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ABSTRACT

Year 1 of the Appalachian Technology Education Consortium Demonstration Project began with formation of an executive committee to serve as the managerial arm and establishment of a board of directors to determine policy direction. Other activities included planning for external evaluation, recruiting of demonstration and observer schools, and establishment of a Professional Development Resource Center (PDRC) at each of four consortium member institutions. Concept-based technology instructional modules that integrated concepts from mathematics and science were developed in three areas: communication, production, and transportation. Modules underwent a content review and were tested in secondary technology classrooms in Pennsylvania. Companion pre-post technological concept literacy tests were developed. Three Teacher Capability Institutes (TCIs) were conducted. The final phase was teaching of the modules in demonstration schools. During Year 2, private sector funding efforts and PDRCs were continued, the last modules were developed, literacy tests were developed and analyzed, the last TCIs were conducted, and modules were demonstrated and disseminated. The management team carried out the primary aspects of the evaluation plan, including site visits and analysis of module performance. (Appendixes include evaluation letters and a replication handbook that lists by topic how the project was conducted, points out problem areas, and offers suggestions to alleviate difficulties.) (YLB)

# Final Report

# Technology Education Demonstration Project

Table of Contents


| | | Page Number |
|---|---|---|
| Part I | A. Project Accomplishments - Year 1 | 3 |
| | Executive Committee | 3 |
| | Board of Directors | 3 |
| | Private Sector Funding Plan | 4 |
| | External Evaluation | 4 |
| | Demonstration & Observer Schools | 4 |
| | Professional Development Resource Centers | 5 |
| | Technology Instructional Module Development | 6 |
| | Module Evaluation | 6 |
| | Teacher Capability Institutes | 7 |
| | Module Demonstration | 8 |
| | Module Publication | 8 |
| | Conclusion | 8 |
| | B. Project Accomplishments - Year 2 | 10 |
| | Board of Directors | 10 |
| | Fund Raising Efforts | 10 |
| | Executive Committee | 11 |
| | External Evaluation | 11 |
| | Professional Development Resource Centers | 11 |
| | Module Development | 12 |
| | Literacy Test Development & Analysis | 12 |
| | Teacher Capability Institutes | 12 |
| | Module Demonstration | 13 |
| | Module Editing & Publishing | 14 |
| | Module Dissemination | 14 |
| | C. Accomplishment of Goals and Objectives | 15 |
| | Goal 1 | 15 |
| | Goal 2 | 18 |
| | Goal 3 | 20 |
| | Goal 4 | 23 |
| | Goal 5 | 24 |
| | Goal 6 | 26 |
| Part II | A. Project Evaluation Overview | 28 |

| | | |
|---|---|---|
| Part III | Appendix | |
| | A. Evaluation Letters - External Evaluator | 30 |
| | Letters | 31 |
| | B. Replication Handbook | 38 |
| | Introduction | 38 |
| | Project Initiation & Organization | 38 |
| | Management Plan | 39 |
| | Project & Consortium Support Personnel | 39 |
| | Selection & Purchasing of Equipment | 40 |
| | Consortium Member Development & Training | 40 |
| | Design, Development & Operation of Professional Development Resource Ctrs. | 41 |
| | Selecting Demonstration & Observer Schools | 41 |
| | Selection of Field Test Sites | 42 |
| | Module Research & Development | 43 |
| | Module Revision Process | 44 |
| | Orientation | 45 |
| | Professional Development - TCIs | 46 |
| | Classroom Use of Modules | 47 |
| | Module Production | 48 |
| | Project Evaluation - Literacy Tests | 49 |
| | Project Evaluation - External | 49 |
| | Project Dissemination | 50 |
| | Board of Directors | 51 |
| | Funding Support | 51 |
| | Conclusion | 52 |

## Part I A

## Project Accomplishments---Year I

The following document is the administrative and operational summary of the Appalachian Technology Education Consortium Demonstration Project for Project Year 1.

### Executive Committee

The first quarter of the Project was primarily concerned with project management. On October 16, 1991, a luncheon with dignitaries from each of the member institutions formalized the establishment of the Consortium with the presidential signing of the Memorandum of Agreement. This document contained the details committing each school to specific requirements necessary to fulfill the covenants of the grant.

An Executive Committee consisting of member institution presidential designees was formed to serve as the managerial arm of the project. The Executive Committee determined the organizational structure and management plan for the life of the project. A PERT chart with target dates was designed. Personnel requirements were reviewed, staff and training associates were interviewed and appointed. A staff associate, an assistant to the director, 3 doctoral students, and 2 masters students were hired. Personnel assignments for each of the sites included coordinating positions for the Professional Development Resource Centers, field test sites, curriculum and instructional development, and materials evaluation.

Other areas of consideration for the Executive Committee included proposing a structure for the Board of Directors and an Advisory Committee each of which consisted of representation from business and industry, public, and higher education. The Executive Board made recommendations for prospective board members. The Director and Assistant to the Director made offers of appointment. Twenty-four people agreed to serve on the Board. William Coates, retired executive vice president with Westinghouse Electric Corporation in Pittsburgh, agreed to serve as Chairman of the Board. A similarly composed member structure was proposed for an Advisory Committee. However, the Advisory Committee membership was not firmly established.

### Board of Directors

The Board of Directors met for the first time for a luncheon meeting on May 17, 1991. At that time, the Chairman of Board recommended the formation of three standing committees; Funding, Auditing, and Planning. Each member was asked to serve on one of the three. Planning and funding efforts addressed ways to continue the work of the consortium beyond the time frame of the Demonstration Project funding. Standing committees held meetings prior to the meeting of the entire Board. Full board meetings provide for the exchange of information and recommendations. The Funding Committee held its first meeting June 14, 1991 and continues to meet approximately one week prior to each Board meeting. The Board of Directors met on a bi-monthly basis.

Private Sector Funding Plan

Private sector funding plans were established. Initial contact letters were drafted and sent to area businesses, industries, and private foundations that had an interest in funding, technology, mathematics, and science education. Follow-up calls and visits resulted in some initial financial and in-kind contributions to the Consortium, and some expressed interest in helping to develop possible long-term support.

External Evaluation

Plans were made to provide for outside evaluation of the Project. The external evaluator for the ATEC Technology Education Demonstration Project was Dr. Richard Hawthorne of Kent University. Dr. Hawthorne visited the Project Office site twice during Year One of the project. His first visit, June 19-20, 1991, oriented him to the goals and objectives of the project. He requested and received a selection of materials developed for the operation and administration of the project.

The second evaluation visit took place October 18, 1992. Dr. Hawthorne held discussions with the project director and co-director, the training associates, members of the Executive Committee, and the Project Office Staff. Various aspects of the product research and development were discussed, and suggestions were made. The consortium as a process was also reviewed.

Demonstration and Observer Schools

One of the operational aspects of the first year included obtaining secondary schools to participate in the Demonstration Project. In conjunction with each demonstration school were 3 observer secondary schools and 1 vocational center, where available. Teachers of technology, mathematics, and science and school administrators were recruited to participate in the Technology Education project. Letters of agreement were signed between ATEC and superintendents from participating demonstration and observer school districts. Seven secondary schools were chosen to represent areas likely to provide a diversity of students from rural to urban backgrounds, a range of economic and social backgrounds, and racial mixture. Four schools in West Virginia and three in Pennsylvania were selected.

West Virginia
Fairmont Senior High School, Fairmont, WV
Sistersville High School, Sistersville, WV
South Harrison High School, Lost Creek, WV
South Junior High School, Morgantown, WV

Pennsylvania
Margaret B. Miller Middle School, Waynesburg, PA
Shaler Junior High School, Pittsburgh, PA
Washington High School, Washington, PA

Dedication ceremonies were held at each of the demonstration school sites to provide an opportunity for interaction with participating faculty and administrators and for local press and video coverage.

A total of 32 demonstration school teachers, one teacher each representing mathematics and science, and at least one teacher representative from technology education participated. (In several cases we had multiple teachers from technology education. In those situations, teachers attend institutes and taught modules based on their areas of specialization within their discipline.)

Each observer school was represented by a teacher each from technology education, mathematics, and science. There were 22 schools selected and 64 teachers chosen to work with the demonstration schools. These teachers were invited, but not required, to attend the five teacher capability institutes. However, they were required to attend demonstrations of the teaching of the modules in the demonstration school classrooms. Demonstration school technology teachers notified observer teachers when the one week long modules were to be taught. Observer school teachers were requested to attend at least one period to observe the students and teaching.

Professional Development Resource Centers

Professional Development Resource Centers were established at each of the four consortium member institutions. The first step toward establishing a PDRC was the acquisition of a dedicated work space. PDRC coordinators made arrangements with respective administrations to set up and furnish a resource center to be used exclusively by ATEC participants. Institutions hosted formal ceremonies to dedicate each of the centers.

The second step toward operating the resource centers was purchasing equipment. Coordinators of the PDRCs requested donations of books from several publishing houses to be replicated at each site. Each coordinator then provided the management staff with an extensive list of books and other resources which were ordered and sent to each of the four sites. Also included in the inventory of the resource centers were computer work stations required for the development of the eight instructional modules. The Year 2 budget provided for additional equipment purchases for the resource centers.

The PDRC coordinators and training associates have initiated a plan to provide for the control and lending of the resource materials including research into establishing a bar code system. Other less technically sophisticated systems have also been considered.

## Technology Instructional Module Development

An area of operational concern was the development of concept based technology instructional modules which integrate concepts from mathematics and science. During the first quarter of the project, the Executive Committee, representing technology education faculty from each of the four member institutions, established guidelines for the design and content of eight concept module units. Research was begun and academic specialists in math, science, and technology were identified to review the content of the modules.

Topics were chosen from the three primary systems emphasized in the teaching of technology education: communication, production, and transportation. Subjects chosen included: spanning structures, lifting forces from air foils, flight control through surface alteration, geodesic domes, push versus pull production, statistical process control, magnetic levitation terrestrial transportation, and light wave communication through acoustical modulation.

Module development teams were established at California University of Pennsylvania and Fairmont State College. California was assigned five modules for development; Fairmont State College, with help from Salem Teikyo University, was assigned responsibility for the development of three modules. California's team consisted of two technology faculty members, three training associates, and work study students. One Fairmont faculty member, with input from one Salem Teikyo faculty member, and work study students researched and designed the content and equipment required teaching the instructional modules in technology laboratories.

Research and development evolved from determining a single predictive technology concept related to the chosen topic. Understanding a predictive concept permits one to predict the performance or behavior of a given technological component, device or system. These concepts provide insight into why a given component, device or system works and behaves the way to does. Each module also contains supporting technological, scientific and mathematical concepts which are described and/or demonstrated.

## Module Evaluation

Completed modules underwent a two step review process. First, each module was sent for review to six content reviewers representing specialists and educators in technology, mathematics, and science. At the same time, the modules and equipment designed to be used in student activities were sent for classroom testing to several secondary school technology classrooms in Pennsylvania. Module was field tested before introduction into the classrooms. The management team established a relationship with a group of secondary schools in Pennsylvania associated with a Pennsylvania funded technology program, Project Tech. Teachers at the nine schools participating in Project Tech agreed to teach the modules in their classrooms. Teachers received only minimal instruction for classroom usage. At the conclusion of each of the instructional units, teachers complete an evaluation form (developed by the Executive Committee). Their suggestions from the teaching of the first four modules was used in the revision process.

In conjunction with module development was the development of accompanying pre-post technological concept literacy tests. A training associate with prior experience in the development of testing instruments was assigned to develop pre-post test tools and to analyze the results. Module developers provided the test developer with drafts of each module. Questions were based upon information derived from this source. A test draft document was then submitted to the module developers to assure test question accuracy. Once approval was been given, tests are printed and packaged for distribution to teachers at the Teacher Capability Institutes.

Teacher Capability Institutes

On April 9 and 10, 1991, the first of the Teacher Capability Institutes (TCI) for teachers of technology, mathematics, and science was conducted. Introduced at this session was the first of a set of eight predictive concept instructional modules in technology which integrated mathematics and science into technology education instruction. The first module topic, based on the study of construction systems, dealt with the behavior of spanning structures. The primary predictive concept was discussed. The equipment was designed to allow students to participate actively in the learning experience. Teachers were instructed in the use of the module and equipment. Since teachers were encouraged to work in school teams of technology, mathematics, and science teachers, the institute also provided teachers with a multidisciplinary environment where they could work together and share experiences and knowledge from their respective disciplines.

Two additional Teacher Capability Institutes were conducted during Year 1. The second TCI was conducted September 24 and 26, 1991. The one day session began with a teacher reorientation into the use of conceptually based teaching units integrating mathematics and science. At this session, teachers were introduced to a module using knowledge based on transportation systems, titled "Lifting Forces from Airfoils". Teachers reviewed the main and supporting concepts, student activities, and the accompanying equipment. The final Teacher Capability Institute for Project Year 1 took place October 24 and 29, 1991. At this session, a second transportation system module, Flight Control, (and accompanying equipment) was introduced. An additional module derived from a construction system, Geodesic Domes, was also presented.

## Module Demonstration

The final phase in module development was the actual teaching of the technology modules to students in the Demonstration schools. All technology, mathematics, and science teachers participating in this phase had received specialized instruction in the use of predictive concept based modules.

It took approximately one week of classroom time in the demonstration schools to complete the teaching of a module. Observer school personnel were invited to visit during this time. Module 1 was taught in the seven demonstration schools during the spring of 1991. The literacy pre-test was administered (by a teacher or administer not scheduled to teach the module) to the students before the module was introduced to the class. The literacy post-test was administered after the module had been taught. Observer school teachers in technology, mathematics, and science observed the module being taught for at least one class session. Training associates from West Virginia University and California University of Pennsylvania also observed the teaching of the module and reported on the results. At the end of the module instruction, demonstration teachers were asked to evaluate the module. Their comments were included in the final revision of each module.

By the end of Project Year One, Behavior of Spanning Structures was undergoing final revision for publication. Lifting Forces from Airfoils had been content reviewed and taught in both the field test sites and the demonstration schools. Flight Control and Geodesic Domes had been content reviewed and tested at the field test sites. Demonstration and observer school teachers had been introduced to the modules at the most recent Teacher Capability Institute. These modules are presently being taught. The last four modules were introduced and taught during Project Year 2.

## Module Publication

The final step in module development was the editing of the modules prior to publication. Completed modules, which included suggested revisions from content reviewers, field reviewers, and demonstration school teachers, underwent final editing by the Director, Co-director, and Assistant. The edited module (in diskette form) was sent to a publisher where it was printed and packaged for distribution.

## Conclusion

The first year of the Appalachian Technology Education Project was a busy one involving many administrative and operational details required for an efficient, quality operation for the design, production, field testing, and evaluation of instructional modules based on predictive technological concepts. This summary offers an overview of the many activities necessary to organize and sustain such a complex, multifaceted project.

## Part I B

## Project Accomplishments
## Year 2

The following document is an administrative and operational summary of the Appalachian Technology Education Consortium Demonstration Project for Year 2 of the Project. The project has addressed the concern of national competitiveness through teacher capability institutes which interface technology, mathematics, and science and through the research and development of curriculum materials for use in technology education. All management plans, procedures, and policies were determined and put in place during the first year of operation. Year 2 was a continuation of the activities necessary to satisfy project goals and address national competitiveness through enhancement in the level of student technological literacy.

### Board of Directors

The Board of Directors continued to meet every other month to determine ATEC policy direction. The Planning Committee, one of the three board standing committees, was very active. It developed a long-term strategic plan to be used by the consortium once the Technology Education Project was completed. Mission and vision statements were formulated, and strategies based on an assessment of the strengths and weaknesses of the consortium were chosen to accomplish the mission. The strategic plan was presented to and approved by the Board of Directors. The final meeting of the Board for Year 2 was held October 23, 1992.

### Fund Raising Efforts

Private sector funding efforts continued. The Director made visits to a number of area companies to solicit financial support. Significant contributions from two organizations helped the consortium in meeting the federal matching requirement. Contacts were established with a regional bank charitable foundation officer who encouraged ATEC to submit a proposal for an equipment grant. The grant was submitted,, and funding in the amount of $15,000 was awarded to purchase a DOS platform computer system and high quality laser printer for each of the four Professional Development Resource Centers. (This equipment was utilized in the final preparation of the instructional modules.) Several other organizations expressed interest and support for the goals of the demonstration project, but due to the 1991-92 economic downturn, financial support was not available.

Local fund raising plans were formulated to raise money to enhance technology programs at the seven demonstration schools. A list of local businesses in the vicinity of each of the schools was compiled. Introductory letters were to precede visits to each of the businesses. Due to the workload of the PDRC coordinators who were to pursue local funding efforts, letters were never designed. Local funding for demonstration schools was not obtained.

Efforts were begun to obtain long-term funding to support the Consortium beyond the Technology Education Demonstration Project. Research indicated that a fit existed between ATEC's mission and a materials development program of the National Science Foundation. The Executive Committee designed, developed and implemented a plan to prepare a proposal for NSF funding.

Executive Committee

The Executive Committee held meetings as needed since procedures and policies were established for module development continuation. Minutes from meetings were maintained as part of the management evaluation process. Problems and issues involving personnel management, time management, and module development, and publication were discussed. Staffing needs were reevaluated and module development staff reassigned due to the resignation of two training associates. To better facilitate time management, several meetings were conducted via conference calling. FAX machine communication with the three remote resource center coordinators was used frequently.

External Evaluation

On March 6, 1992 the last of the visits by the external evaluator took place. Dr. Hawthorne, the Director, and a training associate visited two demonstration schools (one middle school and one high school). The visit was planned to coincide with the teaching of one of the manufacturing modules so that the evaluator could observe the teachers and students. He held discussions with the participating technology, mathematics, and science teachers, students, and school administrators. Various aspects of the demonstration project were discussed. A letter to the Director summarized his findings.

Professional Development Resource Centers

Professional Development Resource Centers continued as the hub of module development operations. Additional computer work stations (See Fund Raising Efforts) were purchased for each PDRC to facilitate module completion. Additional reference materials were bought bringing the total number of resources to approximately 700 pieces of core reference sources for each location.

As was originally planned, participating ATEC demonstration and observer school teachers were able to borrow reference materials and completed modules and equipment to supplement or enhance their curriculum needs. Materials were lent to teachers on an informal basis. Plans to implement a bar coding system did not take place. Time and financial constraints did not allow for the planning necessary to develop or purchase such a system.

## Module Development

The last four predictive concept modules were developed based upon topics chosen from the four primary systems used in the teaching of technology education (manufacturing, transportation, communication, and construction.) Subjects included two manufacturing units (push versus pull production and statistical process control), a transportation unit (magnetic levitation of terrestrial vehicles), and a communication unit (light wave communication). Each module underwent content review by specialists and educators in technology, mathematics, and science and teacher field testers prior to being used by demonstration school teachers.
Reviewer and teacher evaluation comments were incorporated in the final drafts of the modules.

## Literacy Test Development and Analysis

Literacy tests were developed for use with each of the modules. A doctoral student with prior experience in the development of testing instruments designed tests for use with the last four modules. There were some modifications in the development process. Instead of the testing specialist developing questions and answers pertinent to predictive module concepts, module developers wrote questions and answers. The testing specialist selected questions and added detractor responses. Test booklets were designed and printed for distribution to teachers at Teacher Capability Institutes. The testing specialist analyzed testing results and provided demonstration teachers with interpretations of these results based on the performances of the students on pre and post literacy tests. An example of the reporting format follows.

Mean Pre/Post Test Results

| Module Number | Pre-test Mean % | Post-test Mean % |
|---|---|---|
| 1 | 36.09 | 47.74 |
| 2 | 34.39 | 42.77 |
| 3 | 34.39 | 42.77 |
| 4 | 27.98 | 42.91 |
| 5 | 27.34 | 55.66 |
| 6 | 25.31 | 40.07 |
| 7 | 32.06 | 43.35 |
| 8 | 34.41 | 41.96 |

## Teacher Capability Institutes

The last two Teacher Capability Institutes (TCI) for teachers of technology, mathematics, and science was conducted. Push versus Pull Manufacturing and Statistical Process Control were introduced at sessions held February 20 and 25, 1992. Thirty-seven teachers attended Teacher Capability Institute 4. Magnetic Levitation and Light Wave Communication were introduced March 31 and April 7, 1992. Thirty-seven teachers attended Teacher Capability Institute 5. The primary predictive concepts were discussed. Prior modules taught in demonstration schools were reviewed. The equipment designed to allow students to participate actively in the learning experience was examined, and teachers were instructed in the use of the module and equipment. Teachers continued to work in school teams of technology, mathematics, and science teachers where they could work together and share experiences and knowledge from their respective disciplines. Teachers completed surveys used in the evaluation of the TCIs. The TCI coordinator analyzed results, and reviewed his findings with TCI teacher trainers.

Module Demonstration

The final phase in module development was the actual classroom teaching of the technology modules in the demonstration schools. It took approximately one week of classroom time to complete a module. Observer school personnel were invited by demonstration school teachers to visit during this time. Observer school teachers in technology, mathematics, and science from Pennsylvania watched the module being taught for at least one class session. (Due to budget cut-backs, observer teachers in West Virginia were unable to attend.) A training associate observed the teaching of each of the modules at a minimum of one site and reported on the results based upon personal observation and interviews with teachers, administrators, and students. Demonstration teachers evaluated the module based upon teaching experiences. These comments were used in the determination of the final revision of each module. All modules had been taught in demonstration school classes by the end of May, 1992.

As in the previous project year, the literacy pre-tests were administered (by a teacher or administer not scheduled to teach the module) to the students before modules were introduced to the class. Students taking part in module demonstrations as derived from pre-test administration follow:

| Module Number | Number of Students |
|---|---|
| Module 5 | 109 |
| Module 6 | 135 |
| Module 7 | 143 |
| Module 8 | 133. |

The literacy post-tests were administered after the modules had been taught.

A dinner honoring demonstration school teachers was held May 1, 1992. (Private sector funds were used to provide a special evening for some very special teachers.) The Director and Chairman of the Board of Directors honored the teachers by awarding specially designed certificates detailing their participation in the project. Due to the dedication and extra effort on the part of the demonstration teachers, the demonstration project was able to accomplish most of its goals and objectives.

## Module Editing and Publication

The final step in the module development process was module editing prior to publication. The completed modules incorporated suggestions from content reviewers, field reviewers, and demonstration school teachers. In addition, the Project Director, Co-director, and Assistant Director reviewed each module for technical accuracy, grammar, and format consistency. A contract printer offset printed, bound, collated, and stored the module sets prior to packaging and mailing for dissemination.

## Module Dissemination

The consortium was concerned with two areas of dissemination. The first involved disseminating the product (instructional modules). The Executive Committee developed a list of professionals who should receive sets of the eight instructional modules. The list consisted of all ATEC participants and 93 colleges and universities in the United States which offer programs in technology education. The modules were sent to college libraries so they would be available to faculty and students from all disciplines. Over 300 module sets were disseminated. The sponsorship agreement with Kelvin Electronics provided for the promotion of the modules through vendor demonstrations at various professional conferences and trade shows as well as through a corporate sales effort to educators. A special mailing introducing the modules was sent from Kelvin Electronics to 5000 customers chosen by Kelvin's marketing staff as likely to be interested in conceptually based instructional materials. Module content information also appeared in their 1993 catalogue.

The second area of dissemination involved circulating information about the consortium process. Staff and training associates in the consortium continued to disseminate project information to the technology profession through local, regional, and national presentations and article publication. Brochures designed for fund raising and dispersing consortium goals and objectives were printed and distributed. This portion of the final report prepared for the United States Department of Education and distributed to the six national vocational technical curriculum centers and ERIC also provides a means to disseminate information about the project.

The second year of the Appalachian Technology Education Project concentrated on the development, classroom use, production, and dissemination of the ATEC instructional modules. Efforts concentrated on ways to most efficiently and effectively achieve these goals. This summary offers an overview of the many activities necessary to sustain a complex project in a mission designed to enhance the level of technological literacy among our youth.

## Part I C

## Accomplishment of Goals and Objectives

There were six goals, each with associated objectives, addressed in the Appalachian Technology Education Consortium Demonstration Project. They included:

(1) To create an appropriate means for contributing to the establishment of an integrated and applied secondary school technology education curriculum that focuses on the enhancement of the technological literacy of all youth;
(2) To contribute toward the development of students that are knowledgeable about technology, its evolution, systems, techniques, utilization in industry and other fields and its social and cultural significance;
(3) To enhance the capabilities of teachers of technology in the area of technology education.
(4) To contribute to the research, development and evaluation of curriculum and instructional materials for use by technology, mathematics and science teachers in instructional programs that focus on technology and the enhancement of the technological literacy of youth in secondary schools.
(5) To contribute to the research, development and evaluation of curriculum and instructional materials for use by technology, mathematics, and science teachers in instructional programs that focus on technology and the enhancement of the technological illiteracy of youth in secondary schools.
(6) To disseminate to the education and business/industry communities appropriate information about the (ATEC) Technology Education Demonstration Project, the change process used in the project, and the products resulting from the project.

### Goal 1. To create an appropriate means for contributing to the establishment of an integrated and applied secondary school technology education curriculum that focuses on the enhancement of the technological literacy of all youth.

Objective 1: To implement a transferable and sustainable education change process based on the experience of the consortium members and their research, design, implementation and evaluation of technology education programs in the schools.

During the first quarter of operation, it was necessary to design, develop, implement and assess a management plan to coordinate and control a change process model. The operation was headed by a director and a co-director. The director was responsible for the overall management of the project including private sector fund raising. The co-director served as t.e coordinator of the West Virginia University Professional Development Resource Center, coordinated and participated in all Teacher Capability Institutes, coordinated field testing efforts, and aided in the project planning and task assignments, and in module final review. Each member institution had a representative and an alternate appointed by their president to serve on the Executive Committee. The representative at each of the satellite schools also served as the coordinator of a Professional Development Resource Center. Duties included managing the resource center, recruiting demonstration and observer schools, supervising instructional module development, and serving as a trainer at Teacher Capability Institutes.

Early in the project, additional personnel necessary to support the work of the consortium were hired. Two people were hired to function in the positions of staff associate and assistant to the director. The staff associate was primarily responsible for budgeting, office management, purchasing, and record keeping. The assistant to the director was responsible for all reports, correspondence, and liaison duties with the consortium institutions and public schools. A search for training associates was conducted nationally. Three doctoral level and 2 masters level technology education students were hired. They worked with PDRC coordinators to research and develop instructional modules used in the technology education demonstration classrooms and to assist in teacher enhancement at Teacher Capability Institutes.

The management plan utilized a number of tools and techniques to coordinate the various facets of the consortium's activities. Project planning tools such as PERT and GANTT charts and Project Manager software were used to coordinate and delineate module development, Teacher Capability Institute, and fund raising responsibilities. During the first 18 months of the project, twice a month meetings with the Executive Committee were scheduled allowing opportunities to exchange information and address issues. Written agendas and minutes were maintained for use in assessment of the management process. The director and co-director met weekly with management staff and training associates to review weekly work reports to assess progress and problems. As the project drew to a conclusion, meetings with the Executive Committee, staff, and training associates were held as needed. FAX machines and telephone calls facilitated communications with Executive Committee members.

To further sustain the consortium as a change process in technology education, plans were instituted to design, develop, and implement an Advisory Committee and a Board of Directors. The Executive Committee proposed a structure for both which consisted of representation from business and industry, public, and higher education. The Advisory Committee was established but never functioned as planned. However, a board of directors was formed and a chairman chosen.

The Board of Directors met for the first time for a luncheon meeting on May 17, 1991. Three standing committees, Funding, Auditing, and Planning, were established to address ways to continue the work of the consortium beyond the time frame of the Technology Education Demonstration Project funding. The Planning Committee developed a long-range strategic plan to guide ATEC in its mission to upgrade the level of student technological literacy through educational programs. The Fund Raising Committee discussed implementing a funding program to support ATEC in its long-term mission. The Board of Directors met on a bi-monthly basis. Board meetings provided for the exchange of information and recommendations and provided the director with significant corporate and public school advisory input into possible ways the consortium, business and industry, and the education community might interact.

Objective 2: To develop a management staff and a teacher training staff to operate the process/product change model.

Management and staff training was conducted as needed. Before research and development of instructional modules began, it was necessary to train developers in the understanding of predictive technology concepts. The Director provided module development coordinators with research pertaining to predictive versus descriptive concepts. Additional training took place at module planning sessions. Hands-on sessions for management, staff, and module developers were offered on the use of the DOS computer system and accompanying module development software. All Teacher Capability Institute trainers met with the TCI coordinators prior to each session to train on the concepts, materials, and equipment used for teacher enhancement. Feedback from teacher TCI evaluations gave trainers a chance to respond to teacher needs. Finally, all training associates working with field test site personnel received training from module developers in the use of the concepts, materials, and equipment in the instructional modules. Additional training was provided based on individual needs. Due to the sporadic nature of staff training, no formal system of training assessment was developed. However, changes were made and training altered based on information received from TCI evaluations and other sources of performance information.

Objective 3: To establish Professional Development Resource Centers for use by Consortium staff and technology, mathematics, and science teachers in researching, developing, and evaluating curriculum and instructional materials for use in school programs to enhance the technological literacy of youth in secondary schools.

Professional Development Resource Centers were established and dedicated at each of the consortium member institutions to serve as the center for research and project operations for each of these schools. The coordinators were responsible for obtaining dedicated space for the PDRC which housed research materials and computer work stations used in producing technology instruction modules and for providing teacher training and enhancement. Dedication ceremonies for the PDRC facilities at all but West Virginia University were held. West Virginia University's PDRC served as a research and management office site only.

Research materials in technology, mathematics, and science were purchased for the PDRCs. Materials were made available to module developers and demonstration and observer school teachers. Technology textbooks and accompanying workbooks and teacher guides, videos, and technology kits which pertained to module development topics or general reference and technology information were donated or purchased for each site as were computers, software, and printers. Methods of cataloguing and controlling the lending of resources and module equipment were discussed. An informal system of lending controlled by each PDRC coordinator was chosen.

To assure that quality instructional materials were developed at the PDRCs required that modules be classroom tested at field test sites before being used in demonstration schools. The co-director drew upon an established relationship with a group of secondary schools in Pennsylvania associated with a Pennsylvania funded technology program, Project Tech. Teachers at the ten schools participating in Project Tech agreed to field test the modules in their classrooms. Each of the eight modules was field tested at least once before being introduced to demonstration school teachers at Teacher Capability Institutes. Most modules were field tested in three field test locations using students in both junior and senior high schools.

Objective 4: To enhance the interfacing of mathematics, science and technology education.

It was originally intended that separate workshops for the interfacing of technology, mathematics, and science would be conducted by the ATEC training staff. However, Teacher Capability Institutes were planned to function with much the same goal in mind. It seemed more economically efficient both for the consortium and the public schools to eliminate workshops. All interdisciplinary activities involving teacher enhancement took place at Teacher Capability Institutes.

Objective 5: To conduct institutes for mathematics, science, and technology teachers for the purpose of developing teacher capabilities in the area of technology education.

Five Teacher Capability Institutes were conducted over the life of the project. Introduced at each session were one or two of the eight predictive technology concept based instructional modules which integrated mathematics and science in the instruction of technology education. Teachers reviewed the central predictive technology concept and the supporting technology, mathematics, and science concepts in the module. They were also instructed in the use of student activities and the accompanying equipment. Teachers were encouraged to work in teams of technology, mathematics, and science which provided teachers with a multidisciplinary environment where they could work together and share experiences and knowledge from their respective disciplines.

## Goal II: To contribute toward the development of students that are knowledgeable about technology, its evolution, systems, techniques, utilization in

industry and other fields and its social and cultural significance.

Objective 1: Implement the consortium process for identifying and organizing fundamental knowledge, concepts, processes and systems that are uniquely technological and relevant to the changing needs of the work place.

Before research and development of individual instructional modules began, it was necessary to define what a predictive concept was and identify technology concepts predictive in nature. The module development teams reviewed the technology literature to focus on fundamental knowledge, concepts, processes, and systems. A predictive concept was defined as one which predicted the performance or behavior of a given technological component, device or system and provided insight into why a given component, device or system worked and behaved the way to did.

Objective 2: To determine for the Technology Education Demonstration Project the relevant instructional content in technology education courses for the areas of communication, construction, manufacturing, and transportation and the effect of development in these areas on people, the environment, and the culture.

Module research and development evolved from determining a single predictive technology concept related to the chosen topic. Topics were identified from the four primary systems emphasized in the teaching of technology education: communication, construction, manufacturing, and transportation. Subjects chosen included: spanning structures, lifting forces from air foils, flight control through surface alteration, geodesic domes, push versus pull production, statistical process control, magnetic levitation terrestrial transportation, and light wave communication through acoustical modulation. These choices adapted well to the development of instructional materials using hands-on, problem solving activities.

Each module also contained supporting technological, scientific, and mathematical concepts which were described and/or demonstrated in student activities. Science and mathematics concepts complimentary to the main technological predictive concept of each module were selected from technology, mathematics, and science textbooks borrowed from each of the demonstration schools. These texts allowed for some integration between the newly developed modules and existing curricula used in mathematics and science classes.

Modules underwent a two step review process. Faculty members at each of the member institutions served as content review specialists and educators in technology, mathematics, and science. Content specialists reviewed instructional guides only (not equipment). They were asked to review the modules for content validity and appropriateness. Upon completion of content review, specialists and educators completed module content review forms which provided useful feedback to instructional developers for use in the module revision procedure. Field test site teachers completed the second step of the module review process. Each instructional module was pilot tested by field test site technology teachers who had received only minimal instruction in the use of the module. Graduate technology education students participating in the Project Tech program provided this instruction. Teachers were on their own to work with the modules in their classrooms. At the conclusion of each of the instructional units, teachers completed an evaluation form. Comments from the evaluation were used in the final revision of the modules.

Development of literacy tests provided a quantifiable measure of the degree of success of the module contents to teach students predictive concepts. A doctoral level student with prior experience in test design helped to design and develop pre and post literacy tests to accompany the modules. It was originally intended that, like the modules, the literacy tests would be field tested and revised for use with the demonstration schools. However, time constraints did not allow for field testing. Once the tests were administered, they were returned to the project office where the answers underwent statistical analysis. Results were compiled, and class testing results were supplied to the demonstration teachers.

Objective 3: To determine the basic remedial skills and prerequisites necessary for students to participate in instructional programs which include technological, mathematical, and science concepts related to automation, robotics, computer-aided design and computer integrated manufacturing.

It was decided not to conduct a student needs assessment which would have been necessary to determine necessary remedial skills and prerequisites necessary for students to participate in instructional programs. Reviewing demonstration school textbooks used in the teaching of technology, mathematics, and science provided module developers with an indication of the prior knowledge students would be likely to have obtained before participating in the demonstration project.

## Goal III: To enhance the capabilities of teachers of technology in the area of technology education.

Objective 1: To assess the knowledge of teachers about the discipline of technology, its structure, systems, content and concepts and the application of relevant mathematical and science.

Originally, it had been planned that a series of workshops for teachers of technology, mathematics and science be designed, developed, and implemented. These sessions would have given trainers an opportunity to assess the knowledge of teachers about technology. However, it was more economically efficient (participating demonstration schools absorbed the costs associated with teacher release time) to combine workshops with Teacher Capability Institutes. Since workshops were not incorporated into the project plan, an understanding of the level of technology knowledge of the teachers was not obtained. The staff, however, was able to infer the level of technological knowledge during the course of the Teacher Capability Institutes.

Objective 2: To enhance the capability of teachers of technology in developing, delivering and evaluating programs of instruction in the technologies that integrate related concepts of mathematics and science.

To enhance adequately the capabilities of teachers to use the concept-based modules, five Teacher Capability Institutes were conducted over the 2 years of the project. Each institute was held at California University of PA for PA teachers and at Fairmont State College for West Virginia teachers. A flow chart for each TCI was developed. Module developers introduced training staff to the training techniques necessary to enhance teachers in the use of newly developed modules and equipment. The initial responsibility of the early institutes was to orient teachers to the goals and objectives of the project and to introduce to them the knowledge, understanding, concepts, and processes of the systems of technology. One instructional module was explored at each of the first two institutes. Once it was determined that demonstration teachers were reasonably comfortable working with conceptually based problem solving and activity based units, two instructional modules were presented at the remaining TCIs. Thereafter, the institute trainers concentrated their efforts on the introduction and instruction in the instructional modules which integrated concepts from mathematics and science. The institutes were structured to provide teachers with a multidisciplinary environment where they could work together and share experiences and knowledge from their respective disciplines.

At the close of each institute, teachers provided instructional feedback to the trainers in the form of responses to a questionnaire containing specific event statements as well as a comment section. The TCI coordinator analyzed each set of results and shared them with the trainers. This feedback provided quantifiable evaluation data to improve the quality of future enhancement institutes.

Obtaining secondary schools to participate in the Demonstration Project was an early project priority. Each of the seven demonstration schools were served by 3 observer secondary schools, 1 vocational center, and 1 junior college, where available. Teachers of technology, mathematics, and science and school administrators from the demonstration and observer schools were recruited to participate in the Technology Education project. Letters of agreement were signed between ATEC and superintendents from participating demonstration and observer school districts. The demonstration schools were chosen to provide a diversity of students from rural to urban backgrounds, a range of economic and social backgrounds, and racial mixture. Four schools in West Virginia and three in Pennsylvania were selected.

West Virginia
- Fairmont Senior High School, Fairmont, WV
- Sistersville High School, Sistersville, WV
- South Harrison High School, Lost Creek, WV
- South Junior High School, Morgantown, WV

Pennsylvania
- Margaret B. Miller Middle School, Waynesburg, PA
- Shaler Junior High School, Pittsburgh, PA
- Washington High School, Washington, PA

Dedication ceremonies were held at each of the demonstration school sites to provide an opportunity for interaction with participating faculty and administrators and for local press and video coverage.

A total of 32 demonstration school teachers, one teacher each representing mathematics and science, and at least one teacher representative from technology education participated. (In several cases we had multiple teachers from technology education. In those situations, teachers attended institutes and taught modules based on their areas of specialization within their discipline.)

Each observer school had a teacher from technology education, mathematics, and science. There were 22 schools selected and 64 teachers chosen to work with the demonstration schools. These teachers were invited, but not required, to attend the five teacher capability institutes. However, they committed to attend demonstration of the teaching of the modules in the demonstration school classrooms. Demonstration school technology teachers notified observer teachers when the one week long modules were to be taught. Observer school teachers needed only to attend one period to observe the students and teaching.

All administrators and teachers participated in a two part orientation including a satellite broadcast on March 5, 1991 which provided participants with a Project overview and opportunity for a telephone question and answer session. The second part of the orientation included one day sessions in Pennsylvania and West Virginia on March 12 and 13 which offered in-depth coverage of the goals and objectives of the Project. Teachers and administrators from all of the schools met each other and began to establish working relationships. Topics introduced included: purpose, structure and operation of the project; content and structure of technology education; technological systems, processes, and concepts; technological literacy; the role of the school in the project, the role of business and industry in the project; and the role of vocational, technical, and community college programs.

Demonstration school teachers continued their participation in the demonstration project through early May of 1992. Teachers attended a total of five Teacher Capability Institutes where they were introduced to the concepts and instructional techniques needed to teach the instructional modules. All eight modules developed during the duration of the project were taught in the demonstration schools. Literacy pre and post tests were administered and results provided for the teachers. Demonstration teachers completed written evaluation forms for each module. These comments were included in the final revision of each module. An ATEC training associate observed a portion of the teaching of each module in one of the seven demonstration schools. The training associate involved in observation of the classroom teaching spoke with the teacher, participating students, and administrators to acquire qualitative feedback. A dinner was held to honor and award demonstration school teachers for the additional time, enthusiasm, and energy they contributed in helping ATEC to conduct a very successful demonstration project.

## Goal IV: To contribute to the research, development and evaluation of curriculum and instructional materials for use by technology, mathematics and science teachers in instructional programs that focus on technology and the enhancement of the technological literacy of youth in secondary schools.

Objective 1: To design, develop and assess a process for developing, testing, and transferring, on a continuous basis, appropriate curriculum and instructional materials for technology education programs in secondary schools.

During the life of the project, many key components were developed and implemented to assure that a process/change model was in place. A management office and staff were established to oversee and evaluate the work of the project. Professional Development Resource Centers, each with a coordinator in charge of operations, were initiated and provided with equipment and resource materials. Operational plans were developed and implemented. Field test sites were selected and used to evaluate the quality of instructional modules and accompanying apparatus. Teacher Capability Institutes for teachers of technology, mathematics, and science were designed, implemented, and evaluated. Demonstration and observer schools and teachers were selected. They participated in the project orientation, Teacher Capability Institutes, and the demonstration or observation and evaluation of all of the conceptually based instructional modules. A business sponsor was obtained to support the publication and distribution of the ATEC instructional modules. An external evaluator was selected who evaluated both the process and the product of the consortium. Included in the product evaluation plan was the use of content specialists, field test teachers, and demonstration teacher evaluators who reviewed all modules to assure the production of quality instructional materials for use in technology education.

Objective 2: To involve secondary school teachers of mathematics, science and technology in the operational and policy making function of the process/product change model.

Teachers of mathematics, science, and technology contributed to the operational and policy making functions of the change model in a number of ways. An informal procedure for receiving teacher input into the demonstration project took place at each of the Teacher Capability Institutes. TCI trainers took advantage of lunch breaks to discuss informally with teachers problem areas, concerns, and suggestions to improve both the quality of a number of aspects of the demonstration program. Questionnaire surveys conducted at the end of each of the five Teacher Capability Institutes provided teachers an opportunity to reply anonymously. Additionally, one meeting was held between the Executive Committee and demonstration technology teachers to resolve a number of operational and policy issues. Several changes in Teacher Capability Institute procedures and office logistics resulted from these discussions. Teachers cooperated more fully once they understood that their suggestions would be incorporated into the change process.

Objective 3: To implement a technological literacy assessment program for developing, validating and disseminating technological literacy measuring instruments.

A doctoral student and the director worked together in the development of testing instruments. They designed a set of question and answer criteria which was utilized in the development of the pre-post literacy tests. Development of literacy tests provided a quantifiable measure of the degree of success of the module contents to teach students predictive concepts. The level of student learning was discerned by comparing results obtained from each of the module's pre and post tests. Teachers were supplied with these results. Questions were individually analyzed to determine quality. Originally, it was planned that literacy tests would be field tested prior to use in the demonstration classes. However, problems with module and test development delays did not permit field testing. Although tests were developed for each of the modules, the process of validating and disseminating the tests do not progress as far as initially planned.

**Goal V: To focus on the enhancement of preservice and inservice teacher renewal programs that will enable teachers to interface appropriately mathematics, science, and technology education.**

Objective 1: To directly involve teacher educators at the college and university level with the problems associated in the development and implementation of teacher training programs for the preparation of technology teachers for the secondary schools.

Due to the rigorous module development and Teacher Capability Institute schedules, there was little opportunity to address adequately the problems associated with the development and implementation of teacher training programs in technology education. The project staff believe that the eight modules consisting of detailed overview material in the use of predictive concepts for module development will have an impact nationally, particularly since the modules are being marketed by a commercial enterprise.

Objective 2: To directly involve state specialists in mathematics, science and technology with the development, implementation and evaluation of technology education programs in the secondary schools.

Attempts were made to involve state specialists in mathematics, science and technology with the Technology Education Demonstration Project. In March of Project Year 1, a teleconference was arranged with mathematics, science and technology specialists in Pennsylvania and West Virginia. Commitment and cooperation from the math and science specialists in both states was not forthcoming. The level of commitment from the Pa. technology specialist was limited by his inability to travel out-of-state to attend meetings in West Virginia (state travel cut-backs). Although the West Virginia technology state specialist was enthusiastic about the goals of demonstration project, her time to provide input into the project was limited. Other efforts to solicit advice or cooperation from all but the West Virginia technology specialist were not successful.

Objective 3: To involve mathematics, science and technology educators in the design, development and implementation of instructional programs that interface mathematics, science and technology.

Mathematics, science and technology educators were involved in the development phase of the instructional modules only. Six content reviewers representing specialists and educators in technology, mathematics, and science were asked to review the modules for content validity and respond to an evaluation form. Additional comments were welcomed. These comments along with comments from other evaluation sources were addressed in the final revision of the instructional modules. A number of mathematics teachers became intrigued by the direct application of the modules to mathematics and were encouraged to use the modules in their classes, which they did. In one instance the students in an advanced math class analyzed the geodesic dome module and suggested additions.

Objective 4: To involve school administrators in the identification and solution of problems associated with the preservice and inservice education and renewal of mathematics, science and technology teachers.

School administrators participated in the two part orientation to the Demonstration Project and had the opportunity to observe the teaching of the concept modules in technology classrooms. They were welcomed, but not required, to attend all Teacher Capability Institutes. However, issues involving inservice and preservice education and renewal programs for mathematics, science and technology teachers were not addressed except during field visits by the Project Director, the external evaluator, PDRC coordinators and training associates. The Project Director held seminars and meetings with school administration at each Demonstration School site.

Objective 5: To identify the needed changes in preservice and inservice programs for mathematics, science and technology.

Preservice and inservice program needs were not identified specifically. It was evident, however, that all teachers were inadequate in their knowledge of technology and the integration of math and science concepts.

Objective 6: To encourage the development of programs of evaluation and policy changes that will ensure the continual improvement, change and evolution of teacher preservice and inservice programs.

The staff presented programs at state and national meetings where this issue was addressed.

## Goal VI: To disseminate to the education and business/industry communities appropriate information about the (ATEC) Technology Education Demonstration Project, the change process used in the project and the products resulting from the project.

Objective 1: To develop a plan for disseminating project information to secondary schools and the education community.

The Executive Committee concluded that the ATEC process and product (instructional modules) needed to be widely circulated among professionals in technology education if the project was to have a significant impact in combating technological illiteracy. An arrangement was established with the president of Kelvin Electronics of Melville, New York to sponsor the modules. The sponsorship agreement stipulated that Kelvin Electronics would have the right to advertise and sell the modules and equipment and display the modules at trade fairs and conferences involving technology educators. The funding used from the sponsorship agreement subsidized some of the costs of the production of a quantity of modules for dissemination to all ATEC participants and to the 93 colleges and universities in the United States which offer programs in technology education. It was decided that the modules would be housed in college libraries where they would be available to faculty and students from all disciplines. Approximately 300 sets of modules were distributed.

Circulating information about the consortium process was addressed in several ways. The satellite orientation teleconference was aimed at introducing the demonstration project and process to participating teachers and the education community. Further, faculty and graduate students in the consortium disseminated project information to the technology profession through local, regional, and national presentations and article publication. The final report prepared for the United States Department of Education and distributed to the six national vocational technical curriculum centers and ERIC also contain information about the project.

Objective 2: To develop a plan for disseminating project information to the business/industry community.

Brochures designed for fund raising and dispersing consortium goals and objectives were printed and distributed. News releases and publicity from dedication ceremonies held for PDRCs and demonstration schools spread information to the business/education community.

## Part II A

### Project Evaluation-Overview

The project team designed an overall formative and summative evaluation plan to assess the process/product model.

To assist in the evaluation of the process/product model the project team employed an external evaluator and presented the evaluation plan to the evaluator for revision. Unfortunately, no revision took place. The Director discovered after three sessions with the external evaluator that the evaluator was not capable of addressing the evaluation of the key objectives of the process/product model. The evaluator focused on the dynamics of staff interaction rather than on the instructional modules, the technological content and the results with the students in the classroom. The result was that the evaluation plan, as designed, was not carried out to the fullest extent. The focus was primarily on the formative aspects although summative evaluations did occur for specific aspects of the project.

Even with this problem, the management team was able to carry out the primary aspects of the evaluation plan. The management team did:

1. design, develop and implement an evaluation plan for the Demonstration Schools program including:
    a. teacher evaluation
    b. administrator evaluation
    c. student evaluation-technological literacy
        1. knowledge and application of content
        2. knowledge and application of process
        3. knowledge and application of technological concepts and related mathematical and scientific concepts.
        2. conduct a pre-assessment of the technological literacy of students in Demonstration Schools (related to a specific technological concept.)
        3. conduct post-assessment of technological literacy of students in Demonstration Schools.
        4. analyze and compare results of pre and post tests and compare achievement of participants with non participants.

Site visits were designed and conducted by the Director and a Training Associate. Photo documentation of the teaching of the instructional modules at various sites was completed. Interviews with school administrators and students were conducted and unsolicited comments were documented. An evaluation report was prepared.

Each instructional module was reviewed by content experts, field tested, and evaluated by students and instructors, and tested and evaluated in Demonstration Schools. At each stage, the modules were revised to accommodate the findings of the reviewers and field tests.

A complete statistical analysis of the performance of each module taught in each class in a Demonstration School was performed. This data was provided to the instructors in summary form and used by the management team to assess the design of the module in the teaching of a predictive technological concept.

In projects as complex as this demonstration project, it is recommended that a full time position be included as part of the management team to attend to the evaluation program. Quality evaluation of the type intended in this project can only be attained by a knowledgeable evaluator with expertise in the content area and by day-to-day attention to the many tasks required in this type of multifaceted program.

# Appendix A

## Evaluation Letters - External Evaluator

The following pages contain the letters submitted to the Director by the Project External Evaluator. These letters constituted the sole source of project evaluation as provided for the Director by the External Evaluator.

July 22, 1991

Dr. Paul W. DeVore
Director, ATEC
West Virginia University
Department of Technology Education
2945 Universtiy Ave.
Morgantown, WV 26506

Dear Paul:

Thank you for your graciousness in hosting me and making arrangements for me for my visit in June. I appreciate your introducing me to your colleagues and providing such a helpful and thorough overview of the project.

It is quite evident that the project is well conceptualized and managed by a very competent staff. Your management plan and timelines are comprehensive and feasible. You have detailed the tasks and responsiblities in such a manner that the teams have thorough information to work with and can see clearly how each effort relates to other efforts and the goals of the project. Most importantly, your vision and energy, supported so well by Dave, provide the project very capable leadership.

Before I address the overall evaluation plan and timeline, I want to recap a couple of recommendations we considered at out meeting in June. From our discussion, it appears that your external panel of evaluators and their reactions to the draft modules plus the pre/post student assessments will provide the developers very useful information as they design additional modules. I recommend the addition of an hour's worth of discussion and feedback for each of the modules by the site teachers before they are trained to use the next module. The discussion would be broadly focused on general reactions, descriptions of student engagement and student problem solving behaviors observed during the use of the module, and teachers sharing stories about critical events and student reactions. Finally, the teachers might suggest additions based on their own experiences with the modules (ie. spin-offs that spontaneously emerged), appropriateness of the terminology, organizers, problems, tests, etc. An indirect benefit of these discussions (which I would tape record) is that it provides you another way to assess the teachers' understanding of what the curriculum design behind the modules is (E-1).

Another point we discussed was that of the TA's systematic observations and written descriptions of the sessons they observed. Using systematic observations coupled with field notes of a broad sweep nature will provide some stable data for you to use in assessing the content flow, problem solving activities, engagement of the students, and levels of student thinking. The observations also provide the TA's an excellent opportunity to engage in systematic study of educational change, something they rarely if ever have the opportunity to do as classroom teachers.

I have also reviewed the student pre/post test for Module 1 and the trainees reactions to the training sessions. The test seems to be quite comprehensive in addressing the key concepts and measurement and graph mathematics. Some of the objectives suggest application and analysis levels of problem solving. Are there measures that assess students ability to solve problems together, to apply them in the construction phase or to analyze problems not previously encountered? You may want to consider the development of portfolios of randomly selected students to obtain a full range of their ability to use the concepts and principles in situations not taught.

Per our discussion, it is my understanding that I will visit the project site two or possibly three more times in order to provide formative and summative feedback. This will include descriptions of the activities of the project in relation to the goals identified in the proposal. It will also involve flagging any potential problems in the evaluation procedure and making recommendations such as those presented earlier in this letter. In essence, I will analyze the assessment process in relation to the development and field testing of the modules, the training of teachers, the efforts directed toward fostering the collaborative work of the coalition and impact of these on the university and school programs as well as the ongoing support of the community and industrial bodies involved.

If there are other tasks you see that I should address, please advise me. The only one I envision at this time is some in-depth interviewing of a sample of teachers and university personnel to obtain insights about any changes in their pedagogical beliefs and cognitive constructs of technology education, the levels of commitment to the goals and their visions of the potential impact of the project on their overall programs.

Please convey my thanks to Susan for collecting and sending the materials.

Sincerely,

Dick Hawthorne

January 6, 1992

Dr. Paul DeVore, Director
Appalachian Technology Education Consortium
2945 University Avenue
Morgantown, West Virginia 26506

Dear Dr. DeVore:

It was of great value to me to have the opportunity to meet the graduate students and be briefed about the status of the modules they are so enthusiastically developing. Their collaborative work with each other and the faculty members is a real strength of the project. They are learning more about instructional design concepts and principles than any three courses might provide.

Our discussions with the members of the Executive Committee were equally valuable. Because you have extensive notes on the substance and flow of the session, I will not attempt to recapture it. Rather, I will offer some of my own insights, reactions, and recommendations based on the session.

Because the modules are as strong as the teachers' interpretations of them, it is of critical importance that we capture some of the ways they are making sense of the purposes and design of the modules as a whole. The graduate students might want to observe some teachers using the modules and then interview them to obtain descriptive data about why the teachers did what they did. The intent is to delve into the minds of the teachers to determine how they conceptualize the content and processes involved in the modules, students engagement with the modules, and the problem-solving perspectives being developed using the modules. The observation that the teachers are using the language of the modules is significant in this regard. This suggests that they are developing new conceptual frameworks about technology education.

The observation that teachers are not as yet able to explain with comfort and fluency the mathematical and scientific reasoning involved in some of the problem-solving tasks merits attention. The math and science consultants need to address this directly and develop some additional materials for the teachers that will connect their (the teachers') existing mathematical/scientific understandings with the new concepts and procedures used in the modules. I suggest that the consultants review the completed modules and write the additional materials that would serve as optional resources for the teachers. For the modules at the design stage, I would involve the consultants directly so that the additional materials could be integrated throughout the modules when deemed appropriate.

The communication between faculty and graduate students between sites was described as awkward. The GA's schedules of classes at UWV and those of the faculty at the various sites need to be addressed. Perhaps an agreed upon block of times each week will need to be formed before class schedules are set or alternative seminars and independent studies need to be formed to substitute for established courses where possible.

The issue of competing demands upon the faculty to continue their regular assignments and to contribute to the project is one that involves department chairs and Academic Vice Presidents. Each institution needs to reaffirm its commitment to the Consortium and to offer suggestions about how to assure appropriate released time for the project. Perhaps greated visibility needs to be given to each of the institutions and faculty in relation to their contributions. The bottom line is that the faculty and consultants need to become more directly involved in the development, assessment, and revisions of the modules.

There seems to be a time frame conflict that creates undo pressures on institute planning and training sessions. Some additional time needs to be created to assure that comprehensive planning is done for the training sessions. Additionally, the developers must find time to observe teachers using the modules. The testing of the students is not sufficient to obtain feedback about how teachers are in fact using the modules, how students engage with the materials and ideas, or how teachers feel the module might be improved.

Finally, I think the committee would benefit from an analysis of its own problem-solving processes. There is too much dependence on the directors to solve the problems and then to passively react to their decisions. This may be directly related to the time conflict and possible low commitment by faculty from the other institutions. I would attempt to develop a problem-solving atmosphere in the meetings of the Executive Committee. This will create less efficient sessions, but may evoke a greater sense of ownership and thus commitment by the members. I would also plan some well-timed celebration sessions to acknowledge the amount of work accomplished and the quality of the collaborative effort it takes to do such a complex project.

The problems and issues you and your colleagues are facing are very typical of a consortium effort. The working relations of any two people is difficult at times, the working relations of several people across different institutional cultures is very difficult. All involved need to be mindful that the project is as much about forming a collaborative relationship between institutions and individuals as it is about developing the modules. The power of the consortium will, in the long run, be the real outcome of this project.

Sincerely yours,

Dick

Richard D. Hawthorne

4105 Alicia Trail
Stow, Ohio 44224
March 17, 1992

Dear Paul,

Many thanks to you and Karen for arranging the visits to Shalersville and Washington. It was valuable to me to hear teachers and principals express their enthusiastic support for the training, modules, and the overall project concept. It must have been particularly satisfying for you to see your dream played out in real life by teachers and students.

From the comments of several teachers and administrators, it is clear that the quality of the training sessions have continuously improved. The teachers are genuinely appreciative of how well they have been listened to and that their suggestions have been incorporated in the improvement of the training sessions.

A related theme emerged from teachers' and administrators' comments; they wish to be more involved in the design and development stages. They seek even more ownership of the materials and concepts and feel that they can make useful contributions to these aspects of the project in addition to their involvement in the training and piloting of the units.

Another observation, though limited to an N of one, is that the Shalersville teacher seemed to me to miss the problem solving intent of the module when he regrouped the students to analyze the data on the board. Rather than engaging the students in the analyses to identify patterns in the data and to obtain conclusions, he did the thinking for them. All they had to do was agree with his statements. I would want to see how other teachers taught these lessons and observe the extent and nature of student thinking/problem solving evident in those sessions. If a pattern of teacher dominance such as that observed in Shalersville emerged, I would want to reassess the training programs accordingly.

Finally, the full involvement of math and science teachers appears to continue to be problematic. If so, this is a knot that needs to be addressed by a group of math, science and technology educators. I would recommend a day long seminar on campus to clarify the nature of the problems involved, to hear from other educators involved in integrated curriculum work, and to develop strategies to increase the involvement of the math and science teachers. In particular, I would invite project teachers who are able to foster the involvement of math and science teachers to describe how they work together, how they encouraged such collaboration, and what recommendations they might have for other teachers at other sites.

The support the project has from the principals and teachers we visited is very important. A fundamental phase of school reform and curriculum development is the creation of a shared commitment to an educational vision. You have done that, and done it well. The teachers and administrators seem to have a clear idea of what the integrated modules are about and a strong desire to support the continuing evolution of the project. This is important, not only to your project, but to the larger context in which new forms of curriculum, teaching, and learning are created. You and your associates should feel very good about your contributions to this larger reform process.

Again, thank you for another interesting day in the life of your project. Please advise me of our next step.

Sincerely yours,

Dick

Richard D. Hawthorne

# Appendix B

## Appalachian Technology Education Consortium Technology Education Demonstration Project Replication Report

### Introduction

A demonstration project conducted by a consortium of four institutions is complex. Yet a consortium has the major advantage of being able to unite the talents and resources of multiple people and institutions to fulfill mutually agreed upon goals. A well-thought out management plan and clear delineation of multiple duties and responsibilities of each participant is key to the success of the project.

This replication lists by topic how ATEC accomplished its goals in the technology education demonstration project. Many tasks overlap and are interdependent. In some cases, the initial management plan had to be revised. Problem areas have been pointed out, and suggestions to alleviate difficulties have been offered.

### Project Initiation and Organization

Forming a consortium to undertake a project involving several colleges/universities all committed to a common goal required that a formal document listing institutional levels of commitment be developed and signed. A luncheon celebrated the signing of a memorandum of agreement by the four presidents of the four ATEC founding member institutions: California University of Pennsylvania, Fairmont State College, Salem Teikyo University and West Virginia University. The agreement provided for a written commitment by each school to support the goals of the consortium by providing facilities, faculty released time, communication services, and payment of membership fees to cover selected operating expenses.

Formal ceremonies such as the one held to establish ATEC, provided opportunity though press coverage to introduce both the higher education and surrounding communities to the project. Consortium agreements among 4 institutions of higher learning are fairly unusual. The fact that these schools existed in two separate states and were of differing types (a land grant university, 2 colleges, and a private college) made the arrangement unique.

All research projects require well thought out organizational and management plans. A consortium of 4 separate entities makes these plans critical because of the complexity of coordinating various components. The project was headed by a director and a co-director. The director was responsible for the overall management of the project including private sector fund raising. The co-director served as the coordinator of the West Virginia University Professional Development Resource

Center, coordinated and participated in all Teacher Capability Institutes, coordinated field testing efforts, and aided in the project planning and task assignments, and in final reviews of each instructional module.

Each member institution had a representative and an alternate appointed by their president to serve on the Executive Committee. The representative at each of the member institutions also served as the coordinator of a Professional Development Resource Center. That individual was responsible for managing the Resource Center, recruiting demonstration and observer schools, supervising instructional module development, and serving as a trainer at Teacher Capability Institutes. Module development and training responsibilities were shared between the 2 West Virginia member institutions with the main module development site being located at Fairmont State College. Each member school also selected a representative as fund raising business/industry liaison.

## Management Plan

Approaches used to manage the project included several elements. Project planning tools such as PERT and GANTT charts and Microsoft Project Manager were used to coordinate and delineate module development, Teacher Capability Institute scheduling, and fund raising responsibilities. Due to the concurrent nature of many of these activities, planning tools with beginning and ending timelines were very important. Twice a month meetings with the Executive Committee were held allowing opportunities to exchange information and confront issues. Written agendas and minutes were maintained as part of the management evaluation process. The director and co-director met weekly with management staff and training associates to review weekly work reports listing accomplishments, work planned and in process, and to discuss problems and concerns. FAX machines facilitated communication with the three remote Resource Center coordinators. It was hoped that the use of electronic mail and computer conferencing would be part of the communication network, but lack of funds did not permit the purchase of the necessary software and equipment.

## Project and Consortium Support Personnel

Once the organizational structure was determined and the management plan implemented, support staff were hired. Key to the management plan was the selection of appropriate personnel. Positions were advertised, interviews were conducted, and 2 people were hired to function in the positions of staff associate and Assistant to the Director. The staff associate was primarily responsible for budgeting, office management, purchasing, and record keeping. The staff associate worked with the Project Director to establish project budget and accounting procedures with the West Virginia University Research Foundation and the West Virginia University Foundation which was responsible for the management of funds donated from the private sector. The Assistant to the Director functioned in the director's absence. Since this position was responsible for all reports, correspondence, and liaison duties with the consortium institutions and public schools, strong written and verbal communications skills were very important. These two positions required individuals capable of making decisions and functioning with minimal supervision since the director had additional teaching and research responsibilities which removed him from the office for periods of time.

A search for training associates was conducted nationally. Three doctoral level and 2 masters level technology education students were hired. Their primary responsibilities were to work with PDRC coordinators to research and develop instructional modules for use in the technology education classroom and to train teachers at Teacher Capability Institutes. Once all new personnel were on board, everyone was oriented to the management procedures and project operation.

Selection and Purchasing of Equipment

Computer equipment and software for the project office staff were purchased. It was assumed that adequate computer support needed for module development existed at each of the PDRC sites. It was determined several months into the project that the computers available for use in the other member institutions were inadequate for the task, and the software was not compatible from one site to another. Computers and software were purchased for the two major development sites from private sector contributions. (Equipment for the Salem Teikyo and West Virginia PDRCs was purchased as private sector funds became available. Module productivity suffered while developers learned to use new computer systems and several types of software (word processing, art, and graphics packages). Those intending to replicate an instructional materials development project need to determine equipment and software requirements and make purchases at the onset of the project. It is also necessary to include a computer operation training component as part of the project as an on-going operation.

Consortium Member Development and Training

Before research and development of instructional modules could begin, it was necessary to train developers in the understanding of predictive technology concepts. Developers had a difficult time understanding what a predictive concept was. Several Executive Committee meetings dealt with little more than defining predictive versus descriptive concepts. Understanding a predictive concept permits one to predict the performance or behavior of a given technological component, device or system. These concepts provide insight into why a given component, device or system works and behaves the way to does. Research and development evolved from determining a single predictive technology concept related to the chosen topic.

## Design, Development, and Operation of Professional Development Resource Centers

Professional Development Resource Centers were established and dedicated at each of the member institutions to serve as the center for research and project operations for each of these schools. The coordinators at California University of Pennsylvania, Fairmont State College, and Salem Teikyo University were responsible for obtaining dedicated space for the PDRC which would house research materials and computer work stations used in producing technology instructional modules and providing teacher training and enhancement. West Virginia University's PDRC served as a research and management office site only. Dedication ceremonies for the PDRC facilities at all but West Virginia University were held. Dedications provided an opportunity for project exposure within the university and to the surrounding community through press and radio/television coverage. Administrative participation in the ceremonies indicated a level of institutional commitment and support which was a great morale booster to participating faculty members.

Equipping PDRCs with research materials in technology, mathematics, and science was initiated. Materials were intended for use by module developers and demonstration and observer school faculties. Core sets of technology textbooks and accompanying workbooks and teacher guides for each of the 4 PDRCs were donated from major publishers in the field of technology education. PDRC coordinators requested specific resource materials including textbooks, videos, and technology kits which pertained to module development topics or general reference and technology information. All resources and computer software and equipment were purchased, entered into an inventory data base, and marked with identification at the Project Office. Materials were then distributed to each of the PDRCs. Methods of cataloguing and controlling lending of resources and module equipment were discussed. Lack of time and personnel never permitted initiating an efficient system using bar coding. An informal system of lending controlled by each PDRC coordinator was used instead.

## Selecting Demonstration and Observer Schools

During the first quarter of the project, PDRC Coordinators enlisted the participation of demonstration and observer secondary schools and teachers to participate in the project. Each participating school provided at least one teacher representative each from technology, mathematics, and science. Three demonstration secondary schools (2 middle schools and 1 high school) were established in Pennsylvania. The Fairmont State College coordinator selected 2 high schools and 1 junior high school. Salem Teikyo University selected one demonstration school at the high school level. Coordinators also picked 3 observer secondary schools per demonstration school with participating faculty from technology, mathematics, and science.

Demonstration and observer schools were chosen for several criteria. Schools districts were asked to participate because they represented a suitable demographic mix or because their technology teachers and administrators were receptive to or actively looking for ways to upgrade technology curricula. The Executive Committee wanted a heterogeneous group of male and female student participants representing middle through high school, from rural, city, and suburban locations, with a variety of socioeconomic levels and diverse racial and ethnic backgrounds. Several school districts initiated contacts and expressed interest in working on the Demonstration Project. Others were chosen as the result of coordinator visits to schools or through a series of telephone calls resulting in school district commitment to the project.

As part of the formalization process, each participating school district superintendent signed a commitment letter prepared by the Project staff. Principals and teachers received copies. Demonstration school administrators agreed to provide released time for a technology, mathematics, and science teacher to attend the 5 Teacher Capability Institutes scheduled during the 2 years of the project. Observer schools committed to a least a portion of a day's released time for their teachers to observe the classroom teaching of each of the 8 instructional modules. Observer teachers were welcome, but were not, required to attend teacher institutes.

There were problems associated with obtaining schools to participate. Since the PDRC coordinators had teaching responsibilities at their colleges, they were often not available to make or receive calls from school district personnel. It was finally decided that staff and training associates working from the Project Office were more accessible, and therefore, more successful in obtaining commitments from the schools. Another problem involved the lengthy bureaucratic processes sometimes necessary to obtain school board approval. Several school districts expressed interest in working on the project but required school board approval to participate. It can take several months for requests of this sort to be included on a school board agenda. Time constraints were such that other schools districts which allowed for more autonomous administrative decision making were chosen.

Selection of Field Test Sites

The production of quality instructional materials was assured by including classroom "trial run" testing of materials and equipment before modules were used in demonstration schools. The co-director drew upon an established relationship with a group of secondary schools in Pennsylvania associated with a Pennsylvania funded technology program, Project Tech. Teachers at the ten schools participating in Project Tech agreed to teach the modules in their classrooms. Letters of agreement were provided for participating school principals.

Module Research and Development

Module development teams were established at California University of Pennsylvania and Fairmont State College. California University of Pennsylvania was assigned five modules for development; Fairmont State College, with help from Salem Teikyo University, was assigned responsibility for the development of three modules. California's team consisted of two technology faculty members, three training associates, one graduate student, and work study students. One Fairmont faculty member with input from one Salem Teikyo faculty member, two training associates, one graduate student, and work study students researched and designed the content and equipment for classroom use. Planning, conducting, and instructing for the Teacher Capability Institutes were joint efforts. The original management plan indicated that the instructional modules would be developed at the Professional Development Resource Center in Pennsylvania, and teacher enhancement programs would be developed as a joint effort by Fairmont State College, and Salem Teikyo University. Research and development of 8 modules proved to be an intensive and time consuming effort for a single development team. Instead, the Pennsylvania PDRC site developed 5 instructional modules. Fairmont State College and Salem Teikyo University faculty and graduate students developed 3 modules.

Module content evolved from determining a single predictive technology concept related to the chosen topic. Each module also contains supporting technological, scientific and mathematical concepts which are described and/or demonstrated. Each of the 8 teaching module units contained predictive technology concepts which integrate concepts from mathematics and science.

Topics were chosen from the three primary systems emphasized in the teaching of technology education: communication, production, and transportation. Subjects chosen included: spanning structures, lifting forces from air foils, flight control through surface alteration, geodesic domes, push versus pull production, statistical process control, magnetic levitation terrestrial transportation, and light wave communication through acoustical modulation. The original intention of the development team was to adapt existing technology education classroom activities to emphasize a single predictive technology concept and integrate supplementary concepts from mathematics and science. However, push versus pull production and statistical process control were innovative and unique to the teaching of technology education.

Selecting appropriate science and mathematics concepts concerned developers since their area of specialization was technology. Textbooks used to teach technology, mathematics, and science were borrowed from each of the demonstration schools. These texts were used as references sources to locate complimentary science and math concepts. Module developers determined that participating math and science teachers could serve as an in-house resource base to help the technology teacher with difficulties in teaching the math and science. How math and science teachers were used in module instruction was left to the discretion of the technology teacher.

The module developers chose a format for the modules. All modules were designed to fit in a loose leaf notebook. Each module contained a cover, table of contents, introductory information, usage description, teacher section, activity section with individual and group activities, overhead transparencies, and an appendix. The activity sections could be duplicated for classroom use. The developers also designed and developed the accompanying apparatus used in the student activities.

A number of problems were encountered. At first, developers had a difficult time understanding what a predictive concept was. Some developers felt that designing a conceptually based activity resulted in activities contrived to control for a desired outcome and were not truly problem solving in nature. Designing the activities seemed to come more naturally to the developers since technology education is taught through the use of hands-on student activities. Even the activities presented some pitfalls. Budget constraints required that developers design activities which used inexpensive and readily obtainable materials. Developers had to research costs to purchase materials needed to assemble kits which took time away from the module development schedule. Some attempts to obtain donated materials from vendors were attempted, but this approach yielded too little donated equipment to justify the time spent.

Tight development deadlines which are necessary to fulfill goal commitments in a 2 year demonstration project meant that the pace for module developers was very hectic. It necessitated that while one module was under development a second or third module needed to be researched. Writing, equipment design, and preparation took place concurrently. Revision of one module overlapped with the development of other modules. Time to prepare for instruction at the Teacher Capability Institutes was very tight and often took place the last few days before a scheduled institute. Adhering to deadlines and being able to work under pressure were essential qualities in module developers.

## Module Review Process

Module drafts underwent a two step review process. First, each module was sent for review to six content reviewers representing specialists and educators in technology, mathematics, and science. Reviewers were selected from the faculties at each of the member institutions. Reviewers were each assigned a campus contact whose chief task was to expedite the review process by providing reviews with modules, evaluation forms, and return envelopes. Content specialists reviewed instructional guides only (not equipment). They were asked to review the modules for content validity, add comments to the document, respond to an evaluation form, and return response to the Project Office. It was requested that reviews be completed in two weeks or less.

Some difficulty occurred from delays in the review process. Comments and recommendations obtained from the review process often were not available on time to include in the module provided for the demonstration teachers at the Teacher Capability Institutes. (Changes were made in the final product.) Several suggestions to overcome problems in the feedback process follow: (1) Pay reviewers a reasonable sum of money, $100 has been suggested, to expedite the review process. Although all reviewers received written letters of thank you, remuneration may have been more effective in speeding up review time. (2) Select a larger number of reviewers so that the same individuals are not under pressure to review several modules within a short period of time. (3) Arrange for meetings between content reviewers and the module development team. Module developers often felt that many of the content review suggestions overlooked the age and level of sophistication of the secondary school student audience. In a number of situations, developers did not understand what kinds of changes reviewers were trying to suggest. As the result, useful ideas may have been overlooked. Opportunities to review material with the reviewers would have made the commentary more useful.

The second step of the module review process involved the use of the field test sites. Test teachers received only minimal instruction for classroom usage. Training associates participating in the Project Tech program volunteered to undergo training on each module so that they could, in turn, introduce the field test teachers to the new materials and equipment. Teachers were on their own to work with the modules in their classrooms. At the conclusion of each of the instructional units, teachers completed an evaluation form (developed by the Executive Committee). As useful as the data from field test teachers was, the feedback was often received too late to be of significant value for use at Teacher Capability Institutes as was originally planned. As a result, errors in written materials and equipment glitches were often not discovered by the module development teams until the modules were used in the demonstration schools. The short answer evaluation forms may have placed artificial constraints on the field testers by locking them into a limited response framework. Review meetings held between field test teachers and module developers might result in more useful information for developers.

## Orientation

One month prior to the first Teacher Capability Institute, a two part orientation was provided for demonstration project participants and interested parties. First, a satellite teleconference provided a project overview and opportunity for questions and answers. The second part of the orientation consisted of a one-day long seminar at a Pennsylvania and a West Virginia site. The primary objective of the teleconference was aimed at introducing the demonstration project. Satellite downlink sites were located in or near all of the participating demonstration and observer schools. All participants and technical personnel received flyers containing downlink information to assure that there would be no difficulties with satellite reception.

The teleconference was one hour long. The first half introduced the consortium participants including the Director, Co-director, and PDRC coordinators. An overview of the project was presented. Major topics included contemporary technology education programs, creative problem solving, curricula incorporating technology, math, and science, conceptual teaching, and technological literacy. The second half of the program allowed for viewer telephone questions and answers via telephone link.

A number of technical problems developed. Even though preliminary assessment indicated that all designated sites were able to receive the broadcast, fixed satellite dishes at many locations made it impossible for a number of participants to tune to the appropriate frequency. Several other locations were pre-empted from viewing the orientation due to previously scheduled distance learning broadcasts. Finally, technical difficulties with the telephone call-in portion of the orientation made viewer call-in questions impossible. This compromised the quality of the broadcast, and made it difficult for the panel to fill in for "dead" air time. Obviously, there is no substitute for adequate orientation to a project. ATEC provided video tapes for those participants who were unable to see the broadcast. Future attempts at satellite communications require that receiving site personnel be made fully aware of technical information and limitations. A trail run of the system may help to prevent embarrassing errors.

Even though the satellite orientation did not meet expectations, the on-site orientation for demonstration project participants, provided adequate project information. The on-site orientation also presented an opportunity for teachers and administrators from all of the schools to meet each other and begin to establish working relationships. Topics introduced at this phase of orientation included: purpose, structure and operation of the project; content and structure of technology education; technological systems, processes, and concepts; technological literacy; the role of the school in the project, the role of business and industry in the project; and the role of vocational, technical, and community college programs.

Professional Development - Teacher Capability Institutes

The Executive Committee determined that it would require 5 Teacher Capability Institutes over the 2 years of the project to adequately enhance the capabilities of teachers to use the concept-based modules. Institutes were was held at California University of PA for PA teachers and at Fairmont State College for West Virginia teachers. The co-director of the project developed a flow chart for each TCI. He debriefed the prior taught modules for teachers and presented an overview of the new material. Module developers, including technology education faculty and training associates introduced the module and the appropriate teaching techniques necessary to instruct predictive concepts through an activity based format. Since teachers were encouraged to work in school teams of technology, mathematics, and science teachers, the institute also provided teachers with a multidisciplinary environment where they could work together and share experiences and knowledge from their respective disciplines. At each session, teachers received all instructional materials and activities equipment for the modules to be taught. They also received the instructions and literacy pre-tests to be administered before teaching each of instructional modules. For some technology teachers who still adhered to "shop teacher" pedagogy, institutes were a unique experience.

At the close of each institute, teachers provided instructional feedback to the trainers in the form of responses to a questionnaire containing specific event statements as well as a comment section. The TCI coordinator analyzed each set of results and shared them with the trainers. This feedback provided quantifiable evaluation data for the institutes as well as information to improve the quality of future enhancement institutes.

Classroom Use of Module

The final phase in module development was the actual classroom teaching of the technology modules in the Demonstration schools. It took approximately one week of classroom time to teach a module, exclusive of the administration of pre and post literacy tests. Demonstration teachers were provided a master copy of the module. It was their responsibility to reproduce overhead transparencies and duplicate work sheets for student use. The demonstration school teachers were also responsible for inviting observer school teachers to attend a class when a module was being taught.

First, the pre-test was administered to the students by an individual not involved in the actual teaching of the module. The test administrator was furnished an envelope in which to return answer sheets to the project office for grading and statistical analysis. Post tests were mailed from the project office to correspond to the approximate date of module completion. Within several days of module teaching completion, the test administrator gave the test to the students and returned the answer sheets in envelopes provided.

It was planned that ATEC training associates would be able to observe a portion of the teaching of each module in the seven demonstration schools. However, time and distance constraints did not allow for this type of in-class evaluation. Instead, each module was observed at a minimum of one site. The training associate involved in the evaluation spoke with the teacher, participating students, and administrators to acquire qualitative feedback. At the end of the module instruction, demonstration teachers were asked to evaluate the module on a form provided. These comments were included in the final revision of each module.

Several problems were encountered with module instruction at the demonstration schools. Demonstration school teachers were very disappointed with the poor attendance levels of the observer teachers. In West Virginia, state budget cutbacks meant that observer teachers were not able to attend the teaching of any module beyond the first one. This was not the case with the Pennsylvania teachers. Although demonstration teacher invitations were diligently extended to observer teachers, the interest to attend did not seem to be there. In some instances, lack of attendance may have been due to rather large traveling times between demonstration and observer schools. It was never made clear why some observer teachers chose not to attend. Some mathematics and science teachers within demonstration schools complained that they did not feel they were necessary to the project. However, others became very involved and used the modules in their own math or science classrooms. Some math and science teachers helped to team teach the technology students those concepts and activities relating to math and science. Each technology teacher decided how best to integrate their math and science colleagues. Some were quite successful at using these valuable human teaching resources; others chose not to address the issue.

## Module Production

Module production involved those activities needed to produce published instructional materials booklets for dissemination. The production process began once all module feedback was available from content reviewers, field testers, and demonstration teachers. The module development teams incorporated appropriate changes, refined module graphics, and inspected each unit to assure consistency of format. The PDRC coordinator responsible for each module indicated his satisfaction with the finished product by signing a "final production" sheet.

The modules were then passed to the Director, Co-director and Assistant to the Director for final editing. The Director and Co-director examined each module for technological clarity and accuracy. The Assistant looked for problems with grammar and formatting. These three parties signed the final production sheet and returned the edited module to the developers for corrections.

A local printing company was chosen to do the final production work. They offset printed the modules from camera ready laser originals. Covers previously designed by the staff of the Graphics Design Department at West Virginia University were added, and the modules were wire bound. Modules were collated into sets of eight, boxed, and stored at the printer. Fifteen copies of each set were packaged and sent to the module sponsor as per the sponsorship agreement.

Questions surfaced concerning the efficiency of the revision process. Although it was assumed that each module would travel through the above mentioned editing steps only once, each module repeated the process several times. Developers became frustrated with the repetitive nature and long duration of the process, and conflicts between the Director and developers ensued. Lack of effective communication between the development teams and the Director concerning major module changes added to the tension. Production schedules arranged with the printer were delayed as were module delivery commitments with the sponsor of the module. A clear and concise statement of editing and revision practices needs to be established and adhered to if problems like those mentioned are to be avoided.

Project Evaluation - Literacy Tests

Development of literacy tests provided a quantifiable measure of the degree of success of the content of the module to teach students predictive concepts. While the module developers worked on module research and development, a training associate working with the Project Director designed and developed a series of pre and post literacy tests to accompany the modules. Pre and post tests contained identical questions and answers. Question ordering was changed in the post tests. Pre and post tests, printed in booklet form, consisted of a series of questions relating to the module content. Students chose answers from 5 multiple choice responses. Students answered on Scantron sheets to assure speedy grading and statistical analysis.

The test developer needed to work closely with module developers so that questions reflected module content and intended learning outcomes. It was originally intended that, like the modules, the literacy tests would be field tested and revised for use with the demonstration schools. Time constraints in test preparation resulted from delays in the module development process. As the result, time did not permit for field testing of the literacy tests. Late changes in the module content and lack of content knowledge negatively impacted the ability of the test developer to design a quality testing instrument. It was eventually decided that the module developers would furnish the test developer with a series of questions and answers appropriate to the module. The testing specialist would then choose from the list of questions and add appropriate detractor. This approach resulted in a higher quality test. However, it added to the already heavy workload of the module development teams.

Project Evaluation - External

An external

Richard Hawthorne of Kent State University visited with the project members on three occasions. The first session was an informational meeting where he spoke with the director, Co-director, and office staff. Press releases, forms, and documents pertaining to all aspects of the project were shared with him. The second meeting allowed for input from the project staff, training associates, and the Executive Committee. Problems were discussed, and he offered some useful suggestions to alleviate levels of frustration most obviously expressed by the module developers who felt pressured by time constraints and large work loads. The final meeting took place at two demonstration school sites. He talked with teachers, students, and administrators and observed the teaching of one module lesson. The external evaluator provided the

Director with a letter after each meeting which summarized his conclusions and offered suggestions to better achieve project goals.

Although the comments of the project evaluator were useful to the management staff, his capability in addressing the quality of the project related to the goals and objectives was limited. He addressed only those issues which were voiced during his visits. The Director discovered after three sessions with the external evaluator that the evaluator was not capable of addressing the evaluation of the key objectives of the process/product model. The evaluator focused on the dynamics of staff interaction rather than on the instructional modules, the technological content and the results with the students in the classroom. The result was that the evaluation plan, as designed, was not carried out to the fullest extent. The focus was primarily on the formative aspects although summative evaluations did occur for specific aspects of the project.

Project Dissemination

The consortium was concerned with two areas of dissemination. The first involved disseminating the product (instructional modules). The Executive Committee concluded that the eight instructional modules needed to be circulated widely among professionals in technology education if the project was to have a significant impact. Several methods were suggested to provide for nationwide distribution. One method involved the establishment of a relations with a distributor of technology related school supplies to promote the modules through vendor demonstrations at various professional conferences and trade shows as well as through a corporate sales effort to educators. On August 27, 1991 such an arrangement was established with the president of Kelvin Electronics of Melville, New York. A sponsorship agreement detailed the role of Kelvin Electronics in product dissemination and financial support. The funding was used to sponsor the production of a quantity of modules for dissemination to all ATEC participants and to the 93 colleges and universities in the United States which offer programs in technology education. The modules were shipped in the college libraries with accompanying letters so they would be available to faculty and students from all disciplines.

The second area of dissemination involved circulating information about the consortium process. The satellite orientation teleconference, was aimed at introducing the demonstration project and process. Faculty and graduate students in the consortium disseminated project information to the technology profession through local, regional, and national presentations and article publication. Brochures designed for fund raising and dispersing consortium goals and objectives were printed and distributed. News releases and publicity from dedication ceremonies held for PDRCs and demonstration schools spread information to the education community and the general public. The final report prepared for the United States Department of Education and distributed to the six national vocational technical curriculum centers and ERIC also contain information about the project.

Board of Directors

Efforts to establish a board of directors for ATEC was undertaken. The job of the board was to make policy and planning decisions and implement a long-term fund raising effort to guide and support ATEC beyond the 2 year support of the USDE grant. Executive Committee members provided the director with names of people from education and from business and industry to serve on the board of directors. A list of names was evaluated, and the Director and Assistant to the Director contacted individuals. Once the board was selected, a search was made to locate a chairperson. A retired executive from a large manufacturing company accepted the position.

The chairman established three working committees: planning, fund raising, and auditing. The Planning Committee developed a long-range strategic plan to guide ATEC in its mission to upgrade the level of student technological literacy through educational programs. The Fund Raising Committee discussed implementing a funding program to support ATEC in its long-term mission. However, no concrete plans were formulated to implement this effort. The auditing committee never held a meeting.

Although the chairman worked diligently to establish a viable board, individual members seemed to have a lower level of commitment. Meetings were held every other month at varying locations. Attendance declined steadily over the life of the project. A number of more active members did not seem to have a clear understanding of the board's relationship to the consortium and the demonstration project.

Funding Support

Private funding plans were intended to raise funds for participating demonstration schools, to meet the private sector matching requirement of the Demonstration Project grant, and to sustain ATEC beyond the limits of the grant. Local fund raising efforts in the geographic areas of the seven demonstration schools were intended to involve local business support to provide supplementary supply support for technology departments at each of the demonstration schools. Definite plans were never implemented, and no money was raided.

Larger corporate contributions were to be used to satisfy the private sector support requirement for the federal grant and for long-term support of the consortium. Letters detailing the ATEC demonstration project were drafted and sent to area businesses, industries, and private foundations that had an interest in funding education, technology, mathematics, and science. Follow-up calls and visits resulted in some initial financial and in-kind contributions to the Consortium. An equipment grant was applied for and awarded. Several organizations committed to providing support over a several year period. There was some expressed interest in helping to develop possible long-term support arrangements through business and professional organizations. These arrangements were never formalized.

Seeking private sector support for a project requires planning and a significant time commitment. Funding plans need to take into account that private foundations require the submission of proposals within a specified time frame. Awards are issued months after proposal submission. Requesting and receiving funding from local businesses requires that the fund raiser make numerous visits before a gift may be forthcoming. Often there is no gift awarded. It takes a significant amount of advance preparation and time commitment to raise money. ATEC attempted fund raising during a recession. Efforts were not as successful as originally planned.

Conclusion

Carrying out a demonstration project through a cooperative effort like a consortium requires careful planning, good management, and support systems, good communication, and committee participants. Complex projects with limited time frames necessitate that participants maintain sight of the project goals and work toward the fulfillment of these goals. Participants need to have a clear understanding of their multiple roles, responsibilities, and task deadlines. Careful planning and attention to detail is the key to the success of such an effort. For a consortium to be successful, the project management must maintain the good will of all participants. Maintaining good communication with all participants, through a participative management style, helps to assure cooperation. It is only though dedicated cooperation that goals can be accomplished.