

NATIONAL SCIENCE FOUNDATION-ADVANCED TECHNICAL EDUCATION

Program Solicitation: 10-539

Program Track: Small Grants for Institutions New to the ATE Program

Project Title: Sustainability in Concrete Technology

Project Description

Located in rural, northeast lower Michigan, Alpena Community College has been the leading provider of rural technician training in concrete technology for the past three decades. Eleven years ago, a public-private partnership of state and federal government and concrete industry leaders helped ACC build the World Center for Concrete Technology (wcct.net), a 40,000 square foot education, research, testing and training center serving the cement and concrete products industry worldwide.

The WCCT stays connected to industry leaders through an advisory committee structure known as the Partners Council. Members meet annually at the WCCT to discuss current educational offerings and notable trends in the industry. Membership includes executives from Oldcastle, Inc., the largest manufacturer of building materials in North America with 40,000 employees and \$17.2 billion in sales; Besser Company, the world's leading manufacturer of concrete block making equipment; Lafarge Alpena Plant, one of the leading cement producers in North America; and the president and educational leadership of Alpena Community College.

At the most recent Partners Council meeting, discussion focused on the following topics:

- Environmental regulatory agencies are pushing cement producers and concrete products manufacturers to pursue substantial reductions in CO₂ emissions.
- A four-year Baccalaureate degree in Concrete Technology would provide additional career pathways to current two-year AAS graduates, an additional pipeline of graduates for employers, and should be pursued at the legislative level.
- Opportunities for research projects integrating two-year concrete technology students, regional science teachers, high school students, WCCT staff, local contractors, and public works officials should be pursued, promoted, and expanded.
- Online course development should continue, focusing on content that provides the concrete industry with the latest information on energy conservation, sustainability, and green building using concrete masonry.
- Unemployment in the construction industry nationally is more than 30 percent, ranging as high as 75 percent in concrete products industry sectors in hard-hit areas around the country, most notably Florida, the southwest, and California.
- WCCT staff should pursue funding opportunities to support rural technician education and research.

Based on Partners Council feedback and a history of providing rural technician education in concrete technology, Alpena Community College proposes a NSF/ATE project under the Small Grants for Institutions New to the ATE category. The following project components are proposed: (1) enhancing technical education through research on CO₂ sequestration and efflorescence in concrete masonry product, examining a range of mix designs, curing techniques, and admixtures; (2) developing an online certificate for incumbent workers in the concrete industry; (3) reaching out to regional science teachers and occupational students through technology-based seminars and participation in the research project; (4) connecting students to industry employers through an advisory committee structure, sharing research outcomes through video and web-based presentations, and hosting one job fair per year; and (5) offering a 4-year baccalaureate degree in Concrete Technology.

Project Impact

Two-year concrete students impacted by project activities	60
Two-year concrete students participating in the research component	30
Number of regional secondary science instructors engaged	10
Number of secondary science school students engaged	200
Online courses developed	4
Incumbent workers enrolling in online courses developed under the grant	85
Total number of employers participating in project seminars and job fairs	15
Total number of participants engaged	400
ATE investment per participant	\$500

Intellectual Merit

The intellectual merit of the project stems from its potential contribution to research on carbon sequestration in concrete masonry product, one of the most common construction materials used throughout the developed and the developing world. The correlation between CO₂ capture and the impact on greenhouse gas emissions will also be explored.

Carbon dioxide (CO₂) accounts for more than 82.6 percent of greenhouse gas emissions (United States Department of Energy, 2008). The largest source of CO₂ emissions comes from combustion of fossil fuels, but the cement industry contributes approximately 5 percent of global CO₂ emissions. Due to the large quantities of fuel used during manufacture and the release of CO₂ from the raw materials, cement production generates more carbon emissions than any other industrial process (International Energy Agency, 2007).

Concrete is the second most used product in the world, after water (the Guardian, 2007). Cement is the key ingredient in concrete. Research indicates that 0.65–0.92 tons of CO₂ is emitted per ton of cement produced. Demand for cement is growing, especially in the developing world. Nearly half the world’s cement is now produced in China. Cement production in China alone produced 540 million tons of carbon dioxide emissions in 2006 and global projections of cement production at current emissions levels predict 5 billion tons of CO₂ emitted into the atmosphere annually by 2050.

Projections vary regarding the impact of these emission levels on climate change and global warming.

But as Dmitri Papalexopoulos, managing director of Titan Cement, Athens, observed: “No matter what you do, cement production will always release carbon dioxide. You can’t change the chemistry, so we can’t achieve spectacular cuts in emissions. Cement is needed to satisfy basic human needs, and there is no obvious substitute, so there is a trade-off between development and sustainability.”

Research has shown that carbon dioxide can be absorbed in concrete to form stable calcium carbonate, a process known as carbonation (Johnson 2000; Monkman and Shao 2006). More recent research concludes that the most beneficial binder of captured carbon dioxide is concrete masonry product without ferrous reinforcement (Shao, Monkman and Boyd 2010). An uptake rate of 9.8 percent of CO₂ was documented in a July 2010 study published by researchers from McGill University in Montreal.

The primary research focus of this ATE project will be to investigate and quantify the amount of CO₂ sequestration based on a range of mix designs, admixtures, and curing methodologies. A secondary research focus will be to investigate the role of carbonation in reducing efflorescence in concrete masonry product.

It is anticipated that findings from these research studies will support the body of climate change research while providing relevant input to producers that could inform their decision-making on investments into curing innovations.

Broader Impact:

This project will have broad impact in the following areas with a priority focus of enhancing technical education for two-year concrete technology students.

- (1) Provide rural technicians in concrete and construction technology with research experience in sustainability and energy conservation.
- (2) Create a career pathway between secondary, two-year, and four-year institutions.
- (3) Build outreach and professional development opportunities to regional secondary science instructors.
- (4) Outreach to industry through information sharing, product dissemination, seminars, and job fairs hosted at the World Center Concrete Technology at Alpena Community College.
- (5) Develop online courses in energy conservation, sustainability, and kiln optimization leading to an academic certificate for concrete industry professionals.

It is anticipated that participation in this ATE will expand learning opportunities for rural technicians through research linked to climate change, one of the predominant global

issues of our time. An online certificate for industry professionals will provide the only online academic credential available in the concrete sector. Outreach to regional science instructors will create a working partnership between high school and two-year students. Connecting students to employers will expand learning opportunities while extending the research capacity of the WCCT. Offering a four-year baccalaureate degree in concrete technology will be the first of its kind at a community college in the United States.

Capacity of the Grantee Institution

Qualifications of the Grantee Organization:

1. Infrastructure: The World Center for Concrete Technology is a 40,000 square foot education and training facility devoted to concrete products education, training, testing and research.



Education: The WCCT in association with Alpena Community College offers an Associate in Applied Science degree in Concrete Technology, the only two-year degree of its kind in the country. This unique program offers students a hands-on exposure to concrete fundamentals culminating in a student research project in the second semester of the second year. Placement of graduates is very high with employers coming from around the country to interview students prior to their graduation.

Training: The WCCT offers a series of seminars to incumbent workers in the concrete products industry. Seminars are available on site or online. Online training ranges from eight-week instructor-led courses to one-hour micro courses built around video and chat functions supported by industry experts. More than 13,000 trainees from 100 countries have attended incumbent worker training seminars at Alpena Community College during the past three decades.

Research: WCCT staff works directly with clients to provide confidential research from complete studies including product development for the concrete masonry industry through a fully-computerized Besser V3-12 production plant for both research and testing. One of the few training facilities in the world that provides hands-on, material-

based training and research in product testing and manufacturing areas, the WCCT has worked with several clients on waste stream reuse in concrete production as the industry moves toward sustainable development.

Examples of recent research projects at the WCCT include:

- Admixture evaluation and performance studies
- Waste ash from various sources
- Ground glass
- Plastics
- Rubber tires
- Mining waste products
- Concrete ping pong tables
- New cementitious materials

Testing: The WCCT provides industry with a facility to test products and materials according to ASTM Standards. Tests include:

- Aggregate evaluation
- Particle distribution
- Material finer than 200 mesh sieve (loss by wash)
- Specific gravity
- LA abrasion
- Compression testing of concrete
- ASTM C90 evaluation of concrete masonry units
- Freeze/Thaw testing of concrete masonry units
- Masonry mortar and grout testing.

In addition to the block plant referenced above, which allows the WCCT to produce concrete masonry and pavers on an as-needed basis, the research function of the WCCT is supported by eight computer-controlled production kilns, allowing the center to perform all key functions of the proposed NSF/ATE project within the facility.

It is anticipated that beyond scales, testing equipment, instrumentation, CO₂ supplies, and a small test chamber, the WCCT has available on site all other requirements of the project.

2. Online course development

Over the past three years, WCCT staff developed a series of online courses to serve the training needs of the concrete industry. Online courses in Concrete Fundamentals, Aggregates, Admixtures, Mix Design, Plant Safety, LEED, Cementitious Materials, Hydraulics, Electronics, Programmable Logic Controls, and Concrete Masonry Technician were delivered to more than 500 trainees across North America. Feedback on the courses has been very positive.

The courses run approximately eight weeks and are instructor-led. Most courses incorporate instructional video embedded within the course shell that streams to trainees

as they click on a link while migrating through the course content. Pre and post assessments are built in and learner engagement is managed through a chat room function facilitated by the instructor.

A learning curve has accompanied the development of these industry-validated online courses. The technical problem solving associated with online course delivery will not have to be replicated as four capstone courses are developed leading to an online certificate for incumbent workers offered through the WCCT.

Additionally, the necessary level of video production equipment and editing hardware and software is already in place, a significant expenditure that will not have to be written into the project budget.

During the past year, the WCCT has expanded its online course production by developing asynchronous, video-based, online micro courses. These one-hour courses work most effectively with content such as machine adjustments or lab processes that can be presented in their entirety through a combination of video capture, content expert narration, and power point slides. Ten micro courses have been developed to date with several more in development. Marketing of micro courses through employers, trade associations, industry publishers, and the WCCT website is ongoing. The capacity to produce online micro courses also will be available and may be suitable for outreach or dissemination purposes as the project evolves.

3. Four-year degree in Concrete Technology

Alpena Community College has become a leader among Michigan's 28 community colleges in championing legislation that would allow community colleges to offer baccalaureate degrees in unique programs such as concrete technology. The excerpt below appeared in the Detroit News on September 19, 2010.

Two-year colleges may offer bachelor degrees:

Lansing, MI – Students may soon be able to earn a bachelor's degree at some of Michigan's community colleges.

A bill passed Thursday by the state House of Representatives would allow community colleges to offer four-year degrees in nursing, culinary arts, maritime technology, and concrete technology.

If the reform is passed by the Senate and signed by Gov. Jennifer Granholm, Michigan would join 17 other states that offer at least some four-year degrees at community colleges.

“This legislation is critical for Michigan's citizens and students, as well as the future of our state,” Mike Hansen, president of the Michigan Community College Association, said in a written statement. “This is truly a step forward in the retooling of Michigan's work force and its continuing transition into a knowledge-based economy.”

4. Outreach to industry

The WCCT has a history of productive association with influential employers in the concrete industry. The proposed ATE project will cement these associations further according to the following structure:

- A standing advisory committee comprised of industry leaders meeting once per quarter throughout the project cycle to connect the project to industry trends.
- Working with the project evaluator to disseminate research findings to concrete trade associations and periodicals.
- Connecting employers to two-year students through job fairs and campus tours hosted by the WCCT.
- Enhancing research and presentation skills among two-year concrete technicians by facilitating presentations on project outcomes.

5. Creation of online certificate for industry professionals

Work began on the development of online concrete courses for industry professionals with funding support from a \$1.92 million U.S. Department of Labor Community-Based Job training Grant which ran from 2007-2010. A key component of the CBJTG project allowed the college to produce video to enhance instructional content and embed video files in online courses. The college has become a leader in this content development process, especially as it relates to occupational or traditionally “hands-on” vocational programs such as concrete technology.

College staff currently is pursuing change status approval from the Higher Learning Commission of the North Central Association of Colleges and Schools to offer an online certificate in Concrete Studies to industry professionals. The college proposes to complete this process during the three-year NSF/ATE funding cycle, developing capstone courses in energy conservation, kiln optimization, and sustainable project design based on research projects outlined in this proposal.

By Year 3 of the three-year project, it is proposed that ACC will be offering an entire online certificate to industry professionals originating from the WCCT which will represent a unique credential in the concrete products industry nationally.

6. Recent grant funding and grant administration

The grantee has written and managed the following federal grants recently.

United States Department of Labor, Employment Training Administration	
2007-2010 Community-Based Job Training Grant Award.....	\$1,922,516
2004-2007 H-1B Technical Skills Training Grant Award.....	\$1,500,000

Both projects met or exceeded deliverables, expended the total award, and were closed without audit findings or disallowed costs.

Key Project Personnel

Qualifications of the Principal Investigator:

The principal investigator will be Don MacMaster, Dean of Workforce Development and Co-Director of the WCCT. MacMaster has 19 years project management experience at ACC working with federal, state and local grants, and contract training with business and industry. He has managed more than \$7 million in externally funded projects without a disallowed cost.

In 2007, Alpena Community College won the United States Department of Labor's national Recognition of Excellence Award in the category of Educating America's 21st Century Workforce, the only two-year institution in the nation to receive the DOL award that year.

MacMaster has a Bachelor's degree from the University of Michigan (1981) and a Master's degree from Central Michigan University (1996). His expertise lies in project management, coordination between and among key stakeholders, communication with federal project officers, timely submission of reports and financials, budget experience, dissemination strategies, and shared governance to achieve project deliverables.

Qualifications of Co-investigator:

One project co-investigator is proposed. He is identified and his qualifications are detailed below:

Oscar Tavares is an adjunct instructor for Alpena Community College teaching online concrete courses through the WCCT. He is president and owner of Innovative Alternatives, LLC, providing consulting services to cement, concrete, and chemical additive producers on issues related to chemical process, sustainability development, and new product innovation.

He worked as a senior sales specialist for Lafarge North America, responsible for the promotion and marketing of specialty products, a technical manager responsible for new product development, and a special projects manager in charge of research on new uses for waste by-products such as Cement Kiln Dust.

Tavares also has experience as a chief chemist, process engineer, and plant superintendant for Kaiser Cement and as a customer technical services manager for Holnam Cement. He has presented technical reports at numerous national trade association conferences and has published more than a dozen technical articles in trade or academic journals.

He provides committee level leadership in the following trade associations: Portland Cement Association, American Concrete Paving Committee, American Concrete Institute, Pre-stressed Concrete Institute, National Ready-Mixed Concrete Association, ASTM, and the Transportation Research Board.

Tavares has a BS in Chemistry from the University of Texas.

Advisory Team

A project advisory team is proposed. The advisory team will meet quarterly and function as an informal oversight committee for the project. Members of the team are industry and educational leaders. They have been approached and have agreed to perform in this capacity. They include:

Name	Title	Company
Mr. Kevin Curtis	CEO	Besser Company
Mr. John Staton	Senior Engineer	Michigan Department of Transportation
Dr. Olin Joynton	President	Alpena Community College
Mr. David Dziubinski	CEO	Lafarge North America-Alpena Plant
Mr. Bob Eller	Emeriti Faculty	ACC Concrete Technology Faculty
Mr. Eric Krebs	Co-Director	World Center for Concrete Technology
Mr. Michael Kraft	Owner	Kraft Energy

Work Plan

The following work plan is proposed:

1. Research project:

Trial #1 - Testing procedure for determining Carbon Sequestration in Concrete Masonry Units

The purpose of the study is to quantify CO₂ absorption levels in concrete block, concrete pavers, and concrete capstone based on mix design, admixture content and curing methodologies. It is anticipated that all testing will take place at the World Center for Concrete Technology, which has concrete masonry production capacity, available kilns, testing and measuring instruments, and labs suitable for maintaining a controlled testing environment.

The study has seven objectives: (1) establishing the maximum amount of CO₂ that can be absorbed by a concrete masonry unit of specific mix design and admixture content; (2) quantifying the amount in kilograms of maximum absorption; (3) measuring the rate at which CO₂ is sequestered in concrete masonry product; (4) determining the point at which saturation is attained and no further CO₂ can be absorbed; (5) assessing the compressive strength of concrete before, during, and after carbonation; (6) discovering the optimal amount of CO₂ introduced into the kiln process to produce maximum levels of sequestration; and (7) extrapolating the amount of CO₂ that could be sequestered regionally, nationally and internationally based upon the number of concrete masonry units of the type studied that are produced annually worldwide.

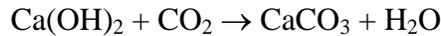
It is anticipated that electronic scales and measuring devices will be required to accurately quantify the amount of CO₂ uptake. A customized kiln will also be required, plus an adequate supply of containerized CO₂. An estimate of these expenditures is detailed in the equipment and supplies line items in the budget on pages 13-15.

Trial #2 - Testing Procedure for Determining Carbonation Depth in Concrete Block Paving

Carbonation on the surface of concrete results in unsightly efflorescence, a natural reaction between the materials in cement, water, and the atmosphere resulting in a plume

of powdery crust on the surface on concrete masonry units. Concrete products producers are looking for cost-effective ways to prevent the formation of efflorescence. Embedding CO₂ into concrete masonry units through natural absorption during the curing process has been proposed as a possible solution to the efflorescence problem.

Carbonation is formed by a chemical reaction between carbon dioxide in the atmosphere and calcium hydroxide Ca(OH)₂ in the concrete, creating calcium carbonate CaCO₃. The chemical reaction found in carbonation is as follows:



It has been observed that carbonation formed under the surface provides a barrier in the concrete which inhibits efflorescence by reducing the movement of calcium hydroxide from inside the concrete masonry unit to the surface. The degree or depth of carbonation plays a significant role in the prevention of secondary efflorescence, which can appear at any stage after the initial hardening process has ended.

The degree of depth of carbonation is based on several factors, including:

1. chemical density of the surface
2. use of hydrophobic admixtures
3. water-cement ration
4. curing time
5. carbon dioxide levels of the curing atmosphere

The focus of trial #2 is (a) measuring and (b) optimizing carbonation depth in a standard 8” concrete masonry unit based upon the five factors above.

Procedure:

One of the most simple and effective means of measuring the degree of carbonation is with the pH indicator known as Phenolphthalein. A 1% solution in ethanol is proposed. Phenolphthalein is pink or red in areas of the concrete with a pH greater than 8 (pH 8 is mildly basic), but at a pH less than 8 the solution is colorless.

Therefore, when phenolphthalein is applied to concrete materials the carbonated areas of the concrete will be colorless while the non-carbonated areas, (i.e. carbon hydroxide, which are strongly basic), will turn a pink or red color.

The following test procedure is proposed: Variables related to mix design, curing time, and CO₂ levels in the curing chamber will be noted and controlled. Concrete masonry units will be removed at the following intervals after the beginning of curing: 4 hours, 8 hours, 12 hours, 16 hours, 20 hours, 24 hours, 36 hours, 48 hours, 96 hours, 28 days

Curing should not be interrupted during the removal. Product will be allowed to dry for five minutes prior to splitting.

1. Select a standard concrete paver unit and split it in half from top to bottom.
2. Remove any large debris and dust by blowing across the surface.
3. Carry out the test immediately after splitting. Otherwise the fresh surface will have a chance to carbonate, falsifying the result.
4. Place the half to be tested on a flat even surface. Cover any materials that should not come in contact with the indicator solution.
5. Apply phenolphthalein from a clean spray bottle adjusted to a fine mist.

Carbonation depth will be recorded either by a mechanical scale or a camera. As the trial time increases, the carbonation depth should increase. The point at which no further carbonation depth occurs based on the factors above will be noted. It is anticipated that a carbonation depth of 3 mm to 5 mm or more will result in an inhibition of secondary efflorescence.

In follow-up trials, admixtures such as plasticizers, water proofing agents, and liquid colors should be removed one at a time in order to determine their effect on depth of carbonation. Water-cement ratio will be varied to provide information on the correlation of moisture content to carbonation depth.

Timeline of Project Activities

Year 1: Months 1-3

- Establish account codes with business office
- Create project web site
- Inform stakeholders of project funding and deliverables schedule
- Begin to procure necessary equipment for research project
- Meet with external evaluator
- Meet with advisory team
- Publicize the project internally
- Publicize the project with industry through trade association contacts
- Begin outreach to area science instructors
- Prepare to submit first quarterly progress report to NSF/ATE staff
- Attend ATE Principal Investigator training sessions as required

Year 1: Months 4-6

- Finalize procurement of equipment needed for research project
- Recruit two-year students to support research project
- Coordinate the implementation of research project with students and Co-Investigator
- Begin research project
- Begin accreditation work with the Higher Learning Commission on online certificate
- Post content and findings on project web site
- Share findings with industry contacts
- Establish timetable for first presentations by students on research findings and methods
- Commence outreach sessions with area science instructors
- Plan for first seminars and job fairs linking two-year students and employers
- Meet with advisory team
- Troubleshoot and resolve any issues arising from research project

Year 2: Months 7-12

- Update web site with project milestones and accomplishments

Share preliminary findings with internal stakeholders
Organize first sustainability job fair with industry representatives
Begin online course development
Formalize schedule of outreach to regional science instructors
Consult with external evaluator on a regular basis
Submit quarterly and annual reports to NSF/ATE field officers

Year 2: Months 13-24

Update web site with project accomplishments
Create video documentary of research project for dissemination purposes
Meet with advisory team on a quarterly basis
Continue outreach to regional science instructors through classroom visits and webinars
Organize second sustainability job fair with industry representatives
Deliver second sustainability job fair
Complete accreditation work with Higher Learning Commission on online certificate
Attend NSF conferences as required
Make two presentations on project at concrete industry trade conferences
Continue consultation with external evaluator
Complete research project, assemble data, and report findings
Submit all quarterly and annual reports to NSF/ATE field staff on a timely basis

Year 3: Months 25-36

Update project web site with project accomplishments
Continue meeting with advisory committee to share milestones and troubleshoot issues
Plan for third sustainability job fair
Expand outreach via webinars to secondary science instructors beyond NE Michigan
Complete online certificate
Roll out certificate to industry professionals
Deliver third sustainability job fair
Prepare to submit another ATE based upon potential new research opportunities
Consult with external evaluator
Prepare final financial and narrative reports
Submit final reports as required

Dissemination Plan

The following 11-point dissemination plan is proposed:

1. An ATE project website linked to the wcct.net web page will be posted within the first month of award. Project milestones will be outlined on the website and updates will be posted on a monthly basis.
2. Notes from advisory team meetings will be posted to the website along with recommendations.
3. Research findings will be reviewed by the project evaluator and submitted for publication to trade journals and trade associations.
4. Outreach to area science educators will be the responsibility of the Principal Investigator and will be organized through contacts with area secondary school administrators and teaching staff.

5. Linkage to industry will be organized by project investigators, trade association representatives, advisory team members, and grantee faculty.
6. Job fairs and seminars linking employers and students will be promoted by email constant contact list available at the WCCT or in person through presentations by project staff.
7. Online coursework will be beta tested by industry professionals and promoted via WCCT website.
8. Principal Investigator will write one feature update monthly for distribution to all project partners, including NSF/ATE staff.
9. Quarterly progress reports will be submitted to NSF on a timely basis.
10. Project staff will participate in NSF-sponsored activities, including training sessions, conferences, and presentations.
11. A video documentary of the project from award to completion will be filmed and shared with NSF staff for promotional purposes.

Evaluation Plan

The Sustainability in Concrete Technology project will be evaluated by Dr. Carl Hanssen from Hanssen Consulting, LLC. Dr. Hanssen has nearly 20 years of experience in the field of evaluation. He is the former co-PI of the national ATE evaluation conducted by The Evaluation Center at Western Michigan University and was the project evaluator for the Nuclear Power Technician project at Bismarck State College, which was funded by ATE. Hanssen Consulting is also the external evaluator for several NSF MSP projects.

The evaluation will have both formative and summative components. Formative evaluation will be conducted through interviews, observations, and stakeholder surveys with an emphasis on gathering feedback for program improvement. These activities will take place in the first year of the project and will also help establish a measurement baseline against which changes can be tracked.

Summative evaluation will begin in Year 1 and continue through Year 3 by monitoring progress toward key project outcomes. Specifically, the summative evaluation will examine progress toward establishment of the proposed four-year degree program and development of the online certificate program for incumbent workers. Summative evaluation activities will include interviews with key stakeholders, including business and industry representatives, during quarterly site visits. In addition, program students will be surveyed to gather their perspectives on program impact. Measurements, such as the number of students participating in sponsored training programs, will be gathered and tracked over time.

Evaluation reporting will consist of brief site visit reports following each evaluation visit as well as annual reports to coincide with the ATE reporting cycle.

Sustainability Plan

Alpena Community College commits to the following sustainability plan:

- Curricula and materials developed under the project will be expanded and disseminated to project stakeholders after grant funding ends.
- College staff engaged in project deliverables will pursue private and public resources to continue research activities to benefit concrete technical education.
- College will allocate resources to fund technical support and additional online course development after the ATE award ends.
- Partners Council activities will continue after grant funding ends with a focus of sponsoring an expansion of research activity initiated by NSF/ATE funding.

Project Budget

Budget Year 1:

Line Item	Amount
Personnel:	
Principal Investigator x .2	\$10,000
Co-Investigator (150 hours x \$50/hour)	7,500
Student Research (500 hours x \$10/hour)	5,000
Fringe Benefits:	
Principal Investigator x .55	\$5,500
Co-Investigator and Student Researchers x .25	3,125
Travel	\$5,000
Supplies	\$6,075
Equipment	\$14,000
Contracted Services	\$6,000
Total Direct Charges	\$62,200
Indirect Charges x .05	\$3,110
TOTAL – YEAR 1	\$65,310

Budget Year 2:

Line Item	Amount
Personnel:	
Principal Investigator x .25	\$15,000
Co-Investigator (160 hours x \$50/hour)	8,000
Student Research (500 hours x \$10/hour)	5,000
Fringe Benefits:	
Principal Investigator x .55	\$8,250
Co-Investigator and Student Researchers x .25	3,250
Travel	\$4,000
Supplies	\$6,000
Equipment	\$7,500
Contracted Services	\$6,000
Total Direct Charges	\$63,000
Indirect x .05	\$3,150
TOTAL – YEAR 2	\$66,150

Budget Year 3:

Line Item	Amount
Personnel:	
Principal Investigator x .25	\$17,500
Co-Investigator (160 hours x \$50/hour)	8,000
Student Research (100 hours x \$10/hour)	1,000
Online Course Development (100 hours x \$50/hour)	5,000
Fringe Benefits:	
Principal Investigator x .55	\$9,625
Co-Investigator and Student Researchers and Online Course Development x .25	3,500
Travel	\$4,000
Supplies	\$5,655
Equipment	\$5,000
Contracted Services	\$6,000
Total Direct Charges	\$65,280
Indirect Charges x .05	\$3,260
TOTAL – YEAR 3	\$68,540

Budget Summary: Years 1-3

Line Item	Amount
Personnel	\$82,000
Fringe Benefits	33,250
Travel	13,000
Supplies	17,730
Equipment	26,500
Contracted Services	18,000
Total Direct Charges	\$190,480
Indirect Charges x .05	\$9,520
TOTAL:	\$200,000