Chapter 4.7

Geospatial Education at U.S. Two-Year Institutions

4.7.1 Community Colleges and GIS&T Education

This chapter documents the rise of geospatial programs at community colleges from the late 1980s to the present. It also highlights key challenges that confront community colleges in the U.S. as they work to respond effectively to current and future workforce needs.

A recent survey carried out by Lakeland Community College with support from the National Geospatial Technology Center of Excellence (GeoTech Center) found that more than 445 community colleges have at least one course related to geospatial technology. This suggests that approximately 38% of the 1,175 community colleges in the U.S. have some type of geospatial program (Rudibaugh, personal communication). The survey also found that of the 445 colleges, 145 offer Certificate programs and 69 offer Associate Degrees. The data cited from this survey is being updated weekly and can be queried from the GeoTech Center web page at geotechcenter.org. The number of courses and programs from this current survey is in stark contrast to the numbers found in a survey carried out in 1995 by Towson State University (Morgan, 1996).

The survey was sent to respondents from four earlier Towson surveys as well as to departments identified from publications by other organizations indicating the likely hood of having GIS programs (Morgan, 1996). Of more than 3,700 departments at higher education institutions worldwide sent surveys, only eight community colleges responded to the 1995 Towson survey. Of those eight responses, only six indicated they

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had a GIS program which is less than 0.0007% of the total number of U.S. community colleges. The other two colleges stated that they were planning to begin a program in the next year.

Why are community colleges important to GIS&T education? According to the Association of American Community Colleges (AACC) FAST FACTS the 1,175 two-year colleges provide education to 44% of the U.S. undergraduate population with an enrollment of 11.7 million students (data current through January 2009). Educational opportunities include academic and vocational courses and programs with 328,268 Certificates and 612,915 Associate of Arts or Science Degrees awarded in 2008. This is a significant number of students that may go directly into the workforce or continue on to universities for four year degrees. While it is likely that not all colleges with GIS programs in 1995 responded to the Towson survey, the results suggest that a very small fraction of community colleges in the U.S were providing geospatial education in 1995. In comparison, more than 820 universities (out of 3,791 surveys sent out) responded that they did have programs, were going to have programs in the next year or were presumed to have programs from data collected in an earlier survey. While this number includes international institutions, it suggests that more than 21% of those surveyed had some type of program.

The apparent low number of community colleges with programs compared to universities in the late 1980 and early 1990's may have to do with several factors including: (1) the different missions of the institutions, (2) the hardware and software requirements during that time interval; and (3) the level of knowledge needed to effectively teach GIScience & Technology (GIS&T). In 1998, Johnson estimated that

150 community colleges had GIS&T courses, certificates or degrees and that 75% of the students in programs were working professionals (Johnson, 1998). These numbers were derived from programs in direct contact with Johnson as part of her position at Environmental Systems Research Institute, Inc. (ESRI) and do not include programs that were exclusively using software from other vendors such as Intergraph, Autodesk or MapInfo. Although not all vendor data was included or available to the author, the number of programs represents a small percentage of the more than 1,175 community colleges that could potentially offer geospatial programs.

4.7.2 The Community College Mission

While some institutions are called junior or technical colleges, most are referred to as community colleges and in fact the AACC changed its name from "Junior" to "Community" in 1991 (AACC, 2009). No matter the name, the mission of these institutions is to provide a low-cost, locally-accessible, lower-division (postsecondary) education tied closely to the community in which they serve (Sullivan, Brase & Johnson 2008).

A college may offer academic (for credit) or Career Technical Education (CTE) formally referred to as vocational (non-credit) programs on the same campus with seamless integration of academic and vocational offerings and sharing of faculty. Other colleges administer these two types of programs separately with specific faculty housed under two, completely independent program tracks. Some U.S. states have two lower

division college systems which separate “community” colleges from “technical” colleges based on whether they provide academic degrees and credits toward a four year degree, or they grant technical degrees that do not easily transfer toward a four-year academic program. Colleges are also expanding their reach outside of their community by offering online distance education programs. Generally though, community colleges are tasked to provide lifelong learning opportunities (Sullivan, Brase & Johnson, 2008) with funding primarily from state funding sources that heavily (in most states) subsidize the educational programs. Fees do range from very low (California, $26 per credit hour) to higher fees with the U.S. average annual tuition at two year colleges of $2,402 compared to $6,585 for four year public institutions (AACC, 2009). This includes educating those individuals that:

- did not complete high school,
- do not wish to go directly into a four-year program,
- only need a certificate or associate degree,
- want training and education to qualify to work in a specific occupation (i.e., respiratory therapist, emergency response, etc.),
- have not acquired adequate educational background to enter a university,
- have a degree but need to upgrade their education to meet the changing skills required to do their current job,
- need new skills to advance in their current career, or
- want to acquire entirely new skills to enter an entirely new field.

The primary mission of faculty and programs at community colleges is to educate students in a particular subject, discipline or occupational area. In contrast, the mission

of universities is not limited to providing students with an education specific to one occupation, but to provide a broad foundation that can be applied to many fields as well as provide the basic knowledge to carry out scientific studies in many disciplines. University researchers were thus instrumental in the early development of GIS&T (Longley, et al, 2005). Chrisman recounts the early meetings, conferences and training events at universities in the early 1960s (Chrisman, 2006) and notes the early funding support from organizations and the National Science Foundation. Many software programs were developed at universities such as SYMAP, Northwestern and Harvard Laboratory of Computer Graphics in early 1960s (Chrisman, 2006). Software was also developed by graduates from these early university programs including ERDAS in the mid 1970s and ArcInfo in 1982 from ESRI. Other programs were outgrowths of basic research including MapInfo in 1986 as a spin off from Rensselaer Polytechnic Institute and Idrisi at Clark University in 1987.

Advances in computer capabilities, printers and printing techniques, evolving programming languages and software encouraged university departments to set up computer labs in their own departments rather than be tied to a campus computing center (Chrisman, 2006). Graduate and upper division programs were thus poised to not only create and advance the technology through research by faculty and graduate students, but to teach the emerging concepts and use of the technology. In contrast, community colleges were not able to participate in the development of the technology as faculty were focused on teaching those subjects that were traditionally part of an academic program or were needed by the current workforce. One such program that did have a link to the current workforce was Computer Aided Drafting (CAD). In fact, several colleges that

were early adopters of GIS were actively engaged in offering CAD programs and CAD served as a gateway to adding GIS with a sharing of hardware and computer skills. These CAD programs were generally focused on environmental management or land use (forestry) topics while those not easily transitioning to GIS were focused on design of objects such as tools in manufacturing. Another factor was that colleges do not have students pursuing advanced research to aid in teaching these programs. Another factor slowing adoption of GIS&T was access to funding sources to support the hardware and software needed to offer the technology as it emerged from research into more common use in education. Universities were more accustomed to applying for and managing grants and this helped many universities acquire the resources required to effectively use and advance GIS&T.

4.7.3 Early Adopters of GIS&T at Community Colleges

Even into the early 1990s, computers at colleges were located in computer science departments, engineering programs or a few other technology-focused programs. Often these programs included Computer Added Drafting (CAD) courses which had computers capable of running GIS software. Of the six community colleges that indicated they had a GIS program in Towson survey of 1995, only one was in a Geography Department (Red Rocks Community College). The other five listed, Forestry (Central Oregon), Agriculture (Haywood), Natural Resources (Spokane), Science and Engineering (Mesa) and Environmental Technology (Lansing). Two of the programs listed CAD software while others listed ArcInfo, MapInfo, Idrisi, AtlasGIS, ERDAS, GenaMap, GRASS and

Intergraph MGE. These institutions may be among the earliest adopters of the technology at a community college because they had access to computers or support from the local user community.

Many of faculty supporting these programs spoke about their development in presentations at national conferences such as the National Symposiums on GIS in Higher Education (GISHE '96 and '97) and abstracts from those session provide some insights. Unfortunately, few presenters submitted full papers or submitted papers to a peer reviewed journal that can be referenced to document the history of these early adopters. Personal communication with some of those involved will be used to provide examples of how GIS&T programs typically started at early adopter colleges. These examples, by no means, are meant to suggest they were the first or only such programs, and it is hoped that others will fill in the missing pieces in the future. Comments from faculty at early adopting colleges suggest that program development was aided when connected to a profession or agency that was an early adopter of GIS or there was support from the local community wishing to expand the available workforce.

Robert Welch from Lansing Community College states that his program was launched in 1986 and he believes it may be the first such program at a two year college (Welch, 2001). Welch began working on curriculum for the program in 1984 and received approval in 1985 (Welch, 2009). He was encouraged to start the program by local users including the Michigan Department of Transportation. Working with IBM on an early software program, he successfully crashed the college system when his IT person tried to install it. Welch was advised that the software "could be installed, but not to add data or do analysis as it would crash the system again." His administration was very

skeptical of starting a program due to the lack of industry requesting job applicants to have GIS and also because of the need for more hardware and software to start a program. Welch applied to Intergraph to become a Center of Excellence and was granted software (Intergraph MGE) and workstations to start a program. This innovative program has continued to grow and add courses and software and currently is focusing on Green technology. Lansing's Green program has seen a rapid growth with an increase in student applicants from 60 in 2008 to 368 in 2009.

Through the 1980s most colleges were still hampered by the problems of lack of faculty development opportunities and curriculum resources. Then, in 1988, the National Science Foundation funded the National Center for Geographic Information and Analysis (NCGIA). Part of this initiative was to enhance the quality of GIS education (Kemp, 1996). One of the outcomes was the Core Curriculum first published in 1990 by NCGIA. These materials, which were course notes on 75 topics, were also used by early adopters at community colleges.

Other colleges were becoming active, including the Community College of Southern Nevada who offered a program in a department called Computing and Information Technology in the Business and Industries Division in 1991. It was funded through the Yucca Mountain Project with support from the Clark County user community. Clark County was an early adopter of GIS technology and in 1991 unveiled its GIS system for the Clark County Assessor office (Clark County, 2009). Southern Nevada Community College taught ArcInfo on Sun Platforms using SunOS (Phalke, 2009). In 1992, Central Oregon Community College's GIS program began with a chance hall conversation between two faculty, Art Benefiel and John Schaeffer. They discovered

they were both interested in doing something with GIS (Benefiel, 2009; Schaeffer, 2009). Benefiel recounts using GeoSQL, built around AutoCad and SQL database and offering the first courses in 1993. The program benefited from having user support (Forestry Program) and faculty with backgrounds in CAD.

Few texts were available and were generally at an upper division level and did not meet the needs of most two-year college (lower division) level programs. By early 1990s, things began to change with texts, such as the *Geographic Information Systems: A Guide to the Technology* by Antenucci, et al. published in 1991 (Atenucci et al, 1991) and the first English Edition of Tor Bernhardsen's text focused at the introductory level (Berhardsen, 1999) in 1992. ESRI also began publishing laboratory books that included data and step by step exercises, including the *Getting to Know* series (3rd Edition, 1999) that helped colleges offer hands on GIS exercises without the faculty having to write every lab.

4.7.4 More Community Colleges Begin GIS Programs

By the mid-1990s, colleges were in a better position to begin teaching GIS&T as computer capability increased, new versions of software could be run on the new, more powerful computers and data access improved with better bandwidth and more sites with data (Bernhardsen, 1999). Perhaps 70 to 80 percent of students in these programs were working professionals who sought to add or update their GIS&T skills. As more community colleges became interested in GIS, there was an increase in the need to have opportunities for faculty to learn the technology well enough to begin to teach it. The

National Science Foundation (NSF) helped by funding several early initiatives to help develop curriculum and provide faculty development opportunities. In fact, the NSF funding levels for community college programs went from $7 million in 1993 to $35 million in1995, with $22 million going to Advanced Technology Education (National, 1996) which is a major source of funding for GIS related programs. Three of the grants awarded in 1995 provided significant contributions to the increased use of GIS and Global Position System (GPS) technology in community colleges.

One of these significant grants was to Indiana State University (DUE 9553694). The *GIS for the 21st Century* grant's goal was to introduce community college faculty to the principles of GIS with enough depth for the faculty to be able to start teaching the technology on their home campus (National Science Foundation, 1996). The grant proposed to provide education to 25 two-year college faculty in three week-long sessions over two consecutive summers in 1996 and 1997. University faculty provided lectures on concepts and faculty from successful community college GIS&T programs provided the technology and hands on training. Three of the community college faculty were chosen because of the programs they had already developed at their home institutions. This included two instructors from Central Oregon Community College (John Schaeffer and Art Benefiel) and one faculty member from Southern Nevada Community College (JR Peay). The grant provided funds for 25 faculty members (mainly in teams of two faculty from the same college), but more instructors wanted to attend and were allowed to if they paid for housing and transportation. Approximately 30 individuals completed the two-summer program. The length of time, the hands on training in Idrisi, ArcView 3.0, ArcInfo, AutoDesk and MapInfo, and the networking opportunities provided by working

together for 6 weeks over two summers did provide most of those attending with the skills necessary to begin to teach GIS&T. Some returned to their campuses and started programs or added courses immediately (San Bernardino Valley, Pierce Community Colleges) while others applied for and were awarded NSF grants (Houston, Hawkeye, Henry Ford Community Colleges). Still others took several years, but over a period of time most have introduced GIS&T into existing programs or create new programs. The participants continued to network after leaving Indiana and many stay in contact today. While some have retired from teaching, many are active in community college GIS&T education. This includes several individuals that are part of NSF Centers of Excellence including Mike Rudibaugh at Lakeland Community College, Terry Brase at Kirkwood Community College and the author.

In 1995, a second significant grant was awarded to the Northwest Center for Sustainable Resources (Visions for Natural Resource Education and Ecosystem Science for the 21st Century ATE DUE 9553760). This Center focused on Agriculture, Wildlife, Fisheries and Forest Management and included GIS and GPS as technology areas. GIS workshops were held for faculty, but one of the important outcomes was a DACUM for GIS Specialist. DACUM stands for Developing a Curriculum and is a facilitated process where expert workers representing a single occupation come together as a panel and define the duties and tasks, along with knowledge, skills and tools needed for that occupation (DACUM, 2009). The outcome is a DACUM chart that can be used to help suggest what should be included in a curriculum designed to provide the practical skills for that occupation.

In 1995, NSF also funded the Community College for Innovative Technology Transfer (CCIT) grant hosted by Prince George's Community College with twelve colleges linked to a local NASA Center. This early grant also helped bring faculty needed education with workshops and curriculum support that emphasized remote sensing and collaboration with NASA education outreach.

In 1996, the NCGIA supported a grant from the National Science Foundation to develop a *GIS Core Curriculum for Technical Programs* (CCTP). This web based curriculum building resource began with a meeting in Santa Barbara in August 1996 and included faculty from several of the early community college GIS&T programs. While the original NCGIA Core Curriculum grant resulted in the creation of widely used course notes on 75 topics, the CCTP did not gain as wide acceptance or volunteers to build content. It may have been that the earlier Core Curriculum was desperately needed by educators, but the later CCTP was less sought after because other texts and materials were available. It did bring educators together to talk about common needs and resources, and those conversations helped build community.

Other granting agencies including State Agencies, Department of Labor and NASA began funding grants related to GIS at two year colleges. In the summer of 1996, Joan Clemens, the Community College Affinity Group advisor for the Association of American Geographers (AAG), hosted a meeting at UCLA for community college faculty interested in GIS. At the meeting, Marshall Gartenlaub volunteered to write a grant proposal to help fund workshops to help train faculty interested in learning GIS. Gartenlaub wrote the small grant in two weeks and the California Community College Chancellors Office award the funds to start the California Community College GIS

(C3GIS.net) support network. In the next two years, more than 120 community college faculty received hands on training in GIS during four day workshops by C3GIS.

This project helped California Community Colleges get a head start in GIS&T education and today, more than half of the 110 colleges offer courses or programs related to GIS&T. In 2007 a second 18-month grant was awarded by the California Community College Chancellor's office to continue the C3GIS support network. This time C3GIS translated to California Community College Geospatial Technology Information Support and focused on providing workshops, webinars and building resources for two year programs including a website at c3gis.net.

By 1997, more than 250 community colleges across the US had access to ESRI software (Phoenix, 1997). By 1998, more than 150 listed courses, certificates and degrees (Johnson, 1998). Additional NSF and Department of Labor Grants were funded to help prepare faculty, create curriculum and develop programs. But major questions still remained and were commonly asked including:

- What department should host GIS&T courses?
- Should it be an academic program or a vocational (Career Technical Education) program?
- Should it be a course/program focused on GIS&T?
- Should it be a tool within a course in a discipline?
- Should it be focused on concepts or hands on software use?
- Should field data collection and GPS be included?
- Should remote sensing be included in GIS&T programs?
- If it is a program, should it lead to a Certificate or Associate Degree?

- What is the most effective method to teach GIS&T – a short course, distance, semester long course?
- Who is the largest audience for this type of program – current workforce, workforce looking for a new career or traditional students?
- How do faculty learn the technology and how do they keep up to date?
- How should the software be managed – within a department or by the campus IT department?

There were also questions about how to determine the need for such programs because of the lack of specific occupational codes and data from the Department of Labor for GIS&T. While some programs did focus on "software training," most included the needed concepts, but there was little consistency in the number of courses or the number of semester credits that constituted a Certificate program. Programs ranged from as few as six to more than 30 credits. There was also growing realization that teaching GIS&T needed different teaching methods than most current disciplines.

Disjointed lecture and lab sessions did not seem to work as well as integrated, short lecture with longer hands on, but this was in conflict with most college program formats with different rooms and times for lecture versus lab sessions. In 1998 the NSF funded the GIS Access Grant (Cypress College DUE ATE 9850306) which based its workshop pedagogy on Active Learning using real world data to learn GIS. By the second year of the grant, this unstructured methodology was modified to include short lectures on important concepts reinforced immediately by hands-on use of software. Evaluations from participants suggested that this revised teaching methodology aided understanding of the technology. The NSF ATE directorate continued to fund grants

related to GIS and geospatial technology including many grants awarded in the late 1990 and early 2000. A search of the NSF website for grants related to GIS and community colleges in the period from 1990 to 2001 found the following grants: Hawkeye Community College DUE ATE 953751, 1995; Henry Ford Community College DUE ATE 9752086, 1997; Alamo Community College DUE ATE 9750585, 1997; Houston Community College DUE ATE 9850344, 1998; Cypress College DUE ATE 9850306, 1998; Evergreen Valley College DUE ATE 0101576, 2001; Burlington County College, DUE HER 008634, 2001.

4.7.5 Development of GIS&T Curriculum and Programs

Two significant initiatives, which were focused more on four-year GIS&T program development, did provide help to faculty at community colleges. These were the Model Curriculum project from the University Consortium for Geographic Information Science (UCGIS) and the NASA Geospatial Workforce Development initiatives. The UCGIS identified eight Educational Challenges during its 1997 Summer Assembly and from one of the Challenges, a Model Curriculum Task Force was formed in 1998 with Duane Marble stepping forward to be Chair (DiBiase, et al, 2006). The Task Force, under Marble, issued a Strawman Report in 2003. This effort was to provide a comprehensive vision for GIS&T curricula reform at a national scale. Lack of funding lead to a slowing of progress on this initiative, but in 2005, David DiBiase was appointed chair of the Education Committee at the UCGIS. DiBiase agreed to move the Model Curriculum project forward, but due to limited funding and time constraints, the Committee agreed to

focus its efforts on creating the Body of Knowledge (BoK) for GIS&T. The BoK, published in 2006, included ten Knowledge Areas further broken down into Units, Topics and Learning Outcomes.

Overlapping in time with the initial UCGIS project, NASA in 2001funded a project to bring together workforce development specialists from the University of Southern Mississippi with representatives from professional organizations, education, business, industry and government to study the key roles and competencies needed by employees in the GIS&T industry. A significant outcome of this imitative (published in 2003) was the grouping of the identified core competencies into four categories that not only included technical and analytical competencies, but also listed the business and interpersonal competencies needed by the geospatial workforce.

While the outcomes from the BoK and NASA initiatives were helpful to community college GIS&T programs, it was felt that they were not at the level needed by two year college programs and that additional support for community college curriculum development was needed (Sullivan, et al, 2008). In fact, by 2005, few baccalaureate GIS degree programs existed and most of those are degrees in other fields with an emphasis on GIS (DiBiase, et al, 2006). Thus, university programs which typically included only upper division or graduate level courses did not provide guidance to community college lower division programs.

In 2005 a group lead by the National Council for Geographic Education (NCGE) and supported by efforts from National and Space Administration (NASA), U.S. Geological Survey (USGS) and ESRI saw the need for college to engage in teaching remote sensing. A workshop, held at NSF in 2005, supported this need (NCGE, 2006)

and a NSF ATE grant was awarded to help community college instructors learn the concepts and use of remote sensing. The Integrated Geospatial Education and Technology Training (iGETT, NSF DUE 0703185) three year grant was awarded in 2008 and provided 40 faculty (mainly community college, but also high school and university) education in remote sensing concepts and software. This successful project helped colleges expand programs to include remote sensing concepts.

Many faculty began to feel that a formal, national organization was needed to support community college GIS&T programs. This was further supported by the study done under a grant from the Department of Labor to the Association of American Geographers (AAG), the Geospatial Information & Technology Association (GITA) and the Wharton School of the University of Pennsylvania (GITA, 2006). The study's goals were to define the geospatial industry and its workforce needs. The Phase I report recommended that two year colleges play a stronger role in GIS&T education (GITA, 2006). In 2006 the National Resource Council report on *Learning to Think Spatially*, while focused on K-12 education, suggested that spatial thinking was a skill needed by everyone in the workforce (National Research Council, 2006).

4.7.6 National Geospatial Technology Center of Excellence – GeoTech Center

In the summer of 2005 a group of community college faculty met at the ESRI Education User Conference in San Diego to discuss support for GIS&T programs. This meeting led to the submission of an NSF grant proposal to research the issues important to

community colleges and define the support that a National Geospatial Technology Center (NGTC) could provide to colleges. The proposal was funded in June 2006 (NSF DUE 0603424) and a systematic process was undertaken to determine what issues were critical to the NGTC in order to support community college programs (Sullivan, 2008). Online surveys of college instructors were undertaken and the project team reviewed 10 issues and developed background materials and preliminary findings. A National Forum was held in 2007 to discuss the issue's and produce a set of draft recommendations. These recommendations were then vetted and prioritized and *A Plan for the National Coordination of Geospatial Technology Education from a Community College Perspective* (Sullivan, 2008) report prioritized a list of goals for a NGTC. Participants from the Forum began to network and discuss what steps should be taken to work collaboratively together using the outcomes from the Forum. In 2007, the results of the study were used to submit a NSF ATE grant proposal for a National Geospatial Technology Center of Excellence (GeoTech Center). This collaborative effort, lead by Del Mar College in Corpus Christi, Texas, was funded in September, 2008.

The GeoTech Center goals are to provide:

- An online repository of resources for geospatial educators including sample curriculum, articulation agreements, course notes, lessons, best practices,
- A national voice for two year colleges in geospatial technology education,
- A Core Competency Model for GIS Technicians,
- Faculty development and training opportunities,
- Networking and collaboration opportunities between colleges, schools, universities and industry, and to

- Empower colleges and help expand the geospatial workforce.

The partners now include these colleges: Del Mar, Cayuga, Central New Mexico, Central Piedmont, Gainesville State, Kentucky Community & Technical College System, Lakeland, and Southwestern and two universities, San Diego State University and The Pennsylvania State University. The partners are initially focused on providing support to community colleges that have geospatial courses, certificates and degree programs. The GeoTech Center website (geotechcenter.org) includes resources for faculty, students and industry. One of the goals is to help define or determine the Model Core Competencies for GIS&T at the technician level in order to help colleges determine what should be included in courses. This will be accomplished by carrying out new DACUMs and combining the results with other DACUMS to create a meta-DACUM. This meta-DACUM will then be vetted with GIS&T professions and further refined in a National Forum of GIS&T experts in early 2010. The outcome should be useful for community colleges wishing to start or update a GIS&T program. The GeoTech Center is also working with the Department of Labor to better define the occupational skills needed by GIS professionals. This is a work in progress at the present time but the outcome should enable colleges to better identify workforce needs and trends.

GIS&T is still not well known as a career path nor is it identified as a tool needed by many different professions. The GeoTech Center is working with its partners and other colleges to identify career pathways aligned with occupations using GIS&T as well as create resources to reach under-represented audiences.

One important goal of the Center is to be a voice for community colleges and help foster communication between college faculty, government agencies, professional

organizations, other educational institutions and the industry. The GeoTech Center will also offer ways for faculty and students to collaborate including opportunities to learn and share through webinars, instructor-lead workshops and social network sites.

A Resource Repository on the GeoTech website will provide a way for educators to find or share resources. Some of the resources on the site will include best practices for developing GIS&T programs, example course outlines, suggestions on what is needed to set up and maintain a lab facility, as well as best practices in working with an IT Department. As computers and Internet became commonplace on campuses, so did Information Technology Departments (IT). The centralization and standardization of IT practices was essential to efficiently servicing computers and Internet technology across a campus. Unfortunately, GIS&T programs have very different requirements than most users of computers on campus. This includes support for installation of software and software updates, data storage and access, student project storage, student administrative rights, Internet access and downloading of data. Colleges need the help of the GeoTech Center to work with their IT Departments for the most effective ways to set up and support GIS&T programs.

4.7.7 Future GIS&T Education at Community Colleges

The GIS&T industry continues to evolve and spread into more occupational domains. New uses of the technology and tools are also emerging that require the workforce to update their knowledge and skills. The GeoTech Center is actively working on ways to help colleges build, expand and update GIS&T programs to meet the needs of the future workforce.

The Center will help community colleges keep current with these trends and provide resources to meet their students and communities needs. Specific focus areas include:

- Providing alternative ways for students to access the needed software and data without relying on campus lab facilities and IT support,
- Providing faculty professional development opportunities through new online or web-based formats,
- Providing a one stop location for help with program development and sustainability including ongoing updates to the Geospatial Technology Competency Model and Handbook on using the Model,
- Serving as a clearing house to help colleges learn about new or emerging geospatial technology trends, and
- Keeping community colleges aware of new trends in education including those that deal with infrastructure changes or mission changes such as allowing more units to be taken at colleges that count toward four year degrees.

Many university administrators are using GIS&T for the business side of higher education. Community colleges are also beginning to use GIS&T in administration. For example, the City College of San Francisco is mapping their campus and providing access via the web and Tacoma Community College is using GIS to improve marketing and outreach.

Because career opportunities are still not widely understood, some colleges continue to struggle to build or sustain enrollments. The GeoTech Center is working on several tactics that it hopes will help colleges with recruitment and retention. One tactic is for the Center to help

colleges work more closely with local high schools to market their program and develop articulation agreements between high schools and universities. More colleges are also working to have GIS&T courses accepted for General Education as this helps bolster enrollment.

In his 1988 book *The Meaning of General Education: The Emergence of a Curriculum Paradigm*, Gary Miller defines general education as "…the conscience of higher education, the part of a university that is concerned most directly with the individual student's responsibility to society at large." If this is accepted as valid, then community colleges should promote courses that help students fulfill their responsibility to society and spatial thinking and tools for spatial analysis of complex problems may be useful. A survey undertaken by the Association of American Colleges and Universities in 2009, suggests that more colleges are turning to general education courses that emphasize integrative approaches focused on big issues such as sustainability. Again, the concepts and tools used in geospatial technology may support general education designation for some geospatial courses. When a course also qualifies as a General Education course at a university, it makes it easier to articulate that course. Southwestern College, among others, has developed courses that qualify for General Education as well as articulate with a university (San Diego State University).

Anthony Salcito, Vice President, Worldwide Education for Microsoft, in his blog on "Education Trends to Watch for in 2010" suggests that educational institutions will need to be more focused on directly connecting education programs and the workforce. He also suggests that blended learning (distance and in class), new devices and mobile technology use in the classroom and Cloud Computing will become more important. While his predications cover all education, not just community college geospatial education, in many respects, they do apply and it will be interesting to see how the

economic downturn will affect technology innovation in geospatial education as well as the effects of evaluation and accountability on program sustainability.

More students are becoming aware of spatial thinking and visualization through tools like Google Earth, but can this be extended to include more complex analysis and use in decision support? New applications and access to remote sensed data and sensor webs are also areas that need to be investigated and supported by the GeoTech Center. This includes mobile and location based services, web-based (Server) mapping and analysis, and remote sensing. New career pathways linked to Energy, Sustainability and Green need to incorporate geospatial technology. This is outlined in detail in the final report from the Forum held by the Advanced Technology Environmental and Energy Center (ATEEC.org, NSF ATE #0702439) in 2008. The report suggests that GIS Technicians or Geospatial Technicians are cross cutting knowledge and skills needed by Energy or Green related occupations.

The GeoTech Center is investigating how to best meet the needs for colleges to effectively access and use these technologies and provide the needed education for emerging career pathways. Industry is also asking for students that can work with databases and customize applications as well as include those soft skills identified by the NASA Workforce Development report. The GeoTech Center and its partners are working to provide samples, examples and models for colleges wishing to start or geospatial expand programs. The GeoTech Center's web site will also model how to use spatial analysis by providing a mapping application to identify and locate colleges with GIS&T programs.

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The importance of community college programs to help with economic recovery was reinforced by the July 24 speech by President Obama. President Obama announced a $12 billion community-college initiative to help colleges update and upgrade facilities, develop new technologies and increase graduation rates. Community colleges interested in GIS&T should be aware of this and other opportunities to help spread GIS&T education across the college campus. The GeoTech Center aims to help link colleges to funding and collaborative opportunities to effectively meet the needs of the U.S. workforce.

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