities that apply rigorous mathematics and science to realistic technological tasks.	Pilot testing with an estimated 2,160 students in 36 Ohio high schools and community colleges	Pre-tests, post-tests, and survey instruments, student learning gains, and student impressions	Participating faculty who attended 2004 SAM Summer Institutes	September 2004 – ongoing
	Pilot testing with 36 faculty in Ohio high schools and community colleges	Survey forms to evaluate faculty impressions (qualitative and quantitative data)	Project Director Participating faculty who attended 2004 SAM Summer Institutes	September 2004 – ongoing
	Pilot testing with an estimated 100 students existing pre-service science education courses	Pre-tests, post-tests, and survey instruments, student learning gains, and student impressions	Sinclair Senior Personnel	September 2003 – ongoing
Objective 2: To offer four in-depth Summer Institutes based on the curriculum modules to 72 Ohio high school and community college faculty.	SAM Summer Institute (Dayton and Kirtland)	Survey forms to evaluate faculty impressions (qualitative and quantitative data)	Project Director Participating faculty	July 2003
	SAM Summer Institute Follow-up (Dayton and Kirtland)	Survey forms to evaluate faculty impressions (qualitative and quantitative data)	Project Director Participating faculty	October 2003
	SAM Summer Institute (Dayton and Chillicothe)	Survey forms to evaluate faculty impressions (qualitative and quantitative data)	Project Director Participating faculty	July 2004
	SAM Summer Institute Follow-up (Dayton and Chillicothe)	Survey forms to evaluate faculty impressions (qualitative and quantitative data)	Project Director Participating faculty	October 2004

6. Dissemination Plan

The successes and lessons-learned from the project will be shared nationally through several methods. First the Project Director will include materials on Sinclair Physics Department's web site (http://www.sinclair.edu/departments/phy/Fred/CBL_Control.html). The site currently has extensive information on science and math robots and past summer institutes. Second, the project partners will disseminate the project results and products by making at least 10 presentations at the local, regional, or national conferences of professional associations. The nature of the project, the processes used to create the materials, and segments of the products themselves will be highlighted in the presentations. Examples of targeted associations include AMATYC, AAPT, ASEE and the regional and state affiliates of the National Science Teachers Association, the National Council of Teachers of Mathematics, and the International Technology Education Association.

The CDs of the modules and video clips will be commercially sold. The following options currently exist. The Sinclair Community College and Lakeland Community College Bookstores both operate web sites (<http://tartanstore.sinclair.edu>) and (<http://www.lakeland.cc.oh.us/STUSERVI/BOOKSTOR/BOOKSTOR.HTM>) and can stock and sell the CD products through electronic commerce.

The Project Director and PIs will continue discussions with Norland Research, Vernier Software & Technology, and other companies to establish marketing and sales agreements. These companies sell robot frames and components to construct the science/mathematics laboratory apparatus. The companies have expressed interest in marketing and selling the CDs through their sales and distribution networks. During the project, continuing discussions will determine the most favorable approach.