A Scalable Skills Certification Program in Geographic Information Systems (GIS)

REQUESTED AMOUNT
$ 883,311

PROPOSED DURATION (1-60 MONTHS)
36 months

REQUESTED STARTING DATE
10/01/04

SHOW RELATED PRELIMINARY PROPOSAL NO.

CHECK APPROPRIATE BOXES IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

□ BEGINNING INVESTIGATOR (GPG I.A)
□ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C)
□ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.B, II.C.1.d)
□ HISTORIC PLACES (GPG II.C.2.j)
□ SMALL GRANT FOR EXPLOR. RESEARCH (SGER) (GPG II.D.1)
□ VERTEBRATE ANIMALS (GPG II.D.5) IACUC App. Date

□ HUMAN SUBJECTS (GPG II.D.6)
Exemption Subsection or IRB App. Date

□ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)

□ HIGH RESOLUTION GRAPHICS/OTHER GRAPHICS WHERE EXACT COLOR REPRESENTATION IS REQUIRED FOR PROPER INTERPRETATION (GPG I.E.1)

PI/PD NAME
Kendra Jeffcoat

CO-PI/PD
John Johnson

CO-PI/PD
Ming-Hsiang Tsou
Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 04-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

In addition, if the applicant institution employs more than fifty persons, the authorized official of the applicant institution is certifying that the institution has implemented a written and enforced conflict of interest policy that is consistent with the provisions of Grant Policy Manual Section 510; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the institution’s expenditure of any funds under the award, in accordance with the institution’s conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

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By electronically signing the NSF Proposal Cover Sheet, the Authorized Organizational Representative or Individual Applicant is providing the Drug Free Work Place Certification contained in Appendix C of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?  

Yes ☐  No ☒

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This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

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The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, “Disclosure of Lobbying Activities,” in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE
NAME: Margie Fritch

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TELEPHONE NUMBER: 619-388-6531
ELECTRONIC MAIL ADDRESS: mfritch@sdcdd.net
FAX NUMBER: 619-388-6523

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.*
NSF FORM 1295: PROJECT DATA FORM

The instructions and codes to be used in completing this form are provided in Appendix II.

1. **Program-track** to which the Proposal is submitted: ATE-Projects

2. Name of **Principal Investigator/Project Director** (as shown on the Cover Sheet):
   Jeffcoat, Kendra

3. Name of submitting **Institution** (as shown on Cover Sheet):
   San Diego Community College District

4. **Other Institutions** involved in the project’s operation:
   San Diego State University
   San Diego Unified School District

Project Data:
A. Major Discipline Code: 88
B. Academic Focus Level of Project: AL
C. Highest Degree Code: A
D. Category Code: K
E. Business/Industry Participation Code: PSP
F. Audience Code: HISF
G. Institution Code: PUBL
H. Strategic Area Code: 
I. Project Features: 3 4 5

Estimated number in each of the following categories to be directly affected by the activities of the project during its operation:

J. Undergraduate Students: 360
K. Pre-college Students: 1000
L. College Faculty: 20
M. Pre-college Teachers: 40
N. Graduate Students: 2

NSF Form 1295 (10/98)
A Scalable Skills Certification Program in Geographic Information Systems (GIS)

The San Diego Educational GIS Consortium, comprised of San Diego State University, San Diego Mesa College (part of the San Diego Community College District), and San Diego City Schools, will develop a scalable GIS skills certification program to prepare students for entry into a range of jobs in GIS-related fields and for career advancement. The Consortium will create GIS skills certifications, designed to meet industry and employer needs, that can be combined to provide an articulated educational program. These certificates will build on each other and feed into an associate’s degree in GIS for more comprehensive technical training, a bachelor’s degree, and advanced degrees in the field.

The central goal is to increase the production of qualified GIS technicians to meet workforce demands. Project objectives include: (1) develop skills certificates that certify specific work-based competencies; (2) develop a standards-based curriculum, aligned across the three educational levels, designed to meet identified industry needs and linked to job descriptions; (3) create articulation agreements that ensure that students are able to progress efficiently through the skills certificate and more traditional educational programs; (4) prepare high school teachers and post-secondary faculty to provide the GIS skills training; (5) develop a Web-based GIS career awareness program to encourage students to pursue careers in the field and enhance enrollment in technician training and educational programs; and (6) share the model GIS skills certification and technician training program with other educational institutions and communities.

Project activities include development of DACUM-derived job descriptions for GIS-related positions, program improvement to create model GIS skills certifications, and development of curriculum and educational materials, including Web-based introductory programs in GIS. Exemplary curricula and educational materials will be adapted for use in short term skills certificate programs. The project will train college faculty and secondary school teachers to teach the introductory courses and use GIS materials in their classes. The project also will develop new internships and field experiences for students in the skills certificate and technician training. The primary audiences to be affected by these activities are two-year college students, high school students, high school teachers, and two-year college faculty members.

The intellectual merit of the proposed activity. The proposed project takes a creative approach to link the skills needed in the workplace with training, certificate and degree programs. The Consortium members have developed successful GIS programs at the certificate, associate degree, baccalaureate and master’s levels. Public community college and university resources will sustain the skills certification programs beyond the term of project funding.

The broader impacts resulting from the proposed activity. The proposed project will encourage underrepresented high school and community college students to pursue careers in GIS, and will provide a ladder of certification and education that will enable students to work in GIS-related positions while pursuing further training and education. It will create well-articulated partnerships among public institutions teaching GIS, and will disseminate project results through a website and presentations at conferences and professional meetings.
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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.*
A Scalable Skills Certification Program in Geographic Information Systems (GIS)

Project Description

Motivating Rationale

The San Diego Educational GIS Consortium, comprised of San Diego State University, San Diego Mesa College (part of the San Diego Community College District), and San Diego City Schools, proposes to develop a scalable GIS skills certification program that will prepare students for entry into a range of jobs in GIS-related fields and for career advancement. The proposed project will create GIS skills certifications that can be combined to provide an articulated educational program. It will start with a series of skills certificates designed to meet industry and employer needs. These certificates will build on each other and feed into an associate’s degree in GIS for more comprehensive technical training, a bachelor’s degree, and advanced degrees in the field. The San Diego Educational GIS Consortium requests three years of ATE program support to develop and pilot test this scalable skills certification program.

Members of the San Diego Educational GIS Consortium. Consortium members include Mesa College, San Diego State University, and San Diego City Schools. Mesa College, part of the San Diego Community College District, is one of 108 community colleges in California. It’s GIS program, created in 2000, offers an Associate’s degree of 60 semester units and a Certificate of Completion of 17 semester units. The degree program and the certificate both require a core of five GIS courses, including work experience. The purpose of the program is to prepare students for careers in GIS-related industries and for transfer to programs within public and private colleges and universities. The program objective is to provide students with the
practical and applications skills necessary for success as a GIS specialist, capable of performing in all aspects of the GIS industry job market. Mesa College has an ESRI site license and offers students access to a complete line of GIS software. It also has been designated as an official ESRI Authorized Learning Center.

San Diego State University (SDSU) is one of 23 masters’ degree-granting universities in the California State University system. The SDSU Geography Department offers undergraduate, Masters and Ph.D. programs with concentrations in both human and physical geography. The Department will also start offering a new MS/BS program in Geographic Information Science in 2004. SDSU also offers a Certificate in Geographic Information Science, the purpose of which is to prepare students to acquire, manage, and visualize geospatial data in public and private organizations. The Certificate is a joint effort of the Departments of Geography and Computer Science. To earn the Certificate, students must earn 27 units distributed between the Departments of Geography and Computer Science. Two of the three required courses are lower division courses in computer science (107, Introduction to Computer Programming and 108, Intermediate Computer Programming). The SDSU College of Extended Studies also offers a fee-based GIS Certificate, which can be completed by students who are not enrolled at the University.

The San Diego Unified School District, also known as San Diego City Schools (SDCS), is the second largest school district in California and the 13th largest urban school district in the U.S. SDCS serves over 140,000 K–12 students living within the City of San Diego at 167 elementary, middle and high schools. Like many urban school districts around the country, SDCS has too many of its students moving through high school without developing the
knowledge and skills they need to succeed in college or in a job. Like other districts, SDCS responded by intensifying its focus on aligning curriculum, assessments and teaching strategies to state standards. These strategies, however, have had only a limited impact, as they have in most urban high schools. By the time they reach high school, many young people are so disaffected that higher expectations and more challenging curricula – the primary tools of standards-based reform – are not enough to engage or motivate them (Steinberg & Allen, 2002).

Looking for new ideas and opportunities in high school reform, SDCS found that, all else being equal, small high schools generally have higher achievement levels, higher graduation rates, lower dropout rates, lower levels of substance abuse, and better safety records than larger high schools (Raywid, 1996; U.S. Department of Education, 2001). Small schools create an environment that contributes to positive student outcomes (U.S. Department of Education, 2001), and have been found to make the greatest difference for low-income and minority students (Howley, Strange & Bickel, 2000).

These findings have led the San Diego Unified School District to develop a comprehensive plan to personalize the high school by creating small schools and breaking larger schools into smaller learning communities. The design of these smaller schools (which are now under development) follows the precepts of the School-to-Career movement by making education relevant to the real world, and providing students with the opportunity to work on projects of real interest to adults in the workplace. Development of project-based learning opportunities that teach students the fundamentals of GIS will be a highly valued addition to the curriculum for these small schools.
GIS Industry Growth and Demand. Geographic information systems (GIS) are computer-based information systems that enable the capture, modeling, retrieval, analysis and presentation of geographically referenced data (Worboy, 1995). GIS has become the principal tool for a wide range of applications, allowing users to combine and synthesize any form of geographic information. “Geospatial technology” is an information technology field of practice that utilizes GIS as it acquires, manages, interprets, integrates, displays, analyzes, or otherwise uses data focusing on the geographic, temporal, and spatial context (Gaudet, et al, 2001).

The worldwide market for geospatial technologies is currently estimated at $5 billion. The market is projected to have annual revenues of $30 billion by 2005; the GIS market will be $10 billion, the remote sensing market $20 billion (NASA 2001). As an emerging growth industry, there is a serious shortfall of professionals and trained specialists who can utilize geospatial technologies in their jobs (Gaudet, 2001). The shortfall of individuals with master’s degrees in GIS in the United States is estimated at 3,000 to 4,000 graduates per year. The demand overseas is even greater due to the lack of GIS teaching programs in many parts of the world (ESRI, 2002).

The California Employment Development Department (EDD, 2002) projected that the employment of GIS Specialists in California will grow by approximately 66.7% between 1998 and 2008, with almost 10,000 jobs created in the field during that decade – almost three times the rate of growth of occupations overall. (EDD and other government agencies have not yet begun to create projections for GIS Specialists as an occupation; instead they use projections for database managers as a proxy in their reports on employment in GIS). EDD (2002) also projected that as the use of GIS increases over time, GIS duties may be added to other
occupations (such as drafters, cartographers, and research analysts) as well, creating more
demand for training for these workers. The U.S. News & World Report (2003) predicted that
database managers, analysts and developers will be in demand for many years to come, as
companies and government agencies “gather a huge amount of data on customers, suppliers and
markets – and struggle to do something useful with it.”

**Growth in GIS Educational Programs.** The demand for college education and training
in GIS has grown tremendously. There are now over 200 GIS programs nationwide, with thirty
offered in California alone – fourteen at community colleges and sixteen at universities
(primarily California State University campuses). One of the greatest factors driving this growth
is the demand from the private and public sectors for workers who can apply GIS in the
workplace. Approximately 70 percent of the students enrolled in GIS workshops and certificate
programs are working professionals acquiring or improving GIS skills (ESRI, 2002).

Until recently GIS education was limited to upper division and graduate level programs
at larger universities, due to the high cost of hardware and the complexity of the systems. With
the price-performance increase in power of desktop computers and new user-friendly software
for the PC, community colleges are now able to develop and offer GIS programs. Community
college GIS programs provide working professionals with hands-on training in various software
and hardware applications, as well as the theory behind GIS and spatial analysis. Community
colleges are working with universities on articulation agreements so that lower-division
academic GIS courses taken at a community college can be transferred to four-year GIS
programs.
K-12 GIS programs also have grown significantly in the last five years and now reach thousands of students annually. These programs can work closely with college or university GIS programs to encourage students to pursue careers in the field. For example, Cape Cod Community College was awarded an NSF grant to develop courses in environmental technology that provide college credit for area high school students. An approved articulation agreement between CCCC and high schools offering the GIS courses will give three credits toward the CCCC GIS certificate for high school students who complete the approved high school course and matriculate at CCCC. The Oregon Institute of Technology developed an introductory, self-study CD-ROM (the product of another NSF grant), which is now in use at several high schools across Oregon. It is used by teachers as supplemental classroom material, or by students as part of advanced placement work, enabling them to earn college credit.

ESRI, the industry leader in GIS software development, noted that teachers are most effective when they offer students the chance to work on open-ended questions, explorations, and projects with GIS. “Outside of class, students may find valuable employment or internships in organizations exploring social, economic, or development conditions. Very often, adults in such organizations lack the time or technical skills to conduct focused geographical analyses, but have a clear vision of what they want, which opens the door for long-term relationships with students” (ESRI, 1997). Community service projects can provide additional venues for students to work with GIS.

**National Efforts to Develop Core GIS Curricula.** Two national groups have undertaken development of core GIS curricula. The National Center for Geographic Information and Analysis (NCGIA), a consortium of 3 institutions (UC Santa Barbara, New York University
at Buffalo, and the University of Maine), developed the original NCGIA Core Curriculum in 1990 for use by University-level instructors teaching technical skills related to the use of GIS systems. NCGIA received an NSF ATE grant in 1996 to develop a Core Curriculum for Technical Programs (CCTP) for community college and technical colleges. A curriculum-building resource rather than a complete set of curriculum materials, the CCTP contains nearly 50 units of information related to GIS education. However, these materials do not address student competencies upon graduation, and have not been upgraded to reflect the rapid technological advancements since the materials were developed (UCGIS, 2003).

The University Consortium for Geographic Information Science (UCGIS, 2003) noted that far too many existing undergraduate programs “choose to stress the attainment of rapidly outdated software manipulation skills at the expense of acquiring the conceptual knowledge necessary to cope with the continuing, rapid scientific and technological change that characterizes Geographic Information Science and Technology (GIS&T).” (p. 2). UCGIS has developed a more outcome-oriented, modular approach to the development of model curricula.

The UCGIS approach to curriculum development in GIS begins by breaking down a relevant body of knowledge into units (individual thematic modules within the areas) and topics (the lowest level of the hierarchy that is used as the building blocks to construct instructional modules). They then identify and sequence the components of supporting technical curriculum (e.g., computer science, mathematics and statistics) that need to be integrated with the GIS&T curricula.

UCGIS’s stated goal is to establish an innovative and flexible interdisciplinary educational activity that (1) defines a clear set of academic paths, each of which leads to a
 specific GIS&T related educational outcome; (2) defines a set of basic or core courses that are common to all paths and that can be offered to students from a number of disciplines; (3) helps existing academic disciplines construct their own courses built on the common academic core; and (4) produces graduates with significantly enhanced technical backgrounds. For each such path, those things that the graduate is expected to know, and at what level of competency, will be clearly defined.

In their report “Development of Model Undergraduate Curricula for Geographic Information Science and Technology, the Strawman Report” (June 2003), the UCGIS Task Force identified 12 GIS&T knowledge areas as well as their unit level breakdowns. These knowledge areas and unit level breakdowns are now being reviewed by the GIS community, at which point the UCGIS task force will continue with its curriculum development procedure. Together, the materials developed by UCGIS and NCGIA will make excellent building blocks for the proposed skills certification program.

GIS Certification. Obermeyer & Onsrud (1997, p. 3) noted that:

“Certification is typically of greatest benefit to those individuals without an academic degree in the discipline or knowledge domain in which they are working or desire to work. Certification is an indication to employers that the applicant or employee has attained a level of education or training in an area that those without the certification or an academic degree in the field probably don’t have. Certification also helps identify those skills and knowledge domains that are most valued by employers in the discipline if one is to be considered competent in the specialization that the certification addresses.”
There are three potential types of certifying entities: professional organizations such as URISA, which certify the attainment of professional experience and contribution to the field; software makers (such as Microsoft and its Microsoft Certified professional series), who certify that the users has attained specific competencies with its software; and accredited educational institutions, which certify that students have successfully completed a series of courses. However, professional organizations and software makers do not appear to be interested in developing GIS skills certifications. ESRI, a leading developer and vendor of GIS software, offers comprehensive short courses in the use of its products, but has not developed independent certifications of skill levels (such as those offered by Microsoft in their Microsoft Certified Professionals series).

Although several professional organizations and groups have concluded that certification of GIS skills is important, no one group has yet been willing to take it on. For example, as the result of a grant from the Federal Geographic Data Committee (FGDC) to assess the feasibility of using the North Carolina Community College System to train and certify GIS technicians, the grant project team recommended that the state’s Geographic Information Coordinating Council (GICC) develop and support a certification program for GIS technicians. In response, the GICC formed the GIS Technician Certification Work Group to evaluate this recommendation. The Work Group, chaired by the North Carolina Secretary of State, concluded that, although there is great potential in establishing a voluntary certification program for GIS technicians, it was more appropriate to support the development of a national certification program by a national organization (GICC, no date).
UCGIS also considered the development of a certification program in a 1997 white paper on educational policy and GIS. They concluded that UCGIS members (primarily universities) do not appear to have a strong enough vested interest in certification to initiate or manage such a program, and that the UCGIS would be inappropriate as the lead institution in a certification program (Obermeyer & Onsrud, 1997).

The Urban and Regional Information Systems Association (URISA), a non-profit association of professionals using GIS and other information technologies, has developed a Certification Program for GIS Professionals. This voluntary program is intended to acknowledge the professional achievements of those people whose primary job responsibility involves the use of geospatial data technology. On behalf of URISA, the GIS Certification Institute (GISC) administers the program by reviewing all applications and either accepting or rejecting them. The program is a point-based system that is self-documented and calculated by the individual seeking certification. It does not include an examination. Applicants must document points in three categories: educational achievement, professional experience, and professional contributions.

The minimum points for certification are based on a model GIS professional who possesses a baccalaureate degree in any field supplemented with a number of courses, workshops, seminars, conferences and other documented educational activities whose subject matter related directly to GIS and geospatial data technologies; at least four years of experience in a position that involves spatial data compilation, teaching, etc.; and a modest record of participating in GIS conferences, publications, or GIS-related events (such as GIS-Day). Once attained, certification is retained by earning additional points in each of the three achievement
categories, thus maintaining currency with the profession. GISC spent much of 2003 pilot testing the certification program; it is expected to be unveiled at the URISA national conference in October 2003.

In their analysis of the certification process, GISC concluded that general agreement on the skills needed for the GIS profession has not yet been achieved, given that there are so many different professions that use GIS technology. GISC noted that “formal educational programs that require tests and a minimum level of grade point average already have an established (and fair) record for evaluating skills. Thus, graduation from a post-secondary educational program, especially with a GIS emphasis, was given a high level of confidence in evaluating an individual’s GIS skill level” (see www.gisci.org).

It is important to make a clear distinction between “certification” and a certificate, which is a document testifying to the fact that a person has completed class work in a subject area. Many colleges and universities have developed certificate programs in GIS. These programs require that students complete a series of courses, at the end of which they receive a certificate that documents that the courses were successfully completed. In many instances, the credits earned in these certificate programs will not transfer to a baccalaureate GIS program of studies.

Although GISC concluded that educational certificates are good evaluators of an individual’s GIS skill levels, UCGIS’s Strawman Report (June 2003) concluded that graduates of existing academic programs often find themselves ill-equipped when they seek employment in one of the many public and private sector activities making substantial use of GIS. Among the difficulties they encounter are:
• an inadequate knowledge of the critical computer science/information technology basis of GIS,
• a weak understanding of the special characteristics of spatial data;
• insufficient knowledge pertaining to the current theoretical and practical status of spatial analysis as well as to the capabilities of the technology that is currently available;
• inadequate understanding of both the nature of spatial data and the methods by which it is acquired, and
• insufficient training in the identification of the spatial components of problems and in the subsequent specification of potential solutions to these problems. (p. 7-8)

This problem is not confined to the U.S. The University of Salzburg has proposed to develop standardized, pan-European entry-level qualifications for “Geoinformation” technicians and professionals. Their proposal (GeoBase, 2003) notes that many employers complain about a shortage of qualified personnel for all kinds of GIS applications. They note that courses on a basic introductory level are urgently needed to provide a foundation for more training, including software-specific vendor training classes. They concluded that employers have little means to gauge worker qualifications in GIS, and no standards to measure qualifications against.

Certification, then, should be based on the individual’s achievement of specified competencies required to do a job effectively. However, college and university certificate programs record the successful completion of a series of courses, rather than the specific skills and competencies they are designed to develop. A competency-based approach to certification and curriculum development is critical to ensure that employers’ actual needs are met.
The GeoSpatial Workforce Development Center of the University of Southern Mississippi (Gaudet et. al, 2001) has made an excellent start in this direction. They developed a competency model that integrates the technical, business, analytical, and interpersonal skills required to develop a workforce for the geospatial technology industry. They concluded that because cross-functional project teams are common and employees shift from project to project throughout the year in many high technology industries, the best approach to develop a workforce is to focus less on specific tasks and duties and to focus more on identifying work-related competencies. They defined competencies as the knowledge and skills that are key to producing the critical outputs of the field and its roles. Groups of competencies typically include the knowledge, skills and abilities required in accomplishing a task or job in a specific work role.

Their process for identifying competencies started with a review of the literature to develop a preliminary list of geospatial technology roles, competencies and outputs. They conducted two focus group sessions with geospatial industry experts to define the industry and identify present and future workforce needs. An electronic collaborative group system was then used to develop a first draft model of the geospatial roles, competencies, outputs and quality requirements. The researchers then conducted face-to-face interviews with role experts in the geospatial industry to give them the opportunity to validate the draft model. Their input was then used to refine the model. Fifteen core competencies that are important to at least half of the geospatial technology roles were identified (Gaudet et. al, 2001, pp. 18-19), and were divided into four key areas: technical, business, analytical and interpersonal competencies.
A Scalable Model of GIS Skills Certification and Education

As noted above, the key challenge lies in making the certificates awarded by accredited educational institutions more directly tied to work-based GIS skills and competencies, particularly at the technician level.

The San Diego GIS Educational Consortium, a partnership of a public school district, a California Community College (Mesa College), and a California State University (San Diego State University), proposes to develop a model integrated educational system for GIS. This system will provide a clear, articulated path through introductory programs, employment skills certifications, and technician training programs to baccalaureate and advanced degrees in GIS. The proposed employment skills certification program will complement the professional certification developed by URISA by preparing individuals for (a) entry into the GIS technician positions and (b) continuing education that will enable them to develop the professional experience, educational achievement and professional contributions required for professional certification in the field.

Goals and objectives

The central goal of the proposed project is to increase the production of qualified GIS technicians to meet workforce demands, while improving the technical skills and the general science, technology, engineering, and mathematics (STEM) preparation of these technicians and the educators who prepare them.

1. Develop skills certificates at identified levels of training, to certify specific work-based competencies.
2. Develop a standards-based curriculum, aligned across the three educational levels, designed to meet identified industry needs. The project-based curriculum will be linked to job descriptions, and will include a work-based component focused on career ladders in GIS.

3. Create articulation agreements across the three educational levels to ensure that students are able to progress efficiently through the skills certificate and more traditional educational programs.

4. Prepare high school teachers and post-secondary faculty to provide the GIS skills training.

5. Develop a Web-based GIS career awareness program to encourage students to pursue careers in the field and enhance enrollment in technician training and educational programs.

6. Share the model GIS skills certification and technician training program with other educational institutions and communities across the U.S.

Project Activities and Deliverables

During Year 1 of the project, a group of GIS employers will be asked to identify their main categories of employees who work in GIS-related fields. The employers will then identify employees within those main categories to participate in a DACUM process to identify career ladders and the knowledge, skills and abilities needed at each level. DACUM (an acronym for “Developing a Curriculum”) is a process through which expert workers identify the duties and tasks they complete at work, and the skills, knowledge, tools and behavior they need to survive at their workplace.
The Co-PIs will review the list of GIS competencies developed by the GeoSpatial Workforce Development Center (Gaudet et. al, 2001) to identify any additional competencies not identified by the DACUM group. Participants at ESRI’s annual conference in San Diego then will be asked to further validate the results of the DACUM process. This will establish the career ladders and skills standards for GIS positions.

The group of expert workers then will meet with managers, trainers, instructors and curriculum experts to convert the chart of workplace skills and abilities into a sequence of instructional units and a rough draft curriculum. The GIS Educational Consortium members will then map the DACUM results to courses across the three levels of education, and identify the additional curriculum needed to provide skills certifications that will prepare students for a variety of GIS-related jobs. The final phase of the DACUM process involves converting the rough draft curriculum into complete courses.

Consortium members will use the results of this DACUM process to develop the curriculum needed for the skills certifications, utilizing core curriculum units developed by NCGIA, UCGIS, and ESRI as building blocks (online ESRI courses are currently included as a component of Mesa College’s GIS classes; under the college’s site license they are provided free to registered students). The curriculum will include ample opportunities for project-based learning. Students will be presented with authentic problems faced by local communities and challenged with developing and applying GIS skills to identify potential solutions. These learning projects will provide opportunities for students from different levels of GIS training and education to work together on specific problems. This collaborative activity will expose students to the range of GIS skills required for authentic problem-solving, provide them with the
opportunity to work with students at a higher level of education, and provide role models for beginning students. The skills certification courses developed will be submitted to the appropriate curriculum committees as required, and then offered through the Mesa College and SDSU GIS programs.

Co-PIs from SDSU and Mesa College will work together to develop a Web-based GIS career awareness program, geared mainly for the high school audience. This program will help students assess their interest in and aptitude for GIS-related careers, provide grounding in fundamental GIS theory and concepts, and encourage students to enter the field. Completion of this program may serve as the first step in the skills certification process.

One advantage of using Web-based GIS programs is that they enable high schools to avoid the complicated (and often expensive) software installation and training problems inherent in traditional GIS programs. Students can utilize a standard PC with a Web browser to access maps and the related technological concepts of GIS. The Web-based GIS program will use ESRI’s ArcIMS 4.0 to provide web mapping services (the software and hardware for this project are already available in the SDSU Department of Geography). ArcIMS can provide comprehensive online mapping capabilities, including zoom-in, zoom-out, pan, spatial query, buffering, and measuring (Peng & Tsou, 2002).

Teacher and faculty training workshops and programs on the use of these Web-based GIS awareness programs also will be developed and offered. Teachers and faculty members will learn how to utilize the contents of the Web-based GIS exercises in their courses or supplemental student activities. They will be able to create a hyperlink to the materials from their own websites to enable their students to access and utilize the materials.
In Year 2 of the project, the GIS Educational Consortium members will complete the development of the curriculum needed for the skills certifications, and ensure that it is aligned across the three educational levels (high school, community college and university). The goal will be to have the skills certification courses build on one another to prepare students for both jobs in the field and entry into the degree-granting GIS programs offered at Mesa College and SDSU.

As part of this process, the Co-PIs will consider the similarities and differences among their current GIS certificates and degree programs. For example, Mesa College requires five lower-division courses in GIS (one of which is work experience), while all of the GIS courses in the SDSU certificate and degree programs are upper division. They also will examine how SDSU’s Computer Science course requirements for their GIS certificate and degree programs correlate with the Computer Science electives recommended in the associate degree program. When this work (which started in Year 1) nears completion, the group will meet for a day-long articulation workshop to develop formal articulation agreements across the institutions. These articulation agreements will then be sent through the respective approval channels at each institution and signed.

Additional project-based activities for the skills certification courses will be developed, and internship opportunities for students in the skills certification programs will be arranged. The SDSU Field Stations Program has pledged internships for students, in addition to those offered by local government, industry, and military organizations. The Web-based GIS fundamentals and career awareness programs, developed in Year 1, will be pilot-tested and revised as needed. A project website will be developed that will provide access to these Web-based exercises and
supporting materials, and will be used to help disseminate them to schools and career centers. Additional teacher and faculty training workshops and programs on teaching the skills certification courses will be developed and offered.

The skills certification training courses developed in year 1 will be offered to students at the community college and university levels. The GIS Educational Consortium will develop project-based certification procedures, and will utilize them to award employment skills certifications to students who successfully complete the skills certification courses and pass the project-based certification tests. Information about the certification policies and procedures developed will be posted on the project website. Students will be encouraged to apply their new skills to earning one of the existing college or university certificates of completion and achievement, and to pursuing an associate degree (with future transfer into a baccalaureate degree program).

During Year 3 of the project, all of the skills certification training courses will be implemented and evaluated. These courses will include internships for students at industry partners and on the educational campuses. The project-based certification procedures developed in year 2 of the project will be evaluated with input from industry partners, revised as needed, and used to award employment skills certifications to students who successfully complete the courses and pass the certification exams.

Additional internship opportunities for students in the skills certification programs will be arranged. The web-based GIS career awareness programs will be updated as needed, and additional teacher and faculty training workshops and programs will be offered. All of the curriculum outlines, supplemental materials, certification policies and procedures and other
information about the GIS skills certification program will be posted on the project website, and will be linked to the Mesa College, SDSU and participating high school websites. These materials will be disseminated to other educational institutions and industry through this website and through presentations made at educational and professional conferences.

The deliverables for the three years of the project include:

- The DACUM-derived job descriptions for GIS-related positions.
- The Skills Certification policies and procedures developed, and posted on the project website.
- Skills Certificates awarded.
- Curriculum outlines, approvals, and supplemental materials.
- Student enrollment and completion of internships.
- Completed articulation agreements.
- A Web-based GIS awareness course/exercises for student outreach and initial skills certification (preparation for a high school or introductory college internship), with its modular components available online.
- Faculty training workshops for high school and postsecondary education.
- A Web site to disseminate certification policies and procedures, job descriptions, Web-based courses, and curriculum materials

**Roles And Responsibilities Of The PI, Co-PIs And Other Senior Personnel**

Dr. Kendra Jeffcoat, Director of Mesa College’s GIS Program (and Dean of the College of Social, Behavioral and Multicultural Studies) will serve as the Principal Investigator for the project. She will direct all project activities, including the implementation of the DACUM
process and curriculum development for the skills certificates to be offered through the project. Dr. Jeffcoat also will guide the development of the articulation agreements among the three education levels, and provide executive support to their successful implementation.

John Johnson, Co-PI, is a GIS and Geography Instructor at San Diego Mesa College. He is an ESRI-authorized instructor for the secondary and postsecondary levels, and provides private GIS consulting and training services to local governments and agencies throughout California. Mr. Johnson will coordinate the DACUM process, will cross-walk the GIS skills and competencies identified through other projects (such as the work of the GeoSpatial Workforce Development Center) to the results of the DACUM process, and will serve as the lead faculty member in the project curriculum development activities, working closely with faculty from SDSU and San Diego City Schools to create the curriculum for the short skills certification courses to be developed through the proposed project. Mr. Johnson also will partner with Dr. Ming-Hsiang Tsou, Assistant Professor of Geography at SDSU, to develop the Web-based career awareness and GIS foundations program. Mr. Johnson will teach the faculty and teacher preparation courses offered through the project.

Dr. Ming-Hsiang Tsou, Assistant Professor of Geography at SDSU, will serve as a Co-PI on the project. Dr. Tsou has been a key participant in the development of the GIS Certificate offered jointly with the Computer Science Department. Dr. Tsou will participate in the DACUM process, in development of the skills certificate curriculum, the articulation of the certificate and degree curriculum across institutions, in training high school and postsecondary faculty to use the materials developed, and in making presentations about the project at professional conferences. With his expertise in Internet GIS and Web-based mapping, Dr. Tsou also will lead
the development of the Web-based GIS awareness program for high school students. He will be assisted by a half-time graduate student, and will supervise the graduate students in the development of the project website.

Dr. Carl Eckberg, Professor of Computer Science at SDSU, also will serve as a Co-PI on the project. Dr. Eckberg was a key participant in the development of the GIS Certificate offered jointly with the Geography Department, and serves as the program’s faculty lead for student advising. Dr. Eckberg will participate in the DACUM process, in development of the skills certificate curriculum, the articulation of the certificate and degree curriculum across institutions, in training high school and postsecondary faculty to use the materials developed, and in making presentations about the project at professional conferences. Dr. Eckberg will be assisted by a half-time graduate student, who also will work with Dr. Tsou in the development of the project website.

Mr. William Berggren, a School-to-Career Specialist with the San Diego Unified School District, will represent the high schools in the project. Highly experienced in the development of project-based learning opportunities, Mr. Berggren will participate in the DACUM process, in alignment and articulation of the postsecondary GIS curriculum with the high school curriculum, development of the standards-based GIS curriculum, and development of high school outreach activities utilizing the Web-based GIS fundamentals course developed through the project. Mr. Berggren also will participate in the planning and delivery of the teacher training workshops.

Management Plan And Timeline

The general objectives of project management are: (a) To ensure consistent and complete compliance with all federal and institutional policies as they relate to the ATE project; (b) to
ensure complete fiscal responsibility in all grant expenditures and budgetary allocations; (c) to schedule, achieve, and monitor specific project milestones and objectives; (d) to oversee and facilitate the evaluation process for the project; and (e) to ensure that project information is disseminated appropriately.

As PI, Dr. Jeffcoat will receive brief quarterly time and effort reports from all full-time and part-time professional employees funded by the project, and will ensure that project funds are used to pay only those personnel costs approved by NSF. The Co-PIs will prepare quarterly progress reports after each Advisory Committee meeting. These reports will be structured to reflect progress toward objectives and activities, and will include as attachments any external reports or developed materials. Formative evaluation issues such as the collection of baseline data will also be included in these reports. Problems or concerns encountered, and possible solutions for them will also be noted. Timeline delays will also be noted and explained, with new deadlines established. The PI will synthesize the quarterly reports into an Annual Report and will include this report as part of any continuation applications for each subsequent year of funding.

The San Diego Regional GIS Council has agreed to serve as an Advisory Committee for the project. Affiliated with the California GIS Council, the San Diego Regional GIS Council was formed to collaborate on the planning, implementation and maintenance of a California GIS infrastructure (the term “infrastructure” is used here in a holistic sense to encompass systems, organizational programs, policy, standards, procedures, and any other factors that affect the ability of member organizations to jointly develop or acquire, share and maintain spatial data adequate to their needs). The San Diego Regional GIS Council is made up of local government
agencies, water agencies, and state and federal agencies. They collaborate to acquire and share data, information and discuss GIS-related issues common to member agencies.

Members of the San Diego Regional GIS council reviewed the concept for this project and provided valuable insight and recommendations to the project design. Members stressed the importance of having the skills certification courses focus on the theory of GIS as well as specific applications. They cautioned that students cannot be pushed through a program too fast, or they will not learn enough to be useful in the workplace, and applauded the idea of having all students participate in internships.

The PI and Co-PIs will present project progress and questions to the Council at their quarterly meetings, and use the feedback obtained to improve the project operations and products. Members of the Council have expressed interest in their organization participating in the DACUM process. Several currently provide internships for Mesa College students, and have indicated that they will continue to provide internships for the students in the skills certification, more extended certificate and degree programs.

The project objectives, specific tasks associated with each project objective, deliverables, responsible parties and timeline for each activity are presented in Attachment A (Supplemental Materials). This work plan presents a comprehensive management plan for the project, and will be used for the day-to-day project management as well as to assess project progress.

**Prospects For Sustainability After The Period Of NSF Funding**

Completion of the proposed project will result in the development of skills certification courses, articulated certificates and degree programs, a Web-based GIS fundamentals program
geared to the high school student, and a web site that will provide access to curriculum outlines, certification materials, and supplemental instructional materials.

Once developed, the skills certification courses, articulated degree and certificate programs, and the Web-based fundamentals program will be used as part of the regular educational program and course delivery at San Diego State University, San Diego Mesa College, and San Diego City Schools. National Science Foundation funds have not been requested to teach these courses; ongoing state educational funding will be used to implement the new courses and sustain them after the end of the project.

The SDSU College of Extended Studies and the San Diego Community College’s Employee Training Institute have both expressed interest in providing the skills certification courses developed through this project to employers on a contract-education basis. This would allow employees to access these courses at the worksite, and would help expand the skills certification programs beyond the credit-granting programs.

The teacher training in how to use the Web-based fundamentals course will be incorporated into the project website, to enable teachers who were not able to attend the workshops during the project to learn to use the materials. As the new small high schools are developed and GIS is integrated into their project-based learning, this training will be integrated into the ongoing professional development activities at these schools.

Training for postsecondary faculty offered through the project will be sustained through the ongoing professional development activities offered at Mesa College. Each faculty member is required to complete continuing education each year; as more faculty members choose to integrate GIS into their courses, the College’s ongoing staff development activities will offer
additional training to serve them. The project website will be maintained by Mesa College and the SDSU Geography Department as part of their institutional websites.

**Evaluation Plan**

The PI and Co-PIs will meet quarterly with project staff to review project progress, suggest ways to improve project efforts to ensure that project goals and objectives are met in a cost effective manner, ensure that the project strategies remain consistent with its mission and goals, and that dissemination is proceeding as planned. The PI will be responsible for collecting the information needed to monitor progress towards annual objectives.

**Formative evaluation.** Realistic timelines have been established for each sequential project implementation task so that the PI can monitor their completion and modify time lines if the task is not being completed as planned. The PI and Co-PIs will conduct semi-annual reviews of the progress of the project implementation plan, using data from the project’s quarterly reports and interviews with project participants. They will review feedback from all project participants, campus constituencies, and the project Advisory Committee. Progress in the development and implementation of the project, with recommendations for improvement, will be summarized in the evaluation reports incorporated in annual reports to the National Science Foundation.

Data elements that will be used in the formative evaluation of the project include: the results of the DACUM process, including feedback from the participants; the approval of the skills certification policies and procedures developed through the project by the appropriate college and university committees; the approval of curriculum outlines and materials, and any problems encountered in this process; student feedback on the Web-based introductory course and on the skills certification courses; employer feedback on the skills certifications; employer
feedback on the quality and performance of student interns; feedback on the processes used to
develop and complete articulation agreements; feedback from participants in the faculty training
workshops for high school and postsecondary education; and user feedback about the usefulness
of the project web page and its content.

Summative results. Student enrollment and outcomes will be the primary indicators of
success in the summative evaluation of the project. These outcomes will be analyzed once each
year during the project, and as a three-year summative evaluation at the end of the project term.
The following data elements will be collected to measure the achievement of project objectives.

- The job descriptions developed for GIS-related positions.
- The number and types of Skills Certificates awarded.
- Student enrollment in the skills certificate courses.
- Student enrollment in the GIS certificate and degree programs.
- Student completion of internships and employer feedback.
- Student completion of the Web-based course for student outreach, and the initial skills
certification
- Teacher and faculty enrollment in and completion of the training workshops for high
school and postsecondary educators.
- The number of “hits,” unique visitors and external links on the project Web site
developed to disseminate certification policies and procedures, job descriptions, Web-
based courses, and curriculum materials
**Dissemination plan**

Information about the GIS skills certification program will be disseminated to other educational institutions and industry through linkages with the San Diego Regional GIS Consortium, the project website and through presentations at selected conferences.

The project website will be the primary source of information about the skills certifications, curriculum, Web-based foundations courses, articulation agreements and supplemental instructional materials developed through the project. The Co-PIs and graduate students will construct the website to ensure that it is returned by major search engines when users search for GIS educational programs, certifications, high school courses, postsecondary courses, training, curriculum, etc.

The major local GIS users (including city and county governments and the military) are represented on the San Diego Regional GIS Consortium. They have agreed to help ensure that their agencies are aware of the GIS Skills Certifications, both by encouraging staff and potential employees to pursue the certifications, and through their continued hiring of interns from the programs.

The Co-PIs and other project staff will write and present papers, conduct workshops and participate on panel presentations about GIS education and certification at a variety of professional and industry conferences. These meetings may include, but are not limited to, the national ESRI Users Conference, the CalGIS Conference, the National Science Teachers Association, the American Association of Geographers, and URISA meetings and conferences.

**Results From Prior NSF Support**

None of the Co-PIs on this project have received prior NSF support.
A Scalable Skills Certification Program in Geographic Information Systems (GIS)

References


Professional Preparation:
Ph.D., Organizational Psychology, California School of Professional Psychology (now Alliant International University)
Master of Arts, Psychology, Connecticut College
Master of Arts, Speech Communication, UCLA

Appointments/Administrative Experience:
- Manage, coordinate and provide leadership for district-wide instructional services;
- Coordinate the development and implementation of information technology applications that support curriculum, instructional services, and enrollment management initiatives;
- Coordinate the development of curriculum, course outlines, instructional materials, and the use of technology and in-service activities;
- Develop grant initiatives and other activities related to workforce training and economic development within the region;
- Seek funding to support and develop international education activities;
- Provide leadership in the development and delivery of distance education;
- Collaborate with student services on curriculum actions.

- Worked with faculty to develop curriculum in the disciplines of asian/filipino studies, anthropology, architecture, black studies, chicano studies, construction management, geography, geographic information systems, interior design, history, philosophy, political science, psychology, and sociology;
- Served on the District International Education Committee;
- Oversaw the faculty coordinator of the International Education Program;
- Oversaw the Associate Dean/Director of the Teacher Education Program;
- Served as site Coordinator for the San Diego Imperial County Community Colleges (SDICCCA) Internship program.

Special Assistant to the President, Institutional Effectiveness, Palomar College, San Marcos: June 1996 to July, 2000
- Met twice each month with the President, the Vice Presidents, the Presidential Cabinet, and the President’s Advisory Council.
- Assessed internal/external opportunities and concerns; developed and implemented legislative strategy.
- Established liaisons with corporate, educational, and government community partners. In doing so, served as Vice-President of the San Marcos Economic Development Corporation; Co-Chair of the Education Committee of the Diamond Gateway Chamber; Member of the Board of Economic Development Association of Poway; Chair of the Government Affairs Committee of the Poway and Rancho Bernardo Chambers, Chair of the Board of Directors of the Poway Chamber of Commerce; and Vice-Chair of the North County United Way Board.
Co-developed the “High School to High Tech Best Practices Showcase”.

- Member of a team that conducted focus groups to evaluate the board and administrative structure of the Rancho Santiago Community College District.
- Facilitated focus groups to rewrite job accountabilities for Disneyland Resorts (Anaheim).
- Provided numerous workshops. For example, with the OSI President, conducted a two-day workshop on “Coaching and Counseling” for the SDSU Continuing Education Leadership Program.

Director/Consultant of the North County Higher Education Alliance (California State University-San Marcos, MiraCosta College, and Palomar College): 1993-1994
- Arranged and facilitated inter-institutional coordination of plans for distance learning, electronic communication, and grant opportunities.
- Developed a new organizational structure for the alliance that has resulted in numerous collaborative projects, a Chancellor’s Office grant for on-line tutoring, and expanded membership.

Director of Activity II of a Title III Federal Grant Project, Palomar College: 1990-1991
- Developed an electronic student identification system for tracking utilization of services for 25,000 students. The system was recognized for its efficiency and cost-effectiveness.

Mediator for Custody and Visitation Disputes, Valley Psychological Association and the Imperial Valley Superior Court: 1982-1984
- Beginning as a sabbatical leave project, developed procedures for providing and evaluating problem-solving mediation techniques and services and worked with mediators and judges throughout California to develop guidelines for joint custody.
- Met with 178 couples to resolve custody and visitation conflicts and made recommendations to the Superior Court Judge.

Teaching Experience:
- Instructor of Psychology: Palomar College, 3 years full-time; 9 part-time 1988-2000
- Associate Professor of Psychology: Imperial Valley College, full-time tenured position 1975-1988

Synergistic Activities:
- Member, 15-person Human Relations Commission of the City of San Diego, reporting to the City Manager Fall, 2002 - present
- Member, Management Development Commission, Association of California Community College Administrators (ACCCA) Fall, 2001-present
- Mentor (ACCCA Mentor Program) for a Dean at Southwestern College Fall, 2001-Spring 2004
- Member, Board of Directors, San Diego Science Alliance 1999-present
- Chair of the Board of Directors, Poway Chamber of Commerce 2000-2001
- Chair, 7-member Sunset Advisory Task Force, County of San Diego 1999-2002
- Selected for the two-week Harvard Institute for Higher Education: Management and Leadership in Education June, 2000
JOHN JOHNSON

EDUCATION
1999-2003  Environmental Systems Research Institute (ESRI), Redlands, CA
            ESRI AUTHORIZED INSTRUCTOR
            ESRI AUTHORIZED K-12 INSTRUCTOR

1994        San Diego State University
            CALIF. SECONDARY TEACHING CREDENTIAL

1987        University of California, Irvine
            MASTER OF BUSINESS ADMINISTRATION

1983        University of Oregon
            MASTER OF URBAN & REGIONAL PLANNING

1977        University of British Columbia, Canada
            BACHELOR OF ARTS - GEOGRAPHY

WORK EXPERIENCE
1995 - 2003  San Diego Mesa College, Palomar, Grossmont & MiraCosta Colleges
            GIS & GEOGRAPHY INSTRUCTOR
            - Co-wrote and developed Mesa’s GIS Certificate Program.
            - Applied for, awarded, and implemented 2 VTEA grants for $77,000
to expand Mesa’s GIS Certificate Program.
            - Lead writer: GIS Program Review, Mesa College 2003
            - Started GIS classes in 3 San Diego Community College Districts.
            - Supervisor, Mesa College GIS Student Internship Program.
            - Active in marketing and promoting GIS in San Diego County.

1999 - 2003  GIS Workshop - Encinitas
            OWNER, GIS TRAINER & CONSULTANT
            - Provide ArcGIS training seminars in San Diego & North County.
            - Prepared route maps for the Metropolitan Transit District in L.A.
            - Developed a GIS system for N.C. Transit District in Oceanside.

1993 - 1995  Oceanside Unified School District
            HIGH SCHOOL TEACHER

            REAL ESTATE ECONOMIST
            Applied real estate, market research & financial consulting.

1983 - 1986  The Irvine Company - Newport Beach
            LAND USE ANALYST / ASSOCIATE MANAGER
            Urban Planning and Research.

1978 - 1981  Calgary Regional Planning Commission - Canada
            PLANNER / SENIOR PLANNER
            Regional Planning Agency

MEMBERSHIPS
            California Geographic Information Association
            National Council for Geographic Education
            URISA - Urban & Regional Information Systems Association

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E-mail: mtsou@mail.sdsu.edu, Web site: http://typhoon.sdsu.edu/People/Pages/tsou/index.html

EDUCATION
• Doctor of Philosophy, Geography, University of Colorado at Boulder, 2001.  
• Master of Arts, Geography, State University of New York at Buffalo, 1996.  
• Bachelors of Science, Geography, National Taiwan University, 1991.

PROFESSIONAL APPOINTMENTS  
2000-Present  
Assistant Professor, Department of Geography, San Diego State University.  
1999-2000  
Teaching Assistant, Introduction to GIScience, University of Colorado, Boulder.  
1995-1998  
1994  
Graduate Assistant, Geographic Information and Analysis Laboratory (GIAL), State University of New York, Buffalo.  
1993  
Research Assistant, Global Change Research Center, National Taiwan University.

RELEVANT PUBLICATIONS

OTHER SIGNIFICANT PUBLICATIONS
GIS AND COMPUTER EXPERIENCES
2000-Present  Webmaster and System Administrator of MAP.SDSU.EDU server.
(13 years experience, GIS software & GIS programming languages: C++, Java, JavaScript, VB).

RECENT PROJECTS AND AWARDS
•  Fall 2001 and Spring 2002 Faculty Fellowship (1/4 salary), Education Center on Computational Science and Engineering (ECCSE), San Diego State University. The ECCSE is part of the National Partnership for Advanced Computational Infrastructure (NPACI). http://www.edcenter.sdsu.edu/faculty-fellows/spring2002/index.html
•  PI: The 2000-01 Faculty Development Program Award, San Diego State University. "Developing a Dynamic Architecture for Internet Mapping and Distributed GIServices" $5000.
•  The 2000-01 Grand-in-Aid Award, San Diego State University. “Software agent for GIServices”, $8000. URL: http://map.sdsu.edu/geoagent

SYNERGISTIC ACTIVITIES
•  Participations of research activities and presentations at the California Institute for Telecommunications and Information Technology, Cal(IT)2. Cal-(IT)2 seeks to ensure that California maintains its leadership in the telecommunications and information technology.
•  Participations of research activities and educational workshops with Dr. Chaitan Baru and Dr. Ilya Zaslavsky, San Diego Supercomputer Center, UC-San Diego. http://www.sdsc.edu/DICE/

GRADUATE STUDENTS:
•  Master Thesis Chair in Geography, SDSU: Rasmus Larsen (grad. 2003), Liang Gou (grad. 2003), Yuying Li (grad. 2003), Susmita Panchal (current), Rachael Ouellet (current).
•  Ph.D. Dissertation Advisee: Jayuan Lin (expected Fall 2003), Dept. of Geography, SDSU.

COLLABORATORS:
Dr. Barbara P. Buttenfield, Department of Geography, University of Colorado at Boulder.
Dr. Zhong-Ren Peng, Department of Urban Planning, University of Wisconsin-Milwaukee.
Dr. Douglas Stow, Department of Geography, San Diego State University.
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San Diego, CA  92182-7720  Telephone: (619) 594-6834, Fax: (619) 594-6746
E-mail:  eckberg@rohan.sdsu.edu

EDUCATION

- Bachelors of Arts, Mathematics, Cornell University at Ithaca, New York, 1964
- Doctor of Philosophy, Mathematics, Purdue University at West Lafayette, Indiana, 1969

PROFESSIONAL APPOINTMENTS

1969-Present  Associate Professor, Department of Computer Science, San Diego State University, San Diego, California

(Mathematics was the original department’s name, which then migrated to the department of Mathematics and Computer Science, and finally splitting into two separate departments)

RELEVANT PUBLICATIONS

The relevant activity to the current proposal is primarily M.S. theses directed. These are archived in the San Diego State Univ. library.  Examples:

(1) Templated Q&A DB System for Independent Study and Self-Assessment-Back End Design and Implementation, Michael Li
(2) Templated Q&A DB System …….Front End Design, Helena X. Kramer
(3) The Research, Design and Implementation of DBANYWHERE, Weifang Zheng
(4) Web-Based Terrain Information Visualization System, Wolfgang Bloem

In progress theses include projects in spatial databases, and Map Objects with Java

SYNERGISTIC ACTIVITIES

(1) The first two theses in (iii) resulted in the creation of an extensible database of hundreds of question each in Java and in Oracle SQL/PLSQL. These data banks have been used by students for self study, as well as for online exams. This project is being enhanced in another M.S. thesis.
(2) Passed Java Programmer exam, prior to teaching a class to prepare students for that test, as part of DOL (Department of Labor) program to help provide technical retraining.
(3) Co-advisor for an SDSU Certificate in Geographic Information Science, which is roughly comprised of half Computer Science classes, and half Geography classes.
(4) Part of a committee to explore an advanced version of (3), namely a joint M.S. degree with equal parts Computer Science and Geography.
(5) Co-taught an upper division class offered to both Computer Science and Geography students, the initial collaboration between these two departments.
COLLABORATORS & OTHER AFFILIATIONS
(a) Collaborators and Co-Editors: none
(b) Graduate Advisors of mine: very historic data
(c) Graduate Advisees: some are listed above, but the numbers are very large, and since these are M.S. advisees, the chances of a reviewer conflict are extremely small. We are not a Ph.D. granting institution in Computer Science or Math.
September 30, 2003

John Johnson  
Professor, Geographic Information Systems  
San Diego Mesa College, H207  
7250 Mesa College Drive  
San Diego, CA 92111  

Dear John,

The Environmental Systems Research Institute (ESRI) is pleased to support your proposal to the National Science Foundation to develop a skills certification program in geographic information systems (GIS) that will prepare individuals for entry-level jobs in a GIS-related position and for career advancement in the field.

We understand that the GIS skills certification program will offer an articulated educational program leading to (a) a series of skills certificates designed to meet industry and employer needs, and (b) an associate’s degree in GIS, a bachelor’s degree, and advanced degrees in the field. Your proposed employment skills certification program will prepare individuals for entry into the GIS technician positions and for continuing education that will enable them to develop the professional experience, educational achievement and professional contributions required for professional certification in the field.

We are delighted that you plan to coordinate your skills certification training with the short courses that we offer. We provide short-term (2-5 days) instructor-led courses and web-based training in GIS concepts, GIS applications, and using ESRI GIS software and related technologies. We will be happy to provide you with our advice and input as you work out your curriculum, and as you investigate the possibility of providing college credit for ESRI training. ESRI also will help project investigators validate the GIS career ladders and skills that you identify at our annual conference, and will be happy to help disseminate information about the skills certifications once they have been successfully developed and pilot tested.

Skills certifications that provide entry into the GIS field are an excellent way to get students involved and interested in GIS as a career. We applaud your focus on developing the workforce in ways that meet both student and employer needs, and look forward to working with you on this important project.

We are honored to be able to participate in your proposal.

Sincerely,

Charlie Fitzpatrick
ESRI Schools & Libraries  
880 Blue Gentian Rd, Suite 200  
St.Paul, MN  55121-1596  
v: 651/994-0823 x.8349  
f: 651/454-0705  
e: cfitzpatrick@esri.com  
http://www.esri.com/k-12
October 9, 2003

John Johnson
Professor, Geographic Information Systems
San Diego Mesa College
7250 Mesa College Drive
San Diego, CA 92111

Dear John,

The San Diego Regional GIS Council (SDRGC) is pleased to support your proposal to the National Science Foundation to develop a GIS skills certification program that will prepare individuals for entry-level jobs in a GIS-related position and for career advancement in the field. The SDRGC is composed of federal, state and local public agencies, military installations, universities and community colleges interested in promoting the coordinated development of GIS infrastructure in the San Diego region.

We understand that the GIS skills certification program will offer an articulated educational program leading to (a) a series of skills certificates designed to meet industry and employer needs, and (b) an associate’s degree in GIS, a bachelor’s degree, and advanced degrees in the field. Your proposed employment skills certification program will prepare individuals for entry into the GIS technician positions and for continuing education that will enable them to develop the professional experience, educational achievement, and professional contributions required for professional certification in the field.

Representatives of SDRGC will be pleased to participate in the project’s process to identify the career ladders within the field and the specific skills required for jobs in GIS-related fields. In addition, our members are committed to providing internships and other work-based learning opportunities for GIS students. Finally, we agree to serve as the Advisory Committee for this project.

Skills certifications that provide entry into the GIS field are an excellent way to get students involved and interested in GIS as a career. We applaud your focus on developing the workforce in ways that meet both student and employer needs, and look forward to working with you on this important project.

Sincerely,

WENDY BARTO, Chair
San Diego Regional GIS Council

WB/SK/ce
October 8, 2003

Elizabeth J. Teles, Ph.D.
Lead Program Director
Division of Undergraduate Education
National Science Foundation
4201 Wilson Blvd., Room 835
Arlington, VA 22230

Dear Dr. Teles,

On behalf of San Diego State University, I am pleased to express our commitment to and support to this proposal to develop a GIS skills certification program that will prepare individuals for entry-level jobs in a GIS-related position and for career advancement in the field. The proposed project will develop an articulated educational program leading to a series of skills certificates designed to meet industry and employer needs, and to an associate’s degree in GIS, a bachelor’s degree, and advanced degrees in the field.

SDSU has an award-winning Geographic Information Systems certificate program, as well as baccalaureate degree and advanced degree programs in the field. The proposed project will develop skills certification courses, a Web-based GIS fundamentals course, and will support the articulation of our degree and certificate programs with those of the San Diego Community College District. These articulated courses and programs will be a part of our regular educational program, supported through state funding for higher education. Our faculty are committed to maintaining the project website to help ensure that the results of the project continue to be disseminated to other schools, colleges and universities.

The proposed project focuses on developing the GIS workforce in ways that meet both student and employer needs. It will be a valuable addition to our program and the opportunities we offer our students, and I urge the National Science Foundation to fund this important project.

Please note, San Diego State University Foundation, a 501(c)(3) nonprofit corporation, administers grants and contracts on behalf of San Diego State University and its faculty. If an award is made, it should be in the name of San Diego State University Foundation.

If you have any questions or need further information, please contact the following:

Programmatic
Dr. Ming-Hsiang Tsou
Geography
San Diego State University
5500 Campanile Drive
San Diego, CA 92182-4493
(619) 594-0205
mtsou@mail.sdsu.edu

Administrative
Ms. Rachel A. Cook
Development Specialist
San Diego State University Foundation
5250 Campanile Drive
San Diego, CA 92182-1931
(619) 594-2511
rcook@foundation.sdsu.edu

Best regards,

Thomas R. Scott, Ph.D.
Interim Associate Vice President, Research and Technology
October 8, 2003

Elizabeth J. Teles
Lead Program Director
Division of Undergraduate Education
National Science Foundation
4201 Wilson Blvd., Room 835
Arlington, VA 22230

Dear Dr. Teles,

On behalf of Mesa College and the San Diego Community College District, I am pleased to express our commitment to and support to this proposal to develop a GIS skills certification program that will prepare individuals for entry-level jobs in a GIS-related position and for career advancement in the field. This GIS skills certification program will offer an articulated educational program leading to a series of skills certificates designed to meet industry and employer needs, and an associate's degree in GIS, a bachelor's degree, and advanced degrees in the field.

Mesa College has a strong program Geographic Information Systems program. The proposed project will develop skills certification courses, articulated degree and certificate programs, and a Web-based GIS fundamentals courses. Once developed, these courses and programs will become a part of our regular educational program. Mesa College will utilize its state funding to support the implementation of these new courses and to sustain them after the term of the grant. We also will support the maintenance of the project website through our institutional website, to help ensure that the results of the project continue to be disseminated to other schools, colleges and universities. In addition, once the grant project is complete the College will sustain the GIS course training for our faculty through our ongoing professional development programs.

The proposed project focuses on developing the GIS workforce in ways that meet both student and employer needs. It will be a valuable addition to our program and the opportunities we offer our students, and I urge the National Science Foundation to fund this important project.

Sincerely,

Constance M. Carroll, Ph.D.
President
September 24, 2003

Dr. Kendra Jeffcoat
Dean, School of Social/Behavioral Sciences
San Diego Mesa College
7250 Mesa College Drive
San Diego, CA 92111-4988

Dr. Jeffcoat:

The San Diego State University Field Station Programs offers our support and encouragement for your proposed GIS Skills Certification Program to prepare students for GIS-related careers. The relationship between SDSU and San Diego Community College District will be fostered by this project, and the opportunities presented to students through this interaction will provide additional opportunities beyond those of the two institutions individually.

The SDSU Field Station Programs' mission is to support teaching, research, and education on the ecosystems of Southern California by collecting, sharing, and understanding environmental data. Education and outreach efforts are important to us, as they lead to a better IT-equipped and trained populace. The SDSU Field Stations can provide unique opportunities for field experiences in large, relatively undisturbed areas of southern California habitats.

The Santa Margarita Ecological Reserve, near Fallbrook CA, has housing and facilities to accommodate day use and overnight field trips for instructors and students. The reserve currently hosts over 50 research projects and there are always opportunities to develop internships. We have staff at the reserve that can work with you to coordinate field trips and internships. The daily use fees for educational use of the reserve are waived.

We are pleased that you have asked us to participate and look forward to the funding of your certificate program.

Sincerely,

Sedra Shapiro
Executive Director
# A Scalable Skills Certification Program in Geographic Information Systems (GIS)

## Project Workplan, Management Plan and Timeline

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Activities</th>
<th>Deliverables</th>
<th>Responsible Parties</th>
<th>Timeline</th>
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<tbody>
<tr>
<td>1. Develop skills certificates at identified levels of training, to certify specific work-based competencies.</td>
<td>A group of GIS employers will be asked to identify categories of employees. A group of GIS role experts will use the DACUM process to identify career ladders and the knowledge, skills, abilities and education needed at each level.</td>
<td>DACUM descriptions of the jobs and career ladders for GIS positions. These descriptions will identify the skills standards for GIS positions.</td>
<td>Kendra Jeffcoat, John Johnson, Ming Tsou, Carl Eckberg, William Berggren, Grad students, Employer Partners and their staff</td>
<td>Year 1: 1/2005 - 6/2005</td>
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<td></td>
<td>Participants at ESRI’s annual conference in San Diego will be asked to further validate the results of the DACUM process.</td>
<td>Revisions to the DACUM descriptions, based on the input received.</td>
<td>Kendra Jeffcoat, John Johnson, Ming Tsou, Carl Eckberg, William Berggren</td>
<td>Year 1: 6/2005 – 9/2005</td>
</tr>
<tr>
<td></td>
<td>The GIS Educational Consortium will develop project-based certification procedures, and will utilize them to award independent employment skills</td>
<td>Certification policies and procedures</td>
<td>Kendra Jeffcoat, John Johnson, Ming Tsou, Carl Eckberg, William Berggren</td>
<td>Year 1 for development, 1/2005 – 9/2005</td>
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<td></td>
<td></td>
<td>Certificates awarded.</td>
<td></td>
<td>Implement starting in Year 2, 10/2005</td>
</tr>
<tr>
<td>Description</td>
<td>Responsible Parties</td>
<td>Year</td>
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<td>Certifications to students who successfully complete the skills certification courses and pass the project-based certification tests.</td>
<td>Kendra Jeffcoat, John Johnson, Ming Tsou, Carl Eckberg, William Berggren, Industry Partners</td>
<td>Year 3: 10/2006 – 9/2007</td>
<td></td>
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<tr>
<td>Updated GIS job descriptions.</td>
<td></td>
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<tr>
<td>Revised policies and procedures for awarding certifications.</td>
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<td>2. Develop a standards-based curriculum, aligned across the three educational levels, designed to meet identified industry needs. The project-based curriculum will be linked to job descriptions, will integrate Geography and Computer Science, and will include a work-based component focused on career ladders in GIS.</td>
<td>Map the DACUM results to courses across the three levels of education, and identify the additional curriculum needed to provide skills certifications. Develop the curriculum needed for the skills certifications. The curriculum will be aligned across the three educational levels (high school, community college and university). Develop project-based activities for the skills certification courses. Offer the skills certification courses to students at the high school, community college and university levels.</td>
<td>List of courses and curriculum is prepared, with gaps identified. Curriculum outlines and approvals. Project curriculum outlines. Program enrollment and completion.</td>
<td>Kendra Jeffcoat John Johnson Ming Tsou Carl Eckberg William Berggren Graduate students John Johnson Ming Tsou Carl Eckberg William Berggren Graduate students John Johnson Ming Tsou Carl Eckberg Graduate students</td>
<td>Year 1: 1/2005 – 9/2005 Year 2: 10/2005 – 9/2006 Year 1: 1/2005 – 9/2005 Years 2&amp;3: 9/2005 – 9/2007</td>
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<td>Arrange internship opportunities for students in the skills certification programs.</td>
<td>Internship completion.</td>
<td>SDCCD District Office Mesa College SDSU</td>
<td>Year 1 1/2005 – 9/2005, then ongoing</td>
<td></td>
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<tr>
<td>3. Create articulation agreements across the three educational levels to ensure that students are able to progress efficiently through the educational programs.</td>
<td>Draft articulation agreements  Obtain approval at each level  Sign agreements</td>
<td>Formal articulation agreements developed and signed.</td>
<td>John Johnson  Ming Tsou  Carl Eckberg  William Berggren  Kendra Jeffcoat</td>
<td>Year 2: 10/2005 – 9/2006</td>
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<td>5. Develop a Web-based GIS career awareness program to encourage students to pursue careers in the field and enhance enrollment in technician training and educational programs.</td>
<td>The Co-PIs will develop and disseminate web-based GIS career awareness programs, geared mainly for the high school audience. These project-based courses will help students assess their interest in and aptitude for GIS-related careers, and encourage students to enter the field.</td>
<td>Web-based courses.</td>
<td>John Johnson Ming Tsou Graduate students William Berggren SDCS teachers</td>
<td>Year 1: 10/2004 – 9/2005</td>
</tr>
<tr>
<td>GIS career awareness program will be piloted, revised as needed, and disseminated to schools and career centers.</td>
<td>Courses accessed by high schools and career centers.</td>
<td>Student completion of web-based courses.</td>
<td>John Johnson Ming Tsou William Berggren SDCS teachers</td>
<td>Year 2: 9/2005 – 12/2005</td>
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<td>Students who complete program course successfully will be awarded initial skills certificate.</td>
<td>Initial skills certificates awarded.</td>
<td></td>
<td>John Johnson Ming Tsou Carl Eckberg Kendra Jeffcoat William Berggren SDCS teachers</td>
<td>Year 2: 1/2006 then ongoing</td>
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<td>6. Share the model GIS skills certification and technician training program with other educational institutions and communities across the U.S.</td>
<td>Information about the GIS skills certification program will be disseminated to other educational institutions and industry through website and presentations at selected conferences.</td>
<td>Web-based courses available to students outside participating districts. Website describing the skills certification process and providing curriculum. Presentations at conferences.</td>
<td>Kendra Jeffcoat John Johnson Ming Tsou Carl Eckberg William Berggren</td>
<td>Year 1: 8/2005 (particularly ESRI conference) Year 2: 8/2006 (ESRI) 10/2005-9/2006 (website and conferences) Year 3: 10/2006 – 9/2007 (conferences and website)</td>
</tr>
</tbody>
</table>
October 13, 2003

Elizabeth J. Teles
Lead Program Director
Division of Undergraduate Education
National Science Foundation
4201 Wilson Blvd., Room 835
Arlington, VA 22230

Dear Dr. Teles:

On behalf of the San Diego Unified School District, I am pleased to express our commitment and support for the development of the GIS skills certification program. The proposed project will develop courses, an articulated degree, certificate programs, and a web-based GIS career awareness program preparing individuals for entry-level jobs as well as career advancement in GIS-related fields.

The San Diego Unified School District has a strong School-to-Career program that is now serving as a foundation of the district’s high school reform efforts. Our reform program includes development of more contextual learning opportunities tied to the workplace. The proposed GIS Skills Certification program and web-based career awareness program will help us integrate authentic, GIS-focused project-based learning into our educational programs. In addition, it will assist students identify careers of interest to them and the educational paths they must pursue to gain employment in their selected field.

Mr. William Berggren, who retired from this office last year, continues to play a leadership role in developing our school-to-career programs. As a contractor with this program, he will work closely with the project’s Principal Investigators while ensuring the programs developed meet our district guidelines and student needs.

The proposed project focuses on developing the GIS workforce in ways that meet both student and employer needs. It will be a valuable addition to our program and the opportunities we offer our students. I urge the National Science Foundation fund this important project.

Sincerely,

Robert K. Atterbury
Director, School-to-Career

RKA:ps:blw

"The mission of San Diego City Schools is to improve student achievement by supporting teaching and learning in the classroom."