Developing and Sustaining Geospatial Programs in Community Colleges

April 1, 2018

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Based upon work supported by the National Science Foundation under Grant DUE ATE 1304591, 1644409 and 1700496. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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Abstract

An historical perspective on the use of Geographic Information Systems (GIS) and geospatial technology (GST) in industry is provided to illustrate how it impacted education focused on community college programs. The term "community college" is used as a collective term for two-year, community, technical or junior colleges. While the focus of this document is on developing community college level programs, most of the suggestions are also appropriate for four-year university programs. Key players, methods and workflows, resources needed and important factors to consider are reviewed that can be used to meet the unique GST program needs of your college and student audience. Specific resources are provided that can be used for assessing current curriculum or used for creation or expansion of GST programs. The resources include: Program Assessment Tool, Program Content Tool, and Self Assessment Tool with links to Model Courses (with lectures). These resources are based on the skills and competencies identified as important for the geospatial workforce from the Geospatial Technology Competency Model from the U.S. Department of Labor Education and Training Administration (DOL-ETA) and Meta-DACUMS complied from DACUM events held by the GeoTech Center and other educational institutions. While there are multiple possible pathways to develop or expand programs, important considerations are highlighted that should be addressed when determining the types of program that best fits the college and the needs of its student and administrative audience. Links are provided to other best practices documents created by partners of the GeoTech Center including creating articulation agreements and ways for GST courses to qualify as part of General Education requirements. Specific resources needed for different levels and uses of GST are included.

1. Historical Context and Growth of Geospatial Technology

In the last couple of decades, Geographic Information Systems (GIS) has gone from an obscure, difficult to use technology available only to graduate students with access to high end workstations to a technology that can be used by students in many disciplines at all levels of education. GIS is also the power behind many consumer products that the public has begun to rely on such as in car navigation systems and online virtual worlds. This paper will broaden the context to include not just GIS, but other geospatial technologies including remote sensing, global navigation satellite system (GNSS) including the US based global positioning system (GPS), Location Based Services (LBS) and mobile technology as well as online web mapping applications, Cloud Computing and other new or emerging technologies. For a compete discussion of the historical development of geospatial technology at community colleges see Chapter 13 of *Teaching Geographic Information Science and Technology in Higher Education* (Johnson, A., 2012).

GST is seen as a profession (GIS Certification Institute http://www.gisci.org/), an occupation (http://online.onetcenter.org/link/summary/15-1099.06), an industry (Geospatial Technology Competency Model, https://www.careeronestop.org/CompetencyModel/competency-models/geospatial-technology.aspx) and as an essential tool in many professions, such as engineering, land use planning, and surveying. The application of GST by government, business, industry and the general public in so many different ways is why there has been

such rapid growth of GST in education and why there are so many disciplines interested in using it in their program or creating specialized GST programs or departments. This growth has been aided by advances in technology including:

- lower cost, yet more powerful computer hardware
- easier access to abundant data (often free) through the Internet and Web Portals
- easier-to-use desktop and server software – lower cost and free options
- free, browser-based online software applications
- Cloud Computing options allowing thin clients to access powerful analytic tools and processes and hosting of large data sets

A definition for the industry was formulated though studies by carried out by the Association of American Geographers (AAG) and Geospatial Information & Technology Association (GITA):

> The geospatial industry acquires, integrates, manages, analyzes, maps, distributes, and uses geographic, temporal and spatial information and knowledge. The industry includes basic and applied research, technology development, education, and applications to address the planning, decision-making, and operational needs of people and organizations of all types. (Samborski, 2006)

Government is using the technology to make better, faster, more cost-effective decisions and using web-based mapping visualizations to make those decisions more transparent to the public. Utility companies, first responders, healthcare professionals, and transportation and logistics organizations are just a few of the many users of the technology (www.esri.com/industries). Campus administrators are also increasingly leveraging the power of geospatial technology for the business of education including campus mapping, facilities management, marketing and outreach, student tracking and campus security.

Because GST can be used in so many ways, it is often difficult to reach a consensus of just what department should host a GST program on a campus. In 2012, Esri (a leading developer and vendor of GIS software), included information about more than 558 GIS programs on its website. A review of the list of programs revealed just how diverse the departments were that offered GIS. While geography was the most common department (about 40%), agriculture, computer science, engineering, forestry, geology, and geomatics were just a few examples of the departments in which GIS or other geospatial technologies were listed. The GeoTech Center on its Program Finder Map (http://geotechcenter.org) includes GST hosting department information at colleges and universities. The map database also indicates that many of the programs are listed (cross-listed) in more than one department. Many departments, while not hosting a course, may also use GST as a teaching tool or use it as a tool for analysis of geospatial data within its discipline suggest that GST can be found in almost all disciplines.

While this rapid growth has presented educators with exciting challenges and opportunities, it has also added logistical, administrative, pedagogical, and curriculum demands that must be considered when implementing a program. This paper is intended to support educators,

researchers, and administrators at colleges in developing a successful and sustainable geospatial program and help spread the use of the technology across their campus. The pathways and resources were compiled from a variety of resources including conversations and recommendations from educators that have successfully developed and maintained a program and as part of Johnson's work at Esri (www.esri.com/highered) and through work with Christine Crown as part of C3GIS (a State of California Chancellors Grant). Valuable recommendations have also been from the GeoTech Center Team as part of the National Science Foundation funded grants to the National Geospatial Technology Center of Excellence (GeoTech Center, DUE ATE 0801893, 1304591, 1644409 and 1700496) and to iGETT: remote sensing (Integrated Geospatial Education and Technology Training (DUE #0703185 and #1205069). For a more detailed history of geospatial education at community colleges and other in depth papers on curriculum development and future trends, please see Teaching Geographic Information Science and Technology in Higher Education (Unwin, et al., 2012).

2. Important Factors When Developing a Geospatial Technology Program

2.1 Factors to Consider

The process of developing a geospatial program, whether it is to offer a course, certificate, degree program or the across campus use of the technology has many elements in common. Each share the need to have a "plan of action" and the necessary personnel, processes and facilities to carry out that plan for the specific audience that will benefit from that plan. Some of the elements needed to carry out a detailed plan and develop a full GST program include:

- Someone with a Vision
- Someone with Power
- A Needs Assessment
- A Resource Assessment
- Identification of student audience
- Determination of how it will be offered
- An overall Plan (Workflow, Implementation and Sustainability)
- An Advisory Committee
- Facilities (lab with needed resources and internet access)
- Hardware (computers, printers, network access, servers, field equipment, etc.)
- Software (GIS, remote sensing, MS Office, Ghost, Deep Freeze, Virtual Desktop, Course Management System, etc.)
- Data and data storage or access to Data online (Cloud)
- Infrastructure and policies allowing students to effectively access GST software, access data, store their work and access to facilities and field equipment
- IT Support (load and update software, security, backups, archives, etc.)
- Curriculum and related resources (course syllabi, curriculum, program structure, teaching materials, texts, lab manuals)
- Program marketing and outreach

- Approvals – College, department, Curriculum Committee, State, etc.
- Faculty and staff qualified and able to teach GST

Each of the above elements will be discussed with specific recommendations within the body of this paper with more details provided in Appendices to this document.

2.2 Where to Start the Process of Developing or Expanding a Program?

Most often an individual becomes interested in GST. They begin investigating what is needed and what other colleges are doing. They begin finding like-minded other individuals at the college that might support or be interested in GST. At that point, the initial GST advisory group may start a more formal process. The information in this paper is meant as a guide to the process pathway and provide details about what might be needed, what factors should be investigated and what resources there are that can help in starting or expanding a program. Our advice is to "start slow and THINK BIG." That is, test the water with a module, but have in mind a longer-term plan to investigate the needs, resources and timeline needed for a stand-a-lone course to a full program. The influence of GST on college courses is incremental. A surging thrust of ambition at the beginning can be lost when there is not a corresponding acceptance by disciplines, college administrators or students taking the courses. Because community colleges conduct their business through committees, the influence of GST needs to be a gradual, studied campaign that embraces college instruction needs and is supported by faculty including marketing to attract students. A steady conversion of potential GST adopters within the college will facilitate the studied discussions that lead to supportive administrative, budgetary and implementation decisions.

2.3 The Vision

Most programs start with a person that has a vision of what they want to do with GST and may or may not include other geospatial technologies at their institution. This visionary may be inspired by what they see in the workplace or in their discipline that leads them to believe that this technology is essential for their students to be able to understand and use for success – either in a course or a career. These visionaries are also often "lifelong learners" themselves and not only see the tremendous potential for GST, but also find learning to use the technology as an interesting and rewarding challenge. If their vision is just to add a module to a course, the needed resources and challenges may be minor and accomplished without too much difficulty – as long as they have ready access to computers, the Web and materials (lesson, data, software). If their vision is to start a new course or program, they will need many more resources and processes in place. The vision needs to be supported by a clear statement of vision and an implementation plan to make the vision a reality.

2.4 The Power

While the visionary may be able to put many of the needed resources in place for a module or even a course, they must have someone that shares their vision and has the power on campus to make it happen if they want to develop a full program. Generally, the "power" person needs to see the value of the technology and become an advocate for the geospatial program development. Most often this person is not interested in learning the technology themselves or dealing with the details of curriculum development and teaching within a program but are

enablers that have access to resources including funding, facilities and curriculum development support. They are an important force to help support new and growing programs as well as provide continuing support to expand programs across a campus. One suggestion is to create GST projects that help administrators accomplish their goals. Some of this can be maps of the campus, student demographics, and emergency planning maps.

2.5 Which Approach – Top Down or Bottom Up?

Sometimes the visionary is not a faculty member, but an administrator who has heard about GST and wants a program to be included in their college, division or department. This is often referred to as a "Top Down" approach whereby they (administrators) recommend and support setting up a program and the faculty in their school or department are directed to learn to use the technology, create the program and offer the new program.

Sometimes it is a faculty member who hears about the technology and its use in their field or discipline, wants to learn to use and teach (or teach using) the technology in their courses and continues to promote it on campus. This is a "Bottom Up" approach where the faculty member is the visionary and takes on the tasks to build a program and works to get approval from the administration.

The easiest approach for success is a two pronged approach – a visionary from the faculty who wants to learn and incorporate the technology and a person with power and funding (the administrator) who sees the value and bigger picture of promoting the technology. This team then works together to form a larger "advisory committee" and carry out the other tasks to put a program in place.

2.6 Understanding the Student Audience

For community colleges, the student audience is quite varied in age, background or motivation for taking geospatial technology courses and include students that are:

- seeking a two-year terminal degree – with or without a specific domain (discipline) focus,
- seeking a two-year degree that meets the requirement to transfer to a four-year university,
- currently employed, but needing specific competencies to continue in or advance in their current occupation,
- seeking additional competencies to start a new career, or
- currently unemployed and seeking new skills to find employment.

This varied student audience must be addressed so that the program can attract and serve the widest possible range of audience needs. Some issues that should be understood include the fact that many students interested in geospatial technology may already have a degree and do not need another degree. They may have domain expertise (i.e., are geologists, surveyors, engineer, etc.), but need to update or add skills and competencies to enter or advance in their current field or position. If your college rates program success based on student completion rates, these highly successful geospatial worker students may hurt your completion rate unless you set up other metrics for success that track these students who do not want or need

a degree. It should also be noted that most traditional college students are not aware of GTS or what careers can benefit from acquiring those competencies. This lack of awareness can be a problem when trying to build programs with sufficient numbers of students. Marketing of programs to address this lack of awareness is important.

2.7 Format of Course Offerings

Will courses be offered in a traditional format with on campus face to face (F2F) lectures one day a week and labs as a longer time block or in an integrated F2F lecture and lab format, or completely online or hybrid (components that are F2F and online) format? Should offering be offered as short (8 week or less) offerings or traditional college course length. It may be that one format is offered at the start of a program with a long-term plan to include more of these other optional formats?

2.7.1 Online courses and programs

More community colleges are adding online offerings either as the only option for GST programs or as an additional option to on-campus programs. Colleges are also offering hybrid or flipped options for courses with lectures generally available online and labs taken on campus. Whether completely online, or a hybrid format, additional software will generally be needed including course management systems and methods to provide student access to software and data. In addition, faculty need to not only have expertise in their discipline and GST, but also online program development, delivery and management. See also Appendix B GST Facility Requirements for more details on this topic.

2.7.2 What type of department hosts the program?

The department where a program is hosted at a community college also varies. Programs may be part of an academic disciplines, while others are in Career and Technical Education (CTE) departments and some programs are part of both academic and CTE. Where a program is located can define who can teach in the program, whether credits students earn can be transferred to four-year programs and what type of Certificates and Degrees are offered. One option that can work, is to host it in the Library. This department is used to addressing the needs of different disciplines and may help spread GST across a campus. For more details about this topic, see the Special Education issue of the URISA Journal, Vol. 22, No. 2, article titled: Spatial Education at U.S. Community Colleges: Background Challenges and Opportunities which can be downloaded from URISA (Johnson, 2010).

2.8 Industry Support

A valuable source of support for program development or expansion is the local geospatial user community. Formation of an Advisory Committee that includes strong industry representatives should be begun early in the planning stage. Programs focused on teaching GST have the potential to produce students with skills and competencies that enhance their value to the local GST industry. Thus, employers in the region can be very helpful in providing information on a Needs Assessment to justify development, sustainability or expansion of geospatial programs. If business and industry participate in the program formulation and help guide program development, college administration and college staff

can have confidence that what they are doing within the GST offerings meets industry needs and students will be prepared to enter the GST workforce. The Advisory Committee industry members can also provide other resources including: data and technical expertise, help students find Internship opportunities, and suggest real-world problems for use as capstone projects. In some regions, the Committee can also provide critical resources (adjunct faculty, expensive specialized equipment, expertise in a domain) as well as helping acquire financial aid to the college GST program.

2.9 Administrative Use of GST

While some colleges are using GST related to administration of institutions, many colleges still make little use of its in-house geospatial technology expertise. This aspect of geospatial use on campus is changing rapidly with the awareness created by free, browser-based applications such as Google Earth, ArcGIS Online and other website data portals and interactive maps used by cities, states and federal agencies. Use of the technology for managing the business of the campus can provide many benefits to administrators and to faculty offering GST programs. Some applications and benefits:

- For Administration:
    - Campus mapping including use for managing facilities, building, classroom utilization, directions for visitors to campus, routing for students with disabilities;
    - Campus Safety, emergency management, incident reporting and tracking;
    - Identification and allocation of funding and resources to target marketing for student recruitment and retention;
- For GST Programs
    - Administrative funding to help programs cover the cost of software, hardware and data to offset departmental GST program funding;
    - Providing real-world applications of GST use for student capstone projects.

3. Planning Phase

A well carried out planning phase is vital to the ultimate success of a GST program. The planning phase should include a Needs Assessment and Resource Assessment that clearly defines the program goals and objectives as well as identifies the existing resources and overall college infrastructure and support for a geospatial program. The plan should include methods for creating awareness of the new program as well as a timeline for accomplishing the stated goals and objectives. It should also clearly identify the costs and benefits of the program to encourage those with the needed funding sources to allocate those funds. A Logic Model can be useful to organize the workflow with needed Inputs and Activities to produce the Outputs and short to long term Outcomes in a simple to understand, one-page format.

3.1 Organizing the Workflow

A Logic Model displays the sequence of inputs, activities and outputs that can lead to the desired short- to long-term outcomes. Figure 1 is a template for creating a Logic Model for a National Science Foundation Advanced Technology Education (NSF ATE) grant. While this

would have to be modified for a Plan and Time Line for starting a program, it does include useful information for creating your own Logic Model (NSF ATE: http://evalu-ate.org/app/webroot/files/uploads/logic_model_template.ppt).

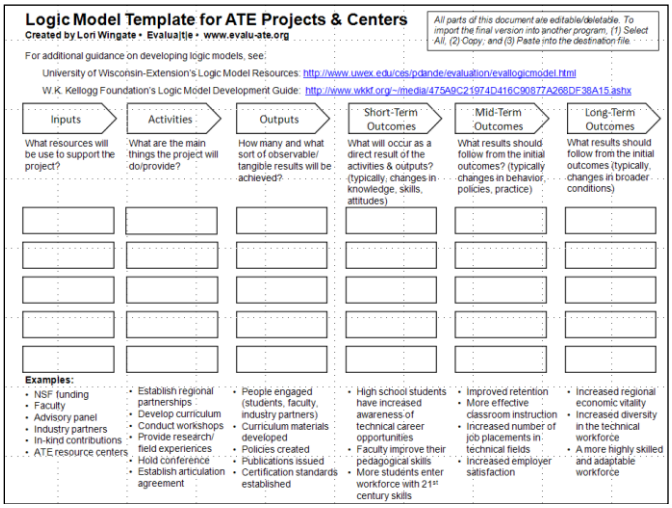

Figure 1 – Logic Model Template

Figure 2 is an example of a GST Program Development Logic Model which should be modified to fit the needs and requirements of the specific community college. This example assumes that Short-Term Outcomes will be achieved in one to two years, Mid-Term in two to five years and Long-Term in more than 5 years.

Figure 2 – An Example GST Program Development Logic Model

Mission: provide a plan for developing, sustaining and expanding Geospatial Technology programs at community colleges.

Inputs	Activities	Outputs	Short-Term Outcomes	Mid-Term Outcomes	Long-Term Outcomes
Research on funding sources (college or grants) needed for hardware/software/ faculties	Organize & convene Advisory Committees	A Planning Phase documents including Needs/Resources	Active Advisory Committees supporting program	Advisory Committee Active & new members added	GST included in multiple disciplines
Power – an enabler	Carry out Needs Assessment	Goals, Objectives and Timeline	Needs & Resource Assessment Complete	Degree Program started	GST commonly used by FM & administration
Visionary (faculty, staff or administrator)	Carry out Resource Assessment	Curriculum for Program	Course(s) Approved by Curriculum Committee	Facilities Management using GST	Students able to transfer course work universities
Program Advisory Committee: academic/CTE faculty, and administrators, IT staff, grants office	Create Goals, Objective & Timetable	Plans for hardware, software & facilities identified	Certificate in Approval process	Administration using GST	GST Center under consideration
IT Staff	Create an Implementation Plan	Implementation Plan written	Lab set up with IT support in place	Student Interns sought after by industry	
Academic Curriculum Committee	Define Curriculum for program	Funding sources identified	Implementation Plan in place	Two Articulation agreements in place	
Industry Advisory Committee	Create & analyze marketing and outreach for program	Documents to support program outreach	Administration & Facilities aware of GST use on campus	Gateway course approved as GE	
GeoTech Center mentor(s)	Identify funding sources	Documents and support to help sustain program	Sustainability methods in development	Awarded funding to help sustain program	
	Research articulation agreements		Funding sources identified & requests or grants in progress		
	Research inclusion as GE course				

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3.2 Establishing Goals and Objectives

The goals and objectives of the program will dictate the extent of the Needs Assessment. If the initial goal is limited to using geospatial technology as part of an existing course, then planning may be carried out more informally by the instructor wishing to add the technology. If the goal is to establish a long term plan with the objective of creating courses, certificate or degree programs, then the Needs Assessment and Resource Assessment should be more extensive. A Needs Assessment can help foster cooperation and communication among departments toward a set of common goals and link current programs to future campus wide activities. In addition, it serves as a learning tool for potential users by describing what geospatial technology is and how it can benefit their department. Without a complete Resource Assessment process, it is possible that individual departments might already be using the technology without others on campus being aware of the program or its resources.

3.3 Adding a Module to an Existing Course

If the goal is to add a module to an existing course the Needs Assessment and Resource Assessment may be combined into one document. It may be as simple as learning what type of software, hardware, data and teaching resources (exercises and lessons) may already be available on campus and adding the activity to the course syllabi. A primary consideration is whether the module will be limited to a discussion and demonstration of geospatial technology or actual hands on use. If it is to be a hands-on activity, then access to hardware (computers or smart phones) and the Internet will be required. Software options include free, browser-based applications, or free software that must be downloaded and installed, or software that must be purchased and installed in a laboratory or accessible using a remote desktop application. If the long-term goal is to set up a full course or program, it may be that this initial offering uses simple awareness techniques which can lead to more advanced software use in the future. Several free options exist for browser-based modules such as Google Earth, ArcGIS Online, Bing Maps and other web-based interactive maps. The GeoTech Center has developed an awareness-level Model Course, GEO 100 Exploring Our World Fundamental of Geospatial Science with lectures and other resources available on its website (www.geotechcenter.org). This course has been highly successful in that it:

- Has qualified as a General Education course in several topical areas;
- Increases spatial thinking of students and awareness of GST use and career options;
- Can serve as a feeder course into a full GST Certificate program;
- May help increase diversity in GST programs;
- Can be offered as a traditional on campus or as an online course;

See Appendix A and B for more information about what resources (hardware, software and data) are needed for an awareness course.

3.4 Adding a Course, Certificate, or Degree Program

An initial step for a more extensive program should include the formation of an Advisory Committee. This should be a task of the individuals providing the vision and power to develop a new program. An Advisory Committee can include representatives from the college, local government agencies, school systems; industry and business that help provide a broad perspective on the goals for a geospatial program as well as what is needed to

effectively offer such a program. This is particularly important if the primary audience is the local user community or graduates of the college that wish to stay in the region surrounding the college. Other subcommittees may need to be formed from time to time to deal with specific tasks. One of these may be a "technical committee" that has specific expertise in technical aspects of the program while another committee may be formed that specifically addresses curriculum needs. Some of the responsibilities and decisions the Advisory Committee can assist with include:

- Identifying the goals and objectives of the program
    - Include how courses/program might be offered (on campus, online, hybrid)
- Present a seminar about GST to faculty and administration. In the seminar, introduce GST and demonstrate how it is useful in most disciplines and for the business of running a campus. Include ways it can be implemented, highlight what students can learn and how it fits into the skills needed in the business world. Enlist speakers from industry and other educational institutions to help your faculty and administration understand the value of GST.
- Assist in carrying out a Needs Assessment
    - Determine program needs (facilities, hardware, staff, software, data);
    - Determine what faculty professional development is needed to prepare faculty to teach the courses;
    - Determine local user needs for geospatial training;
    - Determining what other programs at other educational institutions may impact (compete with) the program
- Assist in carrying out a Resource Assessment
    - Determine what resources are currently available at the institution
        - Including what equipment and facilities may already exist
    - Determine what faculty and support staff may already exist
    - Determine available funding and possible grants may be available
- Helping to designing curriculum to meet identified needs of the local users based on the Model Courses and Certificate using the Assessment and Program Content Tools from the GeoTech Center (see Appendix A);
- Maintaining a realistic timetable and tracking completions of tasks and goals
- Developing an advertising and marketing campaign to create student awareness of the program and attract students
- Helping identify funding and possible grants to support the program
- Supporting the creation of a coordinator or manager to oversee the program or GST Center including coordination between full and adjunct faculty.

Members of the Advisory Committee should rotate every two to three years to include representatives from other local businesses, industries, educational institutions (such as 4-year transfer universities), and government agencies as well as representatives from different campus departments and administrative units. This will generate new energy, enthusiasm, and ideas for long-term success of the GST program. Alternatively, a larger advisory (10-12) committee will allow for longer tenure and a more varied input from government, private industry and education (4-year transfer universities). The Advisory Committee should include recent graduates of similar programs to understand how the college preparation

influenced their career pathway. This helps insure the direction of the program is grounded in functional performance.

3.5 The Needs Assessment

A thorough Needs Assessment should be conducted. As described in this document, the Needs Assessment provides not only the justification for starting a program and identifies the audience, but also includes identifying what resources are required. The Needs Assessment should address the following question:

What are the program's mission, goals, and objectives?

- Will the program offer modules within courses, courses within existing degree programs, a certificate or degree program, or a mix of these offerings?
- What department or disciple will host the program, or will it be cross-listed by more than one discipline.
- Will it be only an academic or CTE program or be qualified in both,
- Will the courses/program include only on campus or online offerings or will both formats or hybrid formats be included.
- Who are the potential audiences for the program - traditional or working professionals, or high school students (dual credit),
- Will there is be a dedicated geospatial lab facility?
  - Who should be the manager of the facility?
  - How will lab setup, development and support be handled for the lab?
  - What equipment will be needed (printers, plotters, computers, servers, GPS, cameras, see Appendix B)?
  - Is lab furniture adequate and appropriate (See Appendix B);
  - How will consumables be replenished (paper, ink, etc.) – who pays for these?
  - How will software, computer, and facility security be provided?
  - Will a Center or lab facility be open or restricted to particular users at set times?
  - What kind of server is available for the lab? Will faculty have administrative access?
  - How will the use of the Internet, data downloads, application customization and student/faculty project storage be handled?
- If the program must share a lab facility, how will access and scheduling of courses be handled, what is the compatibility of software programs for the different offerings held in the shared facility and how will data access and student project storage be accommodated?
- If a separate Center or facility is set up, how will it be managed and funded?
  - How will software and hardware upgrades and maintenance be managed and funded?
  - When, how and who will upgrade software?
- While initial programs may not need a centralized and shared database, how will a central database for data and student projects be developed and managed?
  - How will it be protected?

    - How will users access it and how will it be updated and maintained?
    - Will firewalls and security limit ability to access or save data and projects?
- What type of technical support exists on campus and how will technical support be provided to the Center, dedicated lab facility or shared lab?
- What type of course management system, computer backup and clean up software or virtual desktop software can be or must be used?
- If it is an online program, how will students access software, data and lectures? Is there a cloud data storage option available? Is there software for virtual desktop use by students available? What type of firewall does the college use and will it interfere with the use of the virtual desktop users off campus
- Market analysis to determine:
    - Is there a need for this type of program?
    - What other programs in the region may offer support or compete for students?
    - What academic programs on campus could be using geospatial technology;
    - What administrative activities could benefit from the use of geospatial technology.

3.6 The Resource Assessment

Often, faculty do not know what resources may already be available, or what programs using GST already exist on campus. Other departments may have acquired hardware, software or other resources that they may or may not be willing to share. The Needs Assessment determines if a program is needed or for programs that are already established, if there is a need to continue the program or to modify it. It identifies what is required for a program. The Resource Assessment identifies what resources the college already has in place to support a geospatial program. Combining outcomes from the Needs and Resource Assessment will help identify what may need to be acquired or what process needs to be developed in order to offer a program. The Resource Assessment should determine:

- What courses or programs on campus may already have or use geospatial technology;
- What facilities (rooms, labs, etc) are already available;
- What hardware already exists and is it adequate for use in a geospatial program;
- What software may be available and what is the cost to access that software;
- What IT support may already be in place;
- What curriculum exists that may be used to support geospatial technology;
- What administrative tasks are already using GST or could use geospatial technology more effectively;
- What kind of database is being used on campus and how can a new program use that resources (i.e., Oracle or RDBM software); and
- What rules and policies exist for student access and use of computer facilities on campus and what modification may be needed for a GST program?

3.7 College Curriculum Development Policies and Resource Needs:

The college will have specific steps that must be followed if a new course or program is to be created. The Advisory Committee should be informed as to the rules and policies regarding starting a new course or program and follow the guidelines so that all steps are completed in a timely manner. In a multi-campus college district, there may also be policies about program content and offerings that must be followed. Another consideration is whether the course or program will be housed in an academic or Career and Technical Education (CTE) or a combination of the two types of programs. This may impact the requirements for faculty and staff education and qualifications as well as the number of hours or credits needed for a certificate program. There may also be State rules, policies and requirements for creating courses, Certificates or Degree programs that should be understood and followed if necessary. The answers to these questions will impact the goals for the program and the physical design, priorities, and access policies of the GST facility.

3.8 Other Important Considerations

3.8.1 Course Scheduling

For example, if courses or a certificate program is offered that attracts working professionals, there may be a need for evening offerings as opposed to a program offered only during the day that servers on-campus traditional students. If the college requires lectures to be in one timeframe (i.e., 55 minutes, 2 or three times a week for day classes or longer periods once a week for night courses), and Laboratory times are separated into larger blocks (once a week for 3 hours), this must also be a understood and taken into consideration when developing courses. For GST courses and programs, it may benefit student learning to intersperse lectures, demonstrations and hands-on activities without the need to move back and forth between a class room set up and a computer lab or have separate lecture and lab time blocks. For faculty, the course load values for lectures and labs must also be taken into consideration.

3.8.2 Lab and classroom set up

The physical layout of the lab facility must take into consideration the type of use of the facility. If it is primarily a GST teaching lab, desk and computer arrangement must consider the line of sight and distance from the projection screen for students and instructors to view computer demonstrations with methods to regulate lighting and noise levels. Often student projects require desktop space to allow for paper maps or other resources to be easily accessed. Narrow isles between computer rows and electrical outlets can also be a hazard for students and faculty. If the facility is to be multipurpose room where many different activities and groups will be using the lab, the flexibility to reconfigure the lab to meet varying needs or have adequate desks or conference tables within a lab may be advisable. A multipurpose facility will also require more security for software, data and lab hardware if it is also used for Open Lab use. See also Appendix B GST Facility Requirements for more details on this topic.

3.9 Data and Database Planning

GST is highly dependent on data accessibility and storage. While a central data repository is not needed for modules or initial course offerings, it does become important as programs increase in size, spread across campus or are used for administrative purposes. A GST center or lab facility must include a plan for securing, maintaining, managing data and archiving data with different requirements for data used in teaching, research projects or administrative purposes. This is also vitally important for the administrative use of GST where student or other sensitive data is stored or analyzed. A survey should be performed to analyze and inventory available data and to identify potential sources and uses of data. A master data list should then be compiled, and a Data Administrator appointed with the task of developing and enforcing the GST database rules and policies. As data needs and sources are identified and acquired, expansion of the database becomes an important consideration. Be sure to plan for expansion with adequate server (or cloud) storage space including required timely backups and strategies to protect the security of the databases.

3.10 Developing Support for GST

It is a wise investment of time to establish campus-wide support for GST to ensure the long-term success of a program. In many public and private institutions, financial support for start-up costs is available via interdepartmental grants or grants from state or federal agencies. These grants are helpful for short-term benefits, but without longer-term support facilities may become dated and as technology advances. If at all possible, obtain a financial commitment from the administration by clearly identifying the benefits and sources of revenue that can be obtained from developing the GST program. Securing annual line-item budget support from the college would be the ideal situation, rather than a department by department budget request. If the facility is expected to become self-supporting, strategies for creating revenue should be carefully evaluated especially in regard to software license restrictions for commercial purposes. It should be noted that some software has restrictions on its use for administrative projects.

In all cases, attempts should be made to familiarize deans, department chairs, and other administrators with GST and the benefits it brings to the campus. Tours of the facility, software demonstrations, and mini workshops to give administrators a chance to use the facility first hand can help achieve this goal. As a program grows, having the GST lab serve as the campus mapping center with students actively involved in creation and maintenance of this resource including a web site for the campus can provide added support for funding of the facility. If the facility is intended to be used by various departments, there must be a fair distribution of financial support that is contributed by each participating department. However, the management and oversight of the process should be clearly defined to avoid conflicts that can be counter to the spread of geospatial technology across a campus. This very difficult and time-consuming process for cost recovery can be eliminated if financial support can come from the institution's administrative body rather than multiple or single academic departments. On some campuses, the funding is available through student fees that support software and IT or are part of the library system which is supported centrally by the campus. Housing the GST center as part of the library system has many advantages and has

been successful for many long term, successful GST programs. See also the section below on Sustainability for additional recommendations.

3.11 Program Funding

Assuming there is a positive consensus among college administration and faculty from one or more departments in establishing a GIS program, the next major step is securing the necessary funds to purchase and needed equipment, software, and support personnel. Both internal and external sources of funding should be explored. Internal funding may be available through college grants, capital equipment funds, or laboratory fees. External funding can be obtained through private and federal grants, contracts, and donations. Sharing resources (lab facilities, hardware, software and IT support) with other departments and disciplines (computer science, information technology, graphic design) can help defer some funding needs as you launch a program. For community colleges, the National Science Foundation (NSF) has several programs that support development of programs. These can be discipline specific (such as Geoscience, Biology, Healthcare), or for community colleges the Advanced Technology Education program offers several funding pathways including mentoring to help develop new programs at institutions that have not had NSF funding in the recent past.

3.12 Market Analysis Within and Outside the College

Prior to establishing your GST program, it is important to conduct a benchmark analysis of your competition both within and outside the college, including documenting the need for such a program. As to competition, it is important to determine who will be potential users and if there is a competing program. Oftentimes developing a close relationship or collaboration with other programs may enhance your program and benefit students and defuse any problems regarding competition. Some questions that should be addressed include:

- Are there other departments on campus with GST facilities?
- How many individual groups are using GST?
- What other disciplines and departments can benefit from a GST facility?
- Are there any local or regional colleges or universities that have established GST programs?
- What are their goals?
- Who are their users?
- What kinds of distance education programs (at your institution or other institutions) may aid or compete with your program?

To analyze the need for such a facility or program, supporting documentation should be gathered that includes any local, regional, or national workforce needs including job descriptions, salary surveys, or other documentation from a GST-related professional organization that demonstrates the need for education or training in GST. Many of these resources or links to resources can be found on the GeoTech Center web site (http://geotechcenter.org).

4. GST Curriculum

What to teach and how to teach it are two important questions that must be addressed. The specific answers also depend on the outcomes from other sections in this document including the Needs and Resource Assessments and Planning Phase. Here again, it depends on the goal of the plan. If it is just adding a module to an existing course the topics to be covered will often be dictated by the host course and discipline. If it is a "gateway" course that provides students with an awareness of the technology and leads them to take additional GST courses, the content may be focused on helping students develop spatial thinking skills (see Appendix A). If it is to serve students that are preparing for a GST career or use of GST in their chosen profession or are working professionals seeking new or updated GST, the curriculum should include skills and competencies that address workforce needs.

While there have been many efforts to provide guidance on content for GST programs, in July, 2010 that the Department of Labor (DOL) approved a Geospatial Technology Competency Model (GTCM) (Johnson, A., 2010). The GTCM was built upon the work of earlier efforts and provides a detailed structure that outlines the full set of skills and competencies needed by the GST industry (http://www.careeronestop.org/competencymodel/pyramid.aspx?GEO=Y). The GTCM does not specify the specific skills needed by any one level or GST occupation. The GTCM has been updated in 2014 and is undergoing updating again by the GeoTech Center in 2018.

The GeoTech Center in support of community college GST programs, must focus on entry level (Technician/Technologist) GST occupations. To define the workforce needs for these entry level occupations, GeoTech carried out multiple DACUM events for GIS and Remote Sensing Technicians. DACUM stands for Developing A Curriculum and is a formal job analysis technique which brings together expert workers to describe or define the duties and tasks required by their jobs or occupations. Outcomes from multiple DACUM events by other institutions and the GeoTech were combined into a Meta-DACUM document by John Johnson (Johnson, J., 2010). A full discussion of development of the Meta-DACUM is included in a Special Education issue of the URISA Journal, Vol. 22, No. 2, which can be downloaded from URISA at http://urisa.org/urisajournal. Additional DACUMs related to GST have been undertaken and are scheduled for 2018 and 2019. These new DACUM event outputs will be used to update the Meta-DACUM and other curriculum development tools (Program Assessment, Program Content and Self Assessment Tools) in 2019. The Meta-DACUM chart is available from the GeoTech Center website.

4.1 Model Courses and Certificate – Development Methods and Tools

The Meta-DACUM from 2010 and its update in 2014 provided a set of skills and competencies needed by an entry-level GST workforce. Discussions and surveys of industry users by the GeoTech Team also suggested that programs include real world problem solving (critical thinking) opportunities as capstone projects and an internship as part of the Certificate requirements. The resulting list of skills and competencies were reviewed, and redundancies combined, to create more than 315 skills and competencies identified as needed for entry-level GST occupations. This list of competencies was stored in an Excel

Workbook. Multiple events are described below that resulted in the creation of three Tools based on the competencies in the spreadsheet: (1) a Program Assessment Tool; (2) a Program Content Tool and (3) a Self Assessment Tool.

4.1.2 Process and Activities to Create the Content of the Tools

The GeoTech Center enlisted more that 60 expert GST faculty to determine what model courses would need to be created and what courses would be included in a model certificate to meet the industry needs identified by the skills and competencies listed in the spreadsheet. Panels of educators, each made up of approximately 15 faculty from across the USA, met via webinars and face-to-face meetings. The Panels used the Program Content Tool to define what Model Courses should be created and then rank how each of the competencies should be covered in each of the Model Courses. Each Draft Model Course included:

1. Course title;
2. Description of the course content,
3. Student Learning Outcomes; and
4. A ranking for each competency indicating how that competency should or should not be included in the course.

The depth ranking by each Panel member gave each competency a value based on a scale from 0 to 4 for each Model Course. Figure 3 shows the value and its description.

0	**Not important for this course - do not include in this course**
1	**Slightly important for this course, include only if time permits:** Representative Activities: discussed as part of a lecture or reading assignment; <1 class
2	**Important - include at an awareness level** Representative Activities: Dedicated lecture and/or writing assignment; test questions; 1 or more classes
3	**Very Important; should be included at some level above awareness** Representative Activities: Scripted practical project; test working problems or essay; 1 week or more
4	**Critically important, must be included in depth** Representative Activities: Open-ended project or integration into larger project; research paper or defense; 2 weeks or more

Figure 3: Scale Values for Ranking Competency Inclusion

The ranking scores by the panel members were combined to provide an average ranking and variance for each competency in the course to help determine if it should or should not be included in the course. During the face-to-face meeting, panel members reviewed and

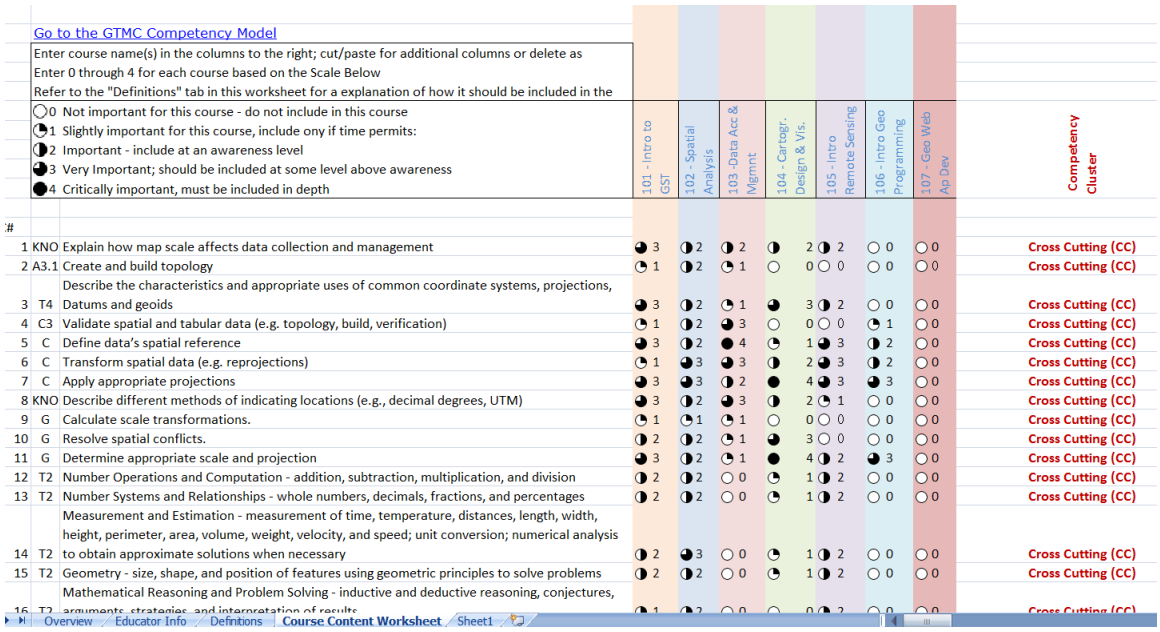
debated each of the above factors to create a model course. The outcome from the panels for each course was then published for public comment. Comments were then reviewed, and revisions incorporated and "Model Courses" developed that included Model Course outlines, example syllabus, and evaluation rubrics.

The Draft Model Course Outlines were again reviewed at a workshop in May, 2012, in Atlanta prior to the Spatial Plexus conference by approximately 30 faculty from around the USA. Faculty (primarily from two year colleges) reviewed each Draft Model Course and debated the title, description, SLO's and competencies and discussed which Model Courses should be included in the Model Certificate. The recommendations were reviewed and finalized by the GeoTech Team.

The competencies were then regrouped under 12 Competency Clusters in order to facility ease of use in developing curriculum and teaching resources. The 12 Competency Clusters are:

- Cross Cutting
- Conceptual Foundations
- Cartography and Visualization
- Generate Data
- Manage Data
- Programming and Application Design
- Project Management
- Professionalism
- Remote Sensing
- Spatial Analysis and Modeling
- Surveying
- Server and Web

The final Program Content Tool (See Figure 4 for the first page of the Content Worksheet Tab), includes an Overview, Description and Course Content Worksheet tabs.



Go to the GTMC Competency Model

Enter course name(s) in the columns to the right; cut/paste for additional columns or delete as
Enter 0 through 4 for each course based on the Scale Below
Refer to the "Definitions" tab in this worksheet for a explanation of how it should be included in the

0 Not important for this course - do not include in this course
1 Slightly important for this course, include ony if time permits:
2 Important - include at an awareness level
3 Very Important; should be included at some level above awareness
4 Critically important, must be included in depth

#			101 - Intro to GST	102 - Spatial Analysis	103 -Data Acc & Mgmnt	104 - Cartogr. Design & Vis.	105 - Intro Remote Sensing	106 - Intro Geo Programming	107 - Geo Web Ap Dev	Competency Cluster
1	KNO	Explain how map scale affects data collection and management	3	2	2		2	2	0	0	Cross Cutting (CC)
2	A3.1	Create and build topology	1	2	1		0	0	0	0	Cross Cutting (CC)
3	T4	Describe the characteristics and appropriate uses of common coordinate systems, projections, Datums and geoids	3	2	1		3	2	0	0	Cross Cutting (CC)
4	C3	Validate spatial and tabular data (e.g. topology, build, verification)	1	2	3		0	0	1	0	Cross Cutting (CC)
5	C	Define data's spatial reference	3	2	4		1	3	2	0	Cross Cutting (CC)
6	C	Transform spatial data (e.g. reprojections)	1	3	3		2	3	2	0	Cross Cutting (CC)
7	C	Apply appropriate projections	3	3	2		4	3	3	0	Cross Cutting (CC)
8	KNO	Describe different methods of indicating locations (e.g., decimal degrees, UTM)	3	2	3		2	1	0	0	Cross Cutting (CC)
9	G	Calculate scale transformations.	1	1	1		0	0	0	0	Cross Cutting (CC)
10	G	Resolve spatial conflicts.	2	2	1		3	0	0	0	Cross Cutting (CC)
11	G	Determine appropriate scale and projection	3	2	1		4	2	3	0	Cross Cutting (CC)
12	T2	Number Operations and Computation - addition, subtraction, multiplication, and division	2	2	0		1	2	0	0	Cross Cutting (CC)
13	T2	Number Systems and Relationships - whole numbers, decimals, fractions, and percentages	2	2	0		1	2	0	0	Cross Cutting (CC)
14	T2	Measurement and Estimation - measurement of time, temperature, distances, length, width, height, perimeter, area, volume, weight, velocity, and speed; unit conversion; numerical analysis to obtain approximate solutions when necessary	2	3	0		1	2	0	0	Cross Cutting (CC)
15	T2	Geometry - size, shape, and position of features using geometric principles to solve problems	2	2	0		1	2	0	0	Cross Cutting (CC)
16	T2	Mathematical Reasoning and Problem Solving - inductive and deductive reasoning, conjectures, arguments, strategies, and interpretation of results	1	2	0		0	2	0	0	Cross Cutting (CC)

Overview | Educator Info | Definitions | Course Content Worksheet | Sheet1

Figure 4. Model Courses and Program Content Tool

More than 500 educators from community colleges and universities have downloaded the documents and continue to make recommendations for improvements. The competencies have been cross-walked to the UCGIS original Bode of Knowledge (BoK) Knowledge Areas (KA), the 2014 updated Meta-DACUM and the GTCM. The GeoTech Center used the Program Content Tool to develop Model Courses that include full lectures and other resources that can be downloaded from its website. The courses have undergone continuous updates and will be reviewed again after the GTCM and Meta-DACUM are updated in 2018-19. The GeoTech Center will also add additional new elective courses. It should be understood that these are models for courses and certificate and should be adapted and modified for local program needs with attribution given to GeoTech.

The Program Assessment Tool and Self Assessment Tool Excel worksheets contain the same listing of competencies. The Program Assessment Tool can be used to review a current program and determine the programs focus as well as identify any competency gaps. The Self Assessment Tool can be used by any individual (faculty, student, GST professional) to assess their GST Knowledge. Appendix A includes descriptions and links to the filled in Program Content Tool and a blank Program Assessment Tool, a Self Assessment Tool. Links are also provided to each Model Course from the GeoTech Center website.

4.2 Creating A Model Certificate

An article in the Inside Higher Education online journal (http://www.insidehighered.com/news/2010/12/07/certificate) reported on a study that suggests industry finds certificate programs of moderate (longer-term) length (one year of study) are most effective in providing the workforce with the needed depth, rigor and breath than shorter-term programs. The faculty suggested that in order to cover all of the

competencies that the Model Certificate should include at least four core courses and 4 electives with a unit total between 27 and 30 units. There was much discussion and debate on whether Cartography or Remote Sensing should be part of the recommended core courses. A study carried out for the California Community College Chancellor's Office between June and December 2012 (Johnson, A, and Lewis, C., 2012) and based on the GeoTech Center Model Courses and Certificate addressed this issue. The study included faculty and industry panels and reached a consensus that recommended the core should include five courses with an Internship course as a required core course. Note the units are just a suggested minimum). The GeoTech Center then reviewed and updated these recommendations to include:

Five Core Courses:

- 101 Introduction to Geospatial Technology (3 units)
- 102 Spatial Analysis (3 units)
- 103 Data Acquisition and Management (3 units)
- 104 Cartographic Design (3 units)
- 109 Internship (1-3 units)

Recommended Elective Course Options include:

- 105 Introduction to Remote Sensing (3 units)
- 106 Introduction to Geospatial Programming (3 units)
- 107 Introduction to Web Application and Development (3 units)
- 108 Capstone Project - (1-2 units)

One additional elective might include:

- 100 "Geospatial Awareness Course" – a General Education "Spatial Thinking and Geospatial Technologies" course that some students take that leads them to continue on and earn the full certificate (3 units)

Other courses that have been discussed are:

- Introduction to Field Data Collection (GPS) (3 units)
- Unmanned Aerial Vehicle Use (3 to 9 units)
- Advanced Field Data Collection (GPS) (3 units)
- Advanced Spatial Analysis and Modeling (3 units)
- Introduction to Surveying (3 units)
- Computer Aided Design (CAD) course: (3 units)
- Domain specific courses such as those for GeoINT, Crime, Healthcare, Geoscience

It was highly recommended that the 100 Geospatial Awareness course be included as an elective so that students do not loose credits. The Awareness course is an excellent feeder course for programs as it has qualified as a General Education Course and transfers between some two-year and four- year programs in California. Since this review, new emerging

technologies (UAV, Lidar, Big Data) and the increased importance of programming (coding) has somewhat altered the recommendations.

The Model Courses and Certificate resources, while useful for assessing or developing curriculum, can have other benefits including alignment of local curriculum to a nationally recognized standard. This may help students who take courses at more than one institution receive credit for all the courses they take. It may help with articulation of courses between institutions in that each course can be compared using the Program Assessment Tools. It may also provide the basis of testing for students to compare programs, for industry when hiring new employees or assessing current employees for advancement. The Program Assessment Tool can help educators assess their program to identify gaps in the program or to promote their program based on unique offerings or strengths. The competencies might also serve as the basis for creating Badges or Micro-credentials.

It should be stressed that these course recommendations and the certificate are Models and should be localized in consultation with the individual program Advisory Committee. This includes the title of the course and its description.

4.3 Preliminary Updated Recommendations for Model Certificate

The GeoTech Center is currently reviewing skill and competency needs that will be incorporated into updated recommendations for Tools and Model Courses in a Certificate Program. Preliminary findings suggest that industry is recommending that students have more skills in programming and web applications. In addition, remote sensing including Lidar has become better integrated with GIS and important for GST rather than a separate discipline. New technologies, including use of Unmanned Aerial Vehicles (drones) are also becoming important for acquiring data by the workforce. New and immerging technology and applications will be reviewed and included in future updates.

4.4 Pedagogy - Delivery Format for Courses

As to "how to teach" a course or program and what type of delivery should be used (face to face, online, or hybrid), the most important consideration is to provide ample hands on application of the concepts, tools and analysis possible using real-world applications and data by an engaged and dedicated teacher (Yanow, 2011). Rather than the traditional lecture and laboratory structure, it is recommended that lectures are integrated within hands on laboratory activities or online to use face-to-face time for problem solving with the software and discussion. Flipped classrooms where students have the opportunity to engage in discussions and work on hands on problems, helps students learn to problem solve and develop critical thinking skills. Student project work and internships that provide real world, hands on experience and include oral and communication skills are stressed by industry as being as essential as specific geospatial skills and competencies.

It should be emphasized that not all incoming students may need or desire a degree. This is particularly true with working professionals that may already possess a Bachelor, Master or even a Ph.D with several to many years of working experience. This student population may be seeking a place to learn GST for their current position or to shift to a new career path.

Thus, it is advisable that all students taking a "gateway" or introductory course complete a standardized survey assessing their needs and reasons for taking the initial course as well as testing their entering GST skill level. This test can be used to support a success matrix for programs where students successfully move up a career path, but do not complete a typical course sequence leading to a certificate or degree. Repeating this survey and test in later courses will allow faulty to access how much students have learned and any changes they have made in their career pathway after starting the program. If possible, graduates of the program should also be contacted to see if they feel the curriculum provided them with the needed skills. They could provide valuable feedback and make recommendations for changes to improve the program.

5. Implementation Phase

Once the planning phase is complete and the outcomes from the Needs and Resource Assessment are available, work should begin on the creation of an Implementation Plan. This Plan should include:

- Overview of the Program Plan with goals, objectives and activities
- Updated GST Program Logic Model
- "Program Organization" chart outlining roles and responsibilities including who will continue to lead the effort and support the program and any adjustments to the Advisory Committee
- Timeline of Tasks for Implementation including:
    - acquiring needed resources (hardware, software and facilities)
    - steering documents through college administrative approval process for course/program offerings
- Budget – funding to start program (within a department, general college funds from administration budget, state or federal grants such as NSF).
- Curriculum for course(s) and program content based on the advice from the Advisory Committee and using the latest curriculum guidelines for Model Courses and Certificate Programs using the resources and tools available from the GeoTech Center.
- Marketing and Outreach plan and activities including creation and distribution of brochures, program website development, GIS Day activities or other marketing resources and activities.
- Faculty and IT support identified and training provided.

6. Sustainability Phase

Once a program has been launched, the longer-term outcomes should include plans for sustaining the program. The GeoTech Center has identified ways to help promote long term sustainability and has created several best practices documents as resources on its website (http://geotechcenter.org) to help in this effort. There are also articles that address some of

these issues in the December 2010 issue of the URISA Journal (Johnson, 2010) (http://urisa.org/files/URISA%20Journal%20Vol.22%20Issue%202.pdf).

Some of the ways to support program sustainability include:

- Creating articulation between the college and high schools and universities (to increase the pipeline of students interested in GST;
- Having gateway or introductory GST courses approved for General Education (GE) status (see URISA Journal, **Enhancing General Education with Geographic Information Science and Spatial Literacy**, Tsou and Yanow, 2010);
- Increasing the number of disciplines that include a GST option by working with other departments and disciplines to create and add a module demonstrating use of GST in their discipline or by including the gateway or GE course in their program, Or cross-listing a geospatial course between several departments,
- Creating certificate programs that help working professionals acquire technical or conceptual skills leading to successfully passing technical (industry) or professional certification examinations;
- Promote and support use of GST by administration. This can include use for marketing and outreach, facilities management, campus security and campus mapping; and
- Survey outgoing and former students to improve program quality and build reputation for successful preparation of students for the workforce.

Promoting the use of GST by administration has several advantages in helping sustain programs. In a time of budget constraints, GST can help administration make better decisions and save money. This can be through better marketing and outreach such as those practiced by Tacoma Community College http://www.esri.com/library/casestudies/tacoma.pdf, projects to better map and manage campus facilities by the Community College of San Francisco (CCSF) (http://www.esri.com/news/arcnews/spring10articles/taking-efficiency.html). Reliance of administration on the use of GST software and data can lead to the administration covering the cost of those resources and alleviate the need for individual departments to fund those resources. Students can also get practical hands on experience by working on administrative projects and community based projects providing awareness of the GST program and promoting it to other students.

7. Conclusion

It remains a challenge to successfully build, implement, support, maintain, sustain and expand a geospatial program at a community college. Inevitably, questions arise concerning the importance of geospatial technology in academic and CTE programs. Some issues that reoccur as technology and use expands are how to successfully update a curriculum including labs, ongoing professional development for facility, finding qualified faculty to teach new courses, what technology is needed to stay at the cutting edge, how to fund a program, how

to boost enrollments at smaller colleges, and how to work with IT staff just to highlight a few. As more colleges are tasked to provide evidence of academic success, how does a college deal with "non-completers" – that is, those students that only take a few courses to learn what they need to know but have no intention of completing a Certificate or an Associate Degree.

There is no doubt that the impact and demand for geospatial technology will continue to experience tremendous growth in the educational sector over the next decade. Progress continues to be made toward determining the most effective and efficient pedagogical methods to enhance geographic problem-solving and spatial reasoning skills. GIScience has helped to facilitate these skills by providing students with a real-world interface between the technology and the content in a variety of subject areas. It is the GeoTech Center's goal to continue to support educators and community college geospatial technology programs across the country to increase the quantity, quality and diversity of the geospatial workforce. Additional resources have been developed and will continue to be crafted that help support GST programs. This includes GST Concepts and Demonstration videos that can be incorporated into curriculum and used by students via a GeoTech Center YouTube Channel. The GeoTech Center will:

- Work with the DOL-ETA and industry to update the GTCM and Meta-DACUM;
- Update the Model Courses and Certificate and add new elective courses;
- Update the Assessment and Program Content Tools and methodology to use them;
- Create new, full model courses or Certificate programs with teaching resources for ancillary disciplines or workforce domains;
- Create additional Videos accessible on YouTube focused on GST Concepts or Demonstrating various methods and techniques;
- Research and create best practices in pedagogy focused on adult learners;
- Provide faculty development opportunities for updating and advancing faculty competencies in geospatial technology through multiple regional faculty workshops and at the GeoEd conference at Jefferson Community and Technical College in Louisville, KY;
- Develop strategies to increase participation in GST programs for underrepresented populations; and
- Mentor colleges in the use of the Tools and Models to develop or expand a geospatial program.

If you have questions, suggestions or concerns about the content of this document, please contact Ann Johnson, GeoTech Center Associate Director, ann@baremt.com.

References:

- Johnson, A., 2012. Chapter 13 in *Teaching Geographic Information Science and Technology in Higher Education.* Wiley-Blackwell, John Wiley & Sons, Ltd.
- Johnson, Ann. (2010). Spatial Education at U.S. Community Colleges: Background Challenges and Opportunities In Special Education issue of the

URISA Journal, Vol. 22, No. 2, which can be downloaded from URISA at http://www.urisa.org/resources/urisa-journal/ Retrieved Jan. 6, 2013

- Johnson, A., Lewis, C. 2012. Final Report: Model Curriculum Certificate for Geospatial technology Program Development Aligned to Industry Needs. Retrieved from c3gis.net on January 10, 2013.
- Johnson, John. 2010. What GIS Technicians Do: Synthesis of Jobs Analysis. In Special Education issue of the URISA Journal, Vol. 22, No. 2, which can be downloaded from URISA at http://www.urisa.org/resources/urisa-journal/ Retrieved Jan. 6, 2013.
- Samborski, Robert. 2006. In a paper submitted for the Esri User Conference based on the Department of Labor, AAG, and GITA Phase I report: An Executive Summary of the Phase One Report of the Project "Defining and Communicating Geospatial Industry Workforce Demands. Retrieved on January 6, 2013 from http://proceedings.esri.com/library/userconf/proc06/papers/papers/pap_1338.pdf
- Unwin, D., Foote, K., Tate, N., DiBiase, D. 2012. Ed. In Teaching Geographic Information Science and Technology in Higher Education. Wiley-Blackwell, John Wiley & Sons, Ltd.
- Yanow, K. (2010). Retention Survey. Retrieved from http://www.geotechcenter.org/News-Media/News-Archive/Retention-Survey, January 11, 2013.
- Yanow, K., Tsou, M., Yanow, K., 2010. Enhancing General Education with Geographic Information Science and Spatial Literacy URISA Journal, Vol. 22, No. 2, which can be downloaded from URISA at http://www.urisa.org/resources/urisa-journal/