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Columbia College, one of two colleges within the Yosemite Community College District, is located in a large rural geographic area in the Sierra Nevada mountains. More than 3,500 students benefit from Columbia’s accredited comprehensive programs and support services. Most students are older than the traditional age of college students and 65% are female. A substantial number of students participate in non-traditional programs. Tuolumne and Calaveras Counties, primary service areas of Columbia College, are listed among the fastest growing counties in California. Future growth in Mining, Forestry, and Construction sectors will rely heavily on the use of Geographic Information Systems (GIS), the integration of Computer Assisted Drafting and Design (CAD) with attribute database development and management.

Geographic Information Systems is a system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems (David Rhind, Birkbeck College, University of London, *ARC News*, Environmental Systems Research Institute, Inc., Vol. 11, No. 3, p. 1). Global Positioning Systems (GPS) are systems of orbiting satellites and special GPS receivers which permit the GIS operator to determine precise latitudes, longitudes, and elevations quickly and economically wherever the receiving instrument is taken throughout the world. GPS units are usually linked to computers to facilitate automatic georeferenced data collection. Dr., Douglas Richardson, President of GeoResearch, Inc., of Billings, MT has remarked: ‘The integration of GPS and GIS represents one of the most significant new developments for natural resource management and facilities mapping in recent years.’

The Yosemite Community College District (YCCD) serves portions of six counties. The Columbia College staff recognizes that to better prepare the workforce of its service area to the demands of an ever-changing workplace, it must expand its offerings to follow the local, statewide, and nationwide efforts to implement Geographic Information Systems.

The information obtained using GIS can be transferred easily into a system which builds the data into so-called "intelligent" maps. This means that it creates maps which can be queried to display all
features which fulfill the desired combination of criteria. This is possible because the information in the database is dynamically linked to the map coordinates. A GIS map is made up of multiple layers of georeferenced data as show in the opposite figure: (Ibid) [FIGURE DELETED]
Columbia

Impact on Systemwide Need

[No information provided in this document for this section.]
This program will address the Basic Agenda area of educational Quality: it would make vocational programs more relevant and enable the college to work with industry and the private sector to prepare students for employment (RFA p. 11).
Local Applications of GIS

Columbia College is located in an area which is ripe for the GIS/GPS combination, yet no program is in place to meet this need. The Seismographic Station at U.S. Berkeley is considering locating a GPS base station on the Columbia College campus as one of a network of four such stations across Northern California which will be used to detect strain near the plate boundary. With a curriculum in place, the college GPS students would have access to this GPS data which is necessary to permit high quality GPS position determinations. U.C. Berkeley already has one of the world's finest seismograph stations (CMB) located in a vault in the bedrock on the campus.

The Sierra Nevada is a vast storehouse of timber which must be carefully managed. Fibreboard Inc., a local participant in the timber industry, is using GIS to help plan their timber harvests by evaluating the mass of data that must be considered, including percent slope, soil type, timber type, property boundaries, watersheds, spotted owl habitat, etc. Condor Earth Technologies, Inc., of Sonora, CA, is an engineering and consulting company that serves natural resource industries and government agencies, currently offers GIS and GPS services to its clients, and anticipates a tremendous increase in demand for these services. Other efforts include those of the Tuolumne County Planning Office to digitize the parcel maps into GIS, using ARC/INFO software. Utility companies need to locate and monitor the condition of thousands of miles of canals, utility lines and equipment GIS can assist in monitoring biodiversity, water resources, recreational facilities, fire protection and response, search and rescue, etc.

State and Federal Need

State and federal actions mirror the local need for GIS and GPS. The U.S. Forest Service, manager of 20% of the state's land, is completing a five-year study that is expected to establish a standard GIS system throughout the United States. Their regional office has informed Columbia College of the need for trained employees in anticipation of the pending GIS explosion.

In addition to the U.S. Forest Service, GIS is being implemented by the U.S. Army Corps of Engineers, all branches of the U.S. Armed Forces, state governments, and county and city governments. In the United States, while all of these applications have been
significant, one that is particularly important is the use of GIS technology in the TIGER (Topographically Integrated Geographical Referencing) project by the U.S. Census Bureau. This project produced a computerized description of the geography of the United States to facilitate taking and reporting the 1990 census and cost about $170 million. TIGER probably represents the largest-but-one collection of geographic data yet made— and ARC/INFO can read TIGER files (David Rhind, Birkbeck College, University of London, ARC News Environmental Systems Research Institute, Inc. Vol II No. 3, p. 3.

At the state level, Teale Data Center, a statewide repository for businesses, counties and educational institutions, is heavily involved in using, distributing, and promoting GIS technology. In cooperation with the Governor's Office of Planning and Research, a Geographic Information Task Force has made recommendations to Governor Wilson and Assemblyman Farr of California. Dr. Randy Moory, GIS manager at Teale Data Center, chaired a meeting with the CMCC (Computer Mapping and Coordinating Committee) to begin implementation of the State's Geographic Information Task Force recommendations by soliciting interested organizations to assist in establishing statewide standards for GIS.

Some private firms also provide services to government (date collection, data entry and database construction); other firms are interested in man: aging their own databases (eg., energy related firms, mineral industry, forest industry and other natural resource firms). Many service firms are implementing GIS to maintain customer databases and monitor trends in their industry (health care, transportation, etc.)

Solution to Address the Problem

To meet these needs, Columbia College proposes to create a three-pronged alliance of support with educational institutions and local businesses, industry and various government agencies and develop the curricula for a Geographic Information Systems program to be offered through a new curriculum project. The curriculum to be developed would be consistent with the Core Curriculum from the National Center for Geographic Information and Analysis (NCGIA) at the University of California, Santa Barbara.

This solution was chosen over alternative solutions because Columbia College recognizes the acute need to update its curricula and educate both faculty, students, and business and industry; it is
currently working with local planners, private engineering firms, the Department of Forestry and other related industries to implement GIS. In cooperation with Condor Earth Technologies, it co-sponsored a conference entitled the "Second Annual Central California (GIS/GPS) Conference" on this emerging technology, which will be vital to many natural resource industries located in the Sierra Nevada. This conference assembled approximately 200 professionals and about 80 students and teachers from the local area and included introductory and technical sessions by professionals from many different companies and governmental agencies.

Local partnerships have been formed with businesses (Condor Earth Technologies, Inc.) and the Tuolumne County Planning Office to develop a better educational environment and provide better careers for our students. The college is currently engaged in discussions with leaders in the field of GIS at the University of California at Berkeley, and plans to open discussions with other colleges and universities, such as the University of California at Davis, University of the Pacific, Sacramento State University Stanislaus State University, and Sonoma State University, in order to facilitate implementation of an appropriate GIS program at Columbia College and establish necessary articulation agreements. Articulation discussions have already begun with instructors from local area high schools (Sonora High, Bret Harte High, and Summerville High.
The population targeted to be served includes college students majoring in earth science, geography or computer science, seeking entry level employment in the growing fields of GIS and Computer Assisted Drafting; and (2), students who may be employed at such federal agencies located in the area as the Dept. of Forestry, who need training in GIS to ensure their retention, using this new technology.

This population needs the services because many private Arms and governmental agencies are implementing GIS and students will require an understanding of the new technology to compete for jobs.

The short term impacts are that vocational programs will be more relevant to students and that students will be better prepared for employment. The curriculum will also be up-to-date with the new technology.

The long term impact is that vocational courses will be tied to meeting intermediate and long term labor market requirements, thereby improving the economic conditions of the area.
Objectives

Objective 1: Collaborate with at least two of the secondary schools and identified technical professionals in the development of the GIS curriculum.
Timeline: September 1994 - October 1994

Objective 2: Develop the GIS Curriculum
Timeline: November 1994 - June 1995

Objective 3: Conduct 2+2+2 Articulation with Secondary and Middle Schools
Timeline: November 1994 - June 1995

Objective 4: Purchase Necessary software to Implement the GIS Curriculum
Timeline: September 1994
The following narrative describes the general work to be done by the project.

**Objective 1:** Collaborate with at least two secondary schools and identified technical professionals in the development of the GIS curriculum.

**Timeline:** September 1994 - October 1994

**Procedure 1:** Establish an advisory board to review proposed curriculum with representatives from participating businesses, industries, government agencies and educational institutions. Obtain appropriate input for curriculum and modify it accordingly.

Include representatives from engineering and consulting businesses in the area, the University of California at Berkeley, University of the Pacific in Stockton, Columbia and Modesto Junior Colleges, local government planning agencies, the Department of Forestry, and other appropriate entities.

**Procedure 2:** Discuss modes of active cooperation by the board members in the delivery of curricula. Examples of how curricula will be delivered include internships for students within alliance member business loans of technical professionals from such businesses as Condor Earth Technologies, (an engineering and consulting company that serves natural resource industries and related government agencies), faculty work shops offered by postsecondary institutions to secondary school professionals and other activities to improve faculty expertise in delivering curricula.

**Objective 2:** Develop the GIS Curriculum.

**Timeline:** November 1994 - June 1995

**Procedure 1:** Provide training opportunities for the Project Director and existing faculty and adjunct faculty to prepare to teach the GIS and OPS courses. They will become qualified through academic study, independent research, and on-the-job experience.

**Procedure 2:** Work with Columbia College Re-Entry Program, Mother Lode Women’s Center, the Disabled Students Programs and Services, the Mother Lode Job Training Center, State Employment Development Department, and other specialized programs, to encourage participation by women, minorities and the disabled in the development of the GIS program.
Procedure 3: Review and modify the National Center for Geographic Information and Analysis model curriculum for incorporation into Columbia College curricula. The curriculum will address the needs of students drawn from such classes as Database Management, Beginning Drafting, Introduction to GIS, Forest Surveying Techniques, Physical Geology, Physical Geography, Cultural Geology and Dendrology.

Other elements of the curriculum will be aimed at sensitizing students to environmental issues, enhancing math skills, and increasing communication and critical thinking skills.

Prerequisite tracks and transferability will be determined through articulation agreements with high schools and universities. The college will utilize the advice of its colleagues and advisory committee to establish requirements "by prescription", based upon each student's measurable strengths and weaknesses and their personal goals.

Procedure 4: Visit educational facilities currently teaching GIS to evaluate software, hardware, curriculum models and textbooks.

Procedure 5: Visit private businesses and government agencies in an effort to evaluate and select software and hardware.

Procedure 6: Survey current GIS/GPS users to determine and rank important GIS/GPS entry-level skills.

Procedure 7: Acquire geographic data from federal, state and county governmental users, as well as universities, colleges, and local businesses, to develop realistic classroom demonstrations and student exercises.

Procedure 8: Develop a certificate program in GIS/GPS.

Procedure 9: Create a student intern program. The first pilot year, student interns will earn six units of credit through work experience with local GIS/GPS firms, complemented by required GIS/GPS course work.

Objective 3: Conduct 2+2+2 Articulation with Secondary and Middle Schools.
Timeline: November 1994 - June 1995
Procedure 1: Establish meetings with faculty and administrators of the local secondary school systems and regional colleges and universities to discuss plans and obtain input as to how to coordinate and articulate.

Procedure 2: Conduct workshops to inform local high school faculty and Columbia College faculty of the wide range of GIS/GPS applications in their areas of expertise. The outcome will be articulation with the high schools on how to motivate and adequately prepare students to intelligently select which aspect and level of GIS/GPS is best for them, whether it be a field mapping and data logger with GPS, a GIS marketing representative, a geography teacher, a high precision GPS registered surveyor, a person who prepares Environmental Impact Statements, a city or county planner, or one of the many other professions related to GIS and GPS.

Procedure 3: Conduct the third annual GIS conference. The focus of the conference will be to update the community and state on: the progress made toward implementation of a GIS/GPS curriculum Guests will include state and federal representatives.

Objective 4: Purchase necessary software to implement the GIS curriculum.
Timeline: September 1994

Procedure 1: Acquire GIS software. Set up GIS work stations within existing computer labs.
The curriculum planning project will focus on a product-oriented approach aimed at producing several educational materials of widespread benefit to the community, the state and the country at large. These outcome products will include:

Objective 1: Report by the Project Director on GIS/GPS needs and curriculum recommendations

Objective 2: Produce a bound GIS/GPS Curriculum Project Handbook for dissemination to prospective teachers and students of GIS/GPS; the handbook will serve as the framework for a more comprehensive textbook to be developed in the implementation phase of the grant.

Objective 3: Produce sample Articulation Agreements to be used as models for other institutions.

Objective 4: Formal evaluation by Project Director of GIS/GPS software and its effectiveness in the GIS/GPS environment

Potential for Continued Support after Expiration of the Grant,

The college is committed to the continuation of the project as evidenced by its decision to approve a sabbatical leave for Dr. Tom Holst, to develop the curriculum. Moreover, the college has also coordinated a GIS Conference with local business, which it plans to continue to hold in the future. As initial funds are obtained for the project, the college will be in a strong position to continue support for the project.

Potential for Adaptation to Other Institutions.

This project is quite portable, because the curriculum handbook can be easily sent to other colleges and adapted for use. In addition to community colleges, the University of California, state agencies such as Teale Data Center and others will be interested in the project for possible adoption.
Both formative and summative evaluations will be carried out in cooperation with the district's Director of Research and Planning. The Director of Research holds a Doctorate and Master's Degree in Pharmacy and has a strong technical background to contribute to the evaluation.

The advisory group for the project will meet regularly to evaluate the progress of the project and suggest improvements to the curriculum. The members of the group will be provided with general questions in which to respond on each objective:

- Is the objective and schedule and will the objectives be completed as proposed? (formative)
- What has been achieved as a result of the implementation? (summative)
- What impact has the project had on the target-represented students and the problems identified? (summative)

Identification of Problems Incurred

Evaluation is a key component of the proposed program, in order to determine if activities are on schedule, identify problems and discuss any changes needed to correct the problems and assess if the proposed outcomes are being achieved. The Yosemite Community College District is fortunate to have a Director of Research who is skilled in evaluation techniques and will provide guidance to the program staff as they conduct their evaluation activities.

An evaluation form will be developed listing the objectives, activities completed and problems incurred. The Project Director will describe when each activity was completed and any problems that occurred. An example follows:

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<tr>
<th>Objective 1:</th>
<th>Activity/Date Completed:</th>
<th>Problems Incurred:</th>
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<tbody>
<tr>
<td>Collaboration with secondary schools in development of GIS curriculum</td>
<td>Establish Advisory Board</td>
<td>Orientation - new technology may be necessary</td>
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(continue with other objectives, activities, problems.)
Identification of Effective Methods

A formative evaluation process will be used to determine whether the program activities are on schedule. The Program Director will be responsible for a few of the activities conducted. The following general questions will be asked:

1. Are the program activities being conducted on schedule?

2. Do any adjustments need to be made to the activities?

Identification of Successes (Outcomes)

The district’s Director of Research and Planning will also work with the advisory group and the Project Director to evaluate the objectives according to the following measures:

Objective 1:  Collaboration with Secondary Schools and Technical Professionals
Process Outcome: Presence of by-laws of alliance
Methods: Minutes of regular meetings

Objective 2:  Develop Curriculum
Process Outcome: Curriculum approved and developed
Methods: Curriculum addresses needs of underrepresented and other target groups

Objective 3:  Develop 2+2+2 Articulation
Process Outcome: Articulation agreements in place with local secondary schools
Methods: Workshops and meetings held

Objective 4:  Obtain Software and Hardware
Process Outcome: Software obtained and hardware leased
Methods: Software tested

Identification of Successes

At the end of the project period, the summative evaluation should identify the successful completion of the following products for each objective:
Objective 1: Collaboration with Secondary Schools and Technical Professionals
Product: Report on recommendations for curriculum and assessment of local need

Objective 2: Develop Curriculum
Product: Curriculum Project Handbook for dissemination to prospective teachers and students of GIS/GPS

Objective 3: Develop 2+2+2 Articulation
Product: Sample articulation agreements to be used as models for other institutions

Objective 4: Obtain Software and Hardware
Product: Formal evaluation by Project Director of GIS/GPS of GIS/GPS software and its effectiveness in teaching GIS/GPS, in consultation with other Senior Personnel.

A final report on the curriculum, its relationship to other disciplines, its implementation and recommendations for change, will be prepared.

Instructors and students will be asked to formally evaluate the project through a survey circulated at the close of the project. Industry representatives will be invited to meet and discuss the effectiveness of the new course in meeting their need for trained technicians and this information will be included in the Project Director's Final Report.

The chart below identifies proposed successes of the project.

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<th>Project Objective</th>
<th>Methods to be Used</th>
<th>Anticipated Outcomes</th>
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<tr>
<td>Collaborate with secondary schools</td>
<td>Records of Advisory Board Meetings</td>
<td>Increased support and expertise in developing curriculum.</td>
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Development of Recommendations

The formative and summative results will be tabulated and used to make careful recommendations for modification to the curriculum and any software changes. Faculty representatives from other disciplines will be asked to evaluate the course content and the curriculum will be modified according to recommendations both they and the Advisory Board offer. It is expected that ongoing contact with industry representatives will also provide valuable input to ensure the project's future success. The data will also be used in refining the curriculum.
handbook.
Dissemination

Product

Aggressive ways to bring visibility to this project include dissemination of the report on the curriculum and the Curriculum Handbook to local industrial groups and government representatives. Articles will be presented to professional publications, journals, the local newspaper and other media for thorough exposure to the entire community. Barry Hillman, senior personnel, has published numerous scientific articles and will consult with the Principal Investigator as he develops articles.

Target Population for Dissemination

Project presentations will be offered to statewide Instructional Officers of the California Community Colleges, the Academic Senates of both the California Community Colleges, the University of California, and the University of the Pacific, and K-12 organizations such as the Association of California School Administrators.

Methods for Dissemination

The project will be described and presented through the special section within the California Community College Info-Net and CAVIX computer bulletin board networks. Other instructional programs throughout the state will be able easily and inexpensively to adapt the curriculum.

Once the planning grant is completed, the Project Director will submit illustrated articles to various journals from business, industry and education. Columbia College will invite the National Geographic Society to produce magazine articles and video productions highlighting the program. The budget includes release time for instructors and participants to attend conferences and conventions to give papers and host discussion groups explaining the program's successes and outcomes.

Timetable for Dissemination

The following timetable will be used for dissemination:
Mega Conference April 1994
GIS Conference November 1994
Academic Senate Conference TBA
Evaluation Methods for Dissemination
The project is, indeed, quite portable, since the contributors and sources are available to most colleges. However, sharing the actual project would greatly facilitate the ease of planning for someone else. Unique features of this project include the significant cooperation from industry, the targeting of both business and high technology as well as disadvantaged students in non-traditional fields, and that the program could be continued in the following years at considerably less cost. These features insure both the project's success and the likelihood that others will want to emulate it.
[No information provided in this document for this section.]